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THE IRRIGATION AGE

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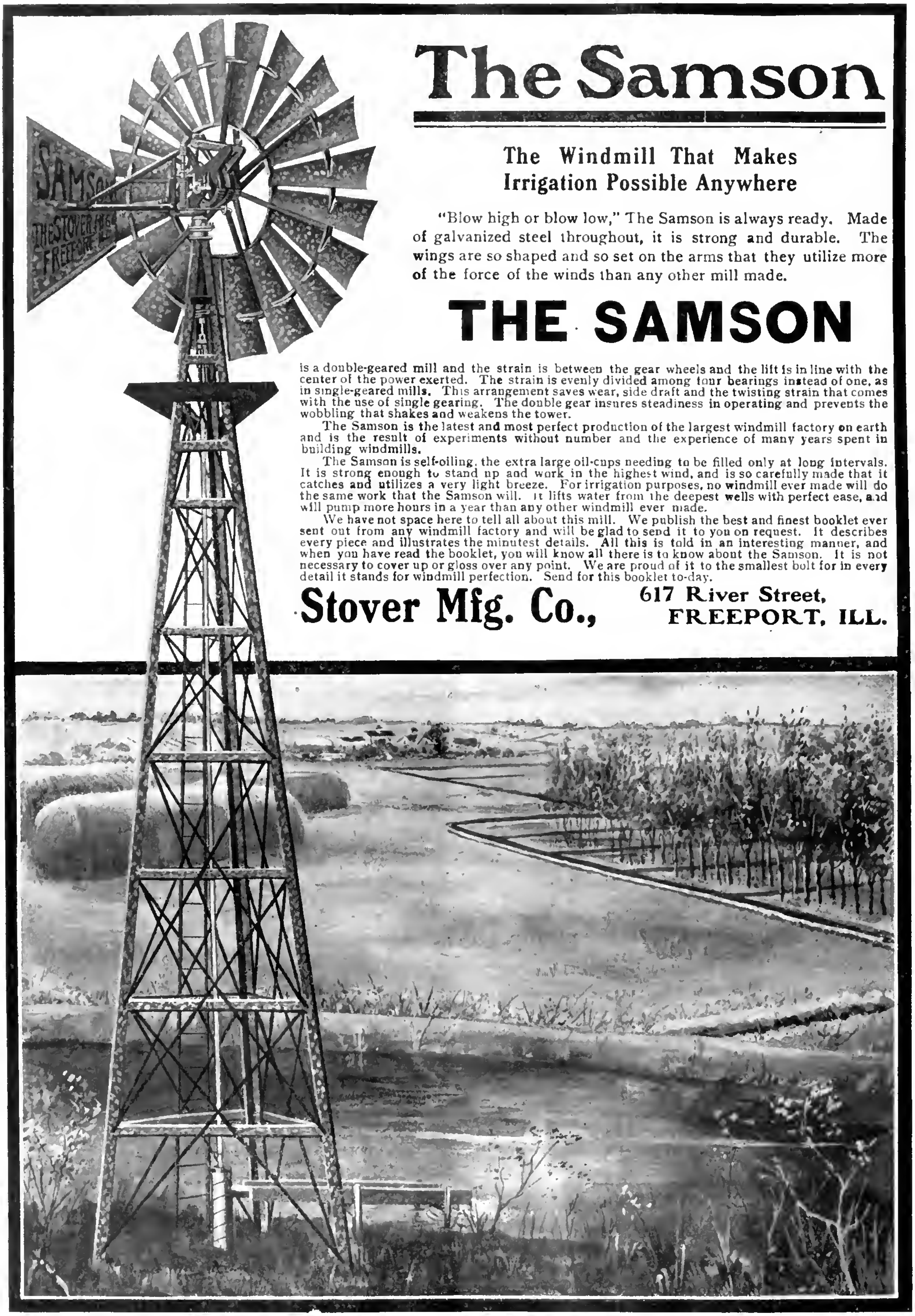
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THE IRRIGATION AGE

VOL. XX — CHICAGO, NOVEMBER, 1904. — NO. 1

THE IRRIGATION AGE

With which is Merged

MODERN IRRIGATION — THE DRAINAGE JOURNAL
THE IRRIGATION ERA — MID-WEST
ARID AMERICA — THE FARM HERALD

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

Twenty Years

With this issue THE IRRIGATION AGE starts in on its twentieth year, this being No. 1, Vol. XX. The publishers are glad to inform all of our readers and friends that the IRRIGATION AGE enters the twentieth year of its existence with better prospects than ever before in its history. A liberal support has been given the publication during the past four years, under the present ownership, for which we heartily thank our advertisers and subscribers as well. We can promise our advertisers to do much better for them in the future in the way of returns and circulation than in the past, as plans are being formed which will materially increase, possibly double, the present circulation.

THE AGE found it necessary during the past several years to devote considerable space to the exposure of individuals who are using the irrigation movement to further their own end. It has as a consequence made some enemies among those whom it has most vigorously attacked, but the majority of our readers are with us in this fight, particularly those who are actual irrigators and home-seekers. This is the class of people whose battle THE AGE will ever wage.

Popluar Where Least Known.

Organized labor, George H. Maxwell and the Los Angeles *Times.* Maxwell stands between the other two. They are pulling in opposite directions. Can he adhere to both and stand the strain? Can he continue to publish his *Talisman*, a paper designed to enlist the support of union labor for his irrigation Tammany, and at the same time continue to send his boiler-plate editorials to the Los Angeles *Times,* as he has for years past, and to throw gorgeous bouquets at himself through the columns of that paper? It seems that the labor organizations, which in the past have been willing for him to formulate resolutions for them on questions of public policy and have permitted him to levy tribute on their membership, would now be moved to inquire into the nature of his affiliations where he has spent the most of his life. Such an inquiry might discover some of the reasons for the fact that he is most popular where he is least known.

$500 Profit Per Acre.

THE IRRIGATION AGE recently received a box of fine large onions, of the Spanish variety, which were grown in the Mesilla Valley at the Agricultural Experiment Station, Mesilla Park, N. M., by the aid of well water, or by irrigation by pumping. The yield of these onions per acre, without the application of fertilizers, was 31,250 pounds; the cost of irrigation per acre, $15; gross receipts, at 2¼ cents per pound, for the crop were $703.12½, and the net receipts per acre $500.

It will be seen from this that pump irrigation is a profitable industry in the Rio Grande Valley in New Mexico and is proving profitable wherever tried in the Southwestern country. If a profit of $500 per acre can be earned where it is necessary to pump water, as is done at the experiment station at Mesilla Park, it can readily be seen that a much greater profit may be obtained where the landowner has an artesian well, where lifting of water to the surface is not necessary.

Those interested in the this subject will secure further information by addressing Prof. J. J. Vernon, New Mexico College of Agriculture, Mesilla Park, N. M.

Twentieth Century Watchwords. Irrigation and Diversified Farming are good twentieth century watchwords. They stand for progress. The thousands of farmers who are seeking new homes and the thousands more who remain in the older settled States should keep these watchwords in mind and give them application in their agricultural labors. They should also be fostered by capitalists and manufacturers everywhere.

The continued prosperity of this country depends in no small degree on making the small farms and the old farms more profitable and attractive. Farm life can only become interesting to young men as the labor is lightened and the profits increased. Hence the need of diversification and a greater degree of certainty in crop production. Without irrigation there is sure to be disappointment.

Men who are choosing new locations ought, in justice to themselves, to at least consider those localities where irrigation has been adopted on a liberal and intelligent scale. Furthermore, capitalists ought to be more liberal and enterprising in aiding irrigation projects than almost any other line of human endeavor. Such investments are reasonably safe and will have a far-reaching effect on the nation's welfare and progress. If the agricultural class is to keep pace with the world's progress it must adopt modern ideas and discard many of the old methods of farming. The one-crop plan has had its day. Mixed farming is the new order, and irrigation is the first great essential next to the possession of the land.

Unoccupied Land in America. The expansion idea of the National Government is heartily approved by a majority of our patriotic citizens. It is the statesmanship of today applied to what will be urgent necessity in the future. Such statesmanship is of the broadest and soundest character. This nation's greatness is always increasing. It is always comparative. While The Irrigation Age is an earnest advocate of the policy of national expansion, as it is expressed politically, it seems timely to call the attention of capitalists, as well as homeseekers, to the fact that there are still vast areas of unoccupied land in America.

In the clamor for expansion beyond the seas we are too apt to overlook some of the great opportunities at our very doors. Nearly every section of this continent extends flattering invitations to settlers. This is as true of the Northern as of the Southern States.

There is a quiet but continual sale of farming lands in the northern part of Wisconsin. The transfers of these lands have been enormous in the aggregate during the last two years. The buyers are mostly farmers who have been renters in the older States. In most cases they are men of ripe experience and possess sufficient capital to enable them to start nicely in their new locations. Their good character, capital and skill will work miracles in northern Wisconsin, just as these essentials have reclaimed the Western prairies within a dozen or twenty years.

The population of northern Wisconsin is being augmented about as fast as that of Minnesota, the Dakotas, Montana, Idaho, Washington, Oregon, Wyoming and Utah. In a few years more all of these localities will resemble the older and wealthier States. Perhaps the new South and Oklahoma and Texas are gaining faster than any Northern States, and, of course, offer opportunities for investment and industry which are unsurpassed.

The most cursory view will convince the interested observer that he does not have to leave the United States in order to obtain a cheap farm or secure any of the advantages which are usually found in a new territory. There are still millions of acres of choice land, both north and south, which may be obtained at a price so low that the poorest citizen is able to become the owner of his home and the tiller of his own farm.

These fields are equally inviting to capitalists. No class of security is safer for investors than agricultural lands. The small towns which develop in a new country also offer innumerable good opportunities for capitalists, merchants and mechanics. The men first on the ground reap the most substantial harvests, provided they have the patience and good sense to stick, despite the early discouragements which are common to the frontier.

LEADING IRRIGATION JOURNAL.

A recent issue of *White's Class Advertising* has the following to say concerning this journal:

The Irrigation Age, now nearing its twenty-first birthday, lays claim to being the pioneer journal of its kind in the world and the leading representative of the irrigation and drainage industries, Western resources, agricultural, mineral and industrial development. Its circulation is greater than the combined circulation of all other irrigation journals. Within the past two years *Modern Irrigation, The Irrigation Era, Arid America*, all formerly published at Denver, *The Drainage Journal* of Indianapolis. *Mid-West* of Denver, and the *Farm Herald* of Denver, have been merged with The Irrigation Age, thereby very materially strengthening it in every way.

ENCOURAGE IRRIGATION BY OPPOSING THE REPEAL OF THE DESERT AND OTHER LAND LAWS.

Speech of Hon. F. W. Mondell, delivered at the National Irrigation Congress at Ogden, Utah.

We shall best serve the West and most speedily accomplish its development through the reclamation of its arid lands by encouraging irrigation along all lines and by means of all available agencies. The conditions surrounding our arid lands are so infinitely diversified that no one agency, no matter how effective, no one law, no matter how comprehensive, can, by any possibility, accomplish the reclamation of all our irrigable territory.

The question of the reclamation of arid America to the fullest extent possible necessarily includes not only the consideration of the large and expensive projects which will be undertaken under the national irrigation act, but as well of enterprises large and small under the provisions of the Carey act in the States where that act is operative, and the countless projects developed by individual and co-operative effort, often for the reclamation of a very limited acreage, but in the aggregate constituting a large proportion of the reclamed area of the country.

The national irrigation law, we confidently believe, will prove in its workings what its supporters claim it to be, the most important legislative aid in Western development since the passage of the homestead law; but no one conversant with conditions in the arid States imagines that the complete reclamation of the West by irrigation can be accomplished through this agency alone; on the contrary, side by side with the work of the national reclamation service must proceed the work of individual, co-operative and corporate enterprise. In fact, one of the most hopeful phases of the national irrigation movement, as I see it, lies in the impetus and encouragement which it has already given and will give to private enterprises in irrigation development.

There never has been a time in my State when irrigation reclamation by private enterprise has been as active as it is now and has been since the passage of the national law. A number of enterprises under the Carey act are progressing favorably, and innumerable projects for the irrigation of small tracts are being carried forward by individual enterprise, and this diversified development will go on without conflict and without complication, each agency in the grand work of reclaiming the desert performing the part within the limit of its ability and the legitimate scope of its operations.

Recently we have heard considerable of an organized agitation for the repeal of certain of our land laws—among others the desert land act—but, so far as I have been able to determine, but little of this agitation has come from the States to which this act applies, or from those that have the best opportunity to know of its workings and have no personal or pecuniary interest in its repeal, and I am of the opinion that the movement for the repeal of this law, which includes also an effort to repeal the timber and stone act and the commutation clause of the homestead act, will find scant support in the West, particularly in the intermountain States.

Under the desert land law more land has been reclaimed from desert and made fruitful than under all the other land laws, and beyond all question its repeal would greatly retard Western development by irrigation. Scattered all over the arid States are innumerable tracts of from a score to two or three hundred acres possible of reclamation from springs, small streams and, to a vastly greater extent, by the impounding of flood waters. I have in mind scores of cases within the past few years, remote and isolated tracts, having no visible water supply, and in their natural state valueless, that have been reclaimed and transformed into verdant and productive fields and made the seat of prosperous and happy homes by the impounding of the storm waters of some dry gulch or drainage basin. This class of development can be best carried on under the desert land law, for the conditions surrounding such enterprises make a continuous residence from the initiation of the enterprise, as would be required under the homestead law, impossible; but the work completed, the water diverted or impounded, the establishment of a home is inevitable.

An entry under the homestead law, perfected after five years' residence and complete compliance with all of the present requirements of the land office, may, at the end of that period, and often does, present nothing but the dilapidated fragments of a claim shack and a disfiguring weed patch, whereas a perfected entry under the desert act, with anything like even a partial compliance with the provisions of the law, must and does present a beautiful picture of verdure and home life in the midst of aridity.

It is no argument against the desert land law to say that, years ago, when the law permitted the entry of 640 acres, before the value and necessity of irrigation were appreciated, considerable tracts of land were patented under the desert land act without complete reclamation. Today, under the limited area of entry allowed, with more intelligent administration, it is well nigh an impossibility to make proof on a tract of desert land without at least making a reasonable provision for its permanent reclamation.

No law on the statute books is surrounded with so many safeguards as the desert land act. With regard to none of the land laws are the rules and the regulations of the department so stringent, so constantly operating upon the entryman, so well calculated to discourage and prevent the acquirement of land without full compliance with the law.

Assurances of the complete and permanent reclamation of the tract entered under the desert land law depend largely upon the State statutes under which the water rights are acquired. If the State law defining the character of a water right, if the State provisions relative to the steps to be taken to acquire the same are lacking, loose, uncertain or illy defined, it is extremely difficult for the federal officials charged with the enforcement of the law to determine whether the entryman really possesses a permanent water right for the irrigation of his tract. But in States in which the character of water rights is clearly defined, the procedure for the acquirement of the same is definite and there are proper administrative officers, the officials of the general land office can demand an official showing from the entryman as to his water right, which, in addition to the other requirements of the law, renders the acquirement of title to a tract of desert land without provision for its permanent irrigation well nigh impossible.

Repeal the desert land act and you take from the statute books the only law under which, by individual and co-operative effort, the multiplied thousands of opportunities for the irrigation of small tracts are made available.

At a meeting of irrigationists it would not be proper to consume time with a discussion of the questions involved in the proposition to repeal the timber and stone act and the commutation clause of the homestead act, except in so far as such action might affect irrigation development. Inasmuch as these laws, however, have furnished a major portion of the national irrigation fund, the question of their repeal is pertinent, for their repeal would amount to the same thing as the repeal of the national irrigation act.

The idea of the repeal of the timber and stone act carries with it the theory of a gigantic permanent Government timber monopoly. It is proposed that the Federal Government shall retain all public lands containing timber, regardless of the kind or quantity, and engage in the wholesale business of selling timber in lots to suit the purchaser. He who can contemplate such a bureaucracy, with its irritating and vexatious regulations, its enormous machinery of administration and its opportunities and probabilities of peculation, with cheerfulness and confidence is much more optimistic than I am. The price paid for land under the timber and stone act, in the intermountain States at least, generally measures its full value, and in many cases is more than the land would bring if in private ownership. It would, in my opinion, be well to amend the law so that the price everywhere may be approximate to the value of the land, for the timber land of the country which for any reason may not properly be included in forest reserves should be considered an asset of the irrigation fund.

The repeal of the commutation clause of the homestead law would, beyond all question, retard settlement and development in the West. The homesteader, under the conditions which surround the major portion of the vacant public lands today, stakes his homestead right, his desire for a home and his labor against the perils of the enterprise, and the repeal of the commutation clause of the homestead law would discourage and prevent settlement, because it would take from the intending settler that partial insurance against total loss, should sickness, death or shortage of crops render it impossible for him to maintain a continuous residence.

To the membership of this congress, interested as we all are in the success of the national irrigation act, the agitation for the repeal of these laws constitutes a most serious menace, for they are the sources from which flows nearly three-quarters of all the irrigation fund. At the close of the last fiscal year there was in the treasury of the United States, to the credit of the irrigation fund, in the neighborhood of $16,000,000. During the three years during which the irrigation fund was accumulating, the proceeds from the sale of lands under the laws in question were as follows, making a total from these source of $13,043,828.16:

	Commuted Homesteads.	Desert Land Entries.	Timber and Stone Entries.
1901...	$ 820,782.10	$ 324,376.04	$ 992,144.93
1902...	1,290,506.80	443,067.00	1,363,166.41
1903...	2,874,793.37	520,979.60	4,413,911.91
	$4,986,182.27	$1,288,422.64	$6,769,223.25

Total, $13,043,828.16.

If these laws had been repealed at the time the national irrigation act was passed, we should have in the reclamation fund today, not $16,000,000, but instead something over $3,000,000.

The fear has been expressed that public land was passing into private ownership so rapidly that little public land would be left in a few years for reclamation under the national act. There need be no uneasiness on this ground. Uncle Sam still owns, within our continental boundaries and exclusive of Alaska, over 500,000,000 acres open to settlement and entry, besides 61,000,000 acres contained in forest reserves and about 60,000,000 acres contained in Indian reservations outside of Indian Territory. The land still open to settlement and entry constitutes a territory over five-eighths as large as the entire acreage which we have disposed of under all laws since the foundation of the Government, and is equal in area to the thirteen original States of the Union and Kentucky, Tennessee, West Virginia, Ohio, Louisiana, Indiana, Mississippi, Illinois, Alabama, Missouri, Arkansas, Michigan, Wisconsin and Iowa.

Even though some tracts may pass into private ownership which it may be found wise and proper to irrigate under the national irrigation act, still such transfer need in no way affect such reclamation, for the provisions of the national act relative to the reclamation of lands in private ownership are complete, and the reclamation service is already contemplating extensive operations under these provisions.

There is another feature of this case which appeals to those of us who had something to do with the passage of the national irrigation act, and should appeal to all those citizens and organizations who urged and promoted that measure. The law was passed and much support obtained for it with the understanding and belief that the West would be reclaimed, so far as national undertakings were concerned, with the proceeds of the sale and disposition of the public lands. The law so provides, and I am not prepared to admit that the enactment was not in good faith; and yet certain gentlemen propose legislation which would either make the law inoperative or compel us to seek direct appropriations from the federal treasury.

When the national irrigation law shall have been in actual operation for a term of years, when there shall begin to roll into the treasury returns for the expenditures made, sufficient to insure that through these sources the fund may be kept intact, when there shall be danger of an actual scarcity of enterprises to be undertaken, instead of an embarrassing and bewildering abundance, as at present, then we may possibly, with propriety and reason, discuss the repeal of some of these laws. In the meantime let us labor for their honest enforcement and welcome that demand for lands which is peopling the West, developing its resources and pouring ducats into the national irrigation fund.

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, courtesy U. S. Department of Agriculture.

CLEARING AND LEVELING LAND IN WASHINGTON.

Land in the Yakima Valley is covered with sagebrush and is usually rough. If greasewood is found mingled with the sagebrush to any considerable extent the land is regarded with suspicion, since this brush is looked upon as an index of the presence of injurious alkali in the soil.

The roots of sagebrush are all near the surface and the earth about them is loose, so that the removal of the brush is not difficult nor expensive. It is grubbed with a sharp mattock which cuts the roots below the surface of the ground. The usual cost of clearing the land by hand work, including burning of the brush, is $3 an acre, though during the winter, when labor is plentiful, it is sometimes done for $2 an acre.

Home-Made Lateral Plow at Right—Front View.

Another plan for clearing the land of brush consists in drawing a railroad rail across the field and doubling back over the same tract. This pulls many of the bushes and loosens others, so that the subsequent work required is much lessened. This plan is not regarded as reducing the cost of the work materially, but it is more expeditious than the first. The loose brush is drawn into windrows with a sagebrush rake and burned. The rake has strong teeth about two feet long made of 2 x 4-inch scantling. The brush is sometimes used for covering stretches of sandy road, greatly improving their condition as soon as the brush is once crushed into place by travel.

The leveling of the land is a work involving more time and expense than anything else connected with the starting of a new place. Much of the land consists of alternate humps and depressions of from one to three feet in height or depth, not infrequently with knobs of larger dimensions. Few implements are required for this leveling, the plow and the buck scraper being chiefly used. The work is often done by contract, $15 an acre being a common price for the leveling of land not so rough that it can not be readily "bucked" off. The buck scraper is a most effective implement for moving loose or sandy earth where the haul is short. Its simplicity and cheapness also commend it to the farmer and contractor. In its simplest form it consists of a plain scraper made of 2-inch plank having a steel shoe on the cutting edge, and a tailboard for holding it in position while filling and also for controlling the angle of the scraper for the purpose of leveling the earth as it is dumped. The size commonly used for four horses is eight feet long and two feet wide. It is securely ironed with strap iron and bolted together. The cost of a scarper of this size is $14. An improvement consists of a tailboard equipped with a lever, by means of which the load may be dumped and scattered or spread. These scrapers are made of different lengths up to twenty-four feet, the latter size requiring six teams to operate.

Some skill is required for this work. The prepared surface should be even—that is, free from hollows and humps, so that when water is turned in at the head of the furrow it will flow across the field without forming pools; and the slopes should be as uniform as practicable. Much labor and inconvenience in irrigating can be avoided by making the leveling as perfect as possible. Before it is considered finished, water is sometimes turned upon the field and its surface practically tested for uneven places, and additional grading done afterward where shown to be desirable. An ideal field is one which slopes gently and uniformly.

REMOVING SAGEBRUSH IN SALT LAKE BASIN.

If the brush is not more than three feet high it can probably be loosened most easily by plowing the land in the early spring when there is sufficient moisture in the soil to favor easy plowing and when the roots are filled with sap and can be cut easily. It can then be collected in piles or windrows by means of a hay rake, or a harrow, and burned. It is probable that two plowings will be necessary for a complete removal of the brush and a sufficient loosening of the soil to permit of crops being planted.

In case the brush is too large to permit of the land being plowed before it is at least partially cleared, some farmers irrigate the land, which decreases the growth or deadens the brush, and in some cases kills it entirely. This also produces a ranker and more abundant growth of grass and weeds. After these have been well dried fires are started and the brush is burned off, after which the plowing can be easily done.

Where the brush is very large and it is desired to remove it at once this may be done by means of a railroad rail, as described above. Most of the brush is pulled up and the rest is broken down so as not to interfere seriously with the subsequent plowing. The part pulled up is piled and burned and that remaining is plowed up.

After the land has been cleared it must be leveled so that lateral ditches can be properly constructed and irrigation easily accomplished. Where the inequalities are but slight a wooden framed harrow turned crosswise and upside down is drawn over the field. In this way some of the soil is taken from the knolls and ridges and deposited in the low places. Sometimes the driver rides the harrow in order to assist in collecting the soil from the knolls and steps off when a low place is reached.

The same purpose is sometimes accomplished by means of a leveler made by fastening a tongue into a log six inches to one foot in diameter. This is used in the same manner as the harrow, and with about the same result, except that the work is accomplished in less time. If the inequalities of the surface are considerable and the soil is deep, scrapers are used.

If the soil is shallow and the value of the land is high, the upper layer of soil is removed from a strip about fifty or sixty feet wide and put in piles near by, after which the lower and poor soil is scraped into the depressions. The soil first moved, together with the upper soil on both sides, is then scraped into the excavation and the underlying poor soil is taken to the low places. The better soil which was scraped into the excavation is then evenly distributed over the surface of the poorer soil exposed.

Water is sometimes used as a leveling agency. Laterals are made on the ridges and the water is allowed to flow toward the depressions or swails, where it deposits its sediment. In case the hollows are steep they are obstructed by manure dams and the sediment is held by them. Crops are produced during the time the leveling is being accomplished, so that this method is comparatively cheap.

PREPARING LAND FOR IRRIGATION IN COLORADO AND WYOMING.

Sagebrush can be killed by copious watering, and it has been a common practice for farmers to destroy it by irrigating the land. As a rule, one season's soaking will kill it. The roots and the dead plants can be removed more easily than the living sagebrush. This practice is less frequently resorted to each year, since water is becoming too valuable to use for this purpose.

If the sagebrush is large, tough and deep-rooted, grubbing by hand with grubbing hoes may be necessary; but ordinarily a heavy plow can be used to loosen if not altogether uproot both sagebrush and greasewood. In contract work it is estimated one man can grub or clear one acre a day, and an energetic man under ordinary conditions should be able to grub two acres a day with the aid of a team and plow.

After land has been cleared of brush the most important requirement is a thorough grading of the land to be watered. The freer from humps and depressions the surface of the ground the more uniformly will water flow over it. The injurious effects of attempting to spread water over uneven surfaces are soon apparent. Water settles in the low ground, waterlogging the soil and drowning out the plant life, while an insufficient supply reaches the higher elevations, leaving the crops to burn up. When once the surface is properly graded one man can apply the water to every part of a field with greater rapidity and effectiveness than two or three men can irrigate a like area where the slopes are rough and uneven. Grading should usually be done after the laterals have been made, as it will be found that less grading will be required than in reducing a whole farm to a uniform slope. Too much stress can not be put upon the importance of grading the surface of the field between the laterals at the outset. The improvement is a permanent one, and the time and labor spent will be repaid many fold.

The ordinary means employed for leveling the surface of fields is deep plowing, followed by harrowing, after which the use of a grader or drag will reduce the humps and leave the excess soil in the depressions. On some of the larger farms common road scrapers are used. On other farms ordinary railroad rails and drags of homemade design are used.

In building laterals the first thing to be considered is the lay of the land over which the water must be made to flow. Judging the true slope of ground by the naked eye is very uncertain, for even the most experienced are often deceived as to whether the surface of the land rises or falls in a given direction. Where possible, every system of laterals should be laid out with an engineer's level and a contour map made of the whole area. In lieu of the services of a surveyor the irrigator may lay out his own laterals, using one of the many types of homemade leveling devices. The average grade for field laterals should vary from one-half inch to one inch per rod, depending upon the nature of the soil.

No special devices are manufactured and put upon the market for building laterals, and farmers have been obliged to depend upon their own ingenuity. The following device was constructed to simplify the work of excavating ditches: Two steel-beam plows, one with a right and the other with a left share, were placed side by side and their beams riveted together. The shares of the plows were spread to give the furrows a width of two feet on the bottom. The rear ends of the shares were rounded instead of being drawn to the usual point. Above the moldboards of the plows, and riveted to them, were placed the right and left moldboards of old alfalfa plows. (Fig. 1.) The handles bolted to the lower moldboards were spread wider than in the ordinary plow and braced to beams.

The beams running side by side were bent apart toward the end, affording an opening wide enough to insert a 4x4-inch timber two feet long, which is bolted in place and on which the clevices are fastened.

This plow is drawn by four to eight horses, according to the character of the ground and depth of lateral to be made. In one operation it turns two furrows to opposite sides of the ditch and throws them high on the banks, leaving an unusually clean bottom about two feet in width. Many plows of different sizes similar to this, made entirely on the farm or with the help of the village blacksmith, may be seen about Greeley, Colo.

Another homemade furrowing device is the so-called "A," which is drawn through an ordinary plow furrow and crowds the loose earth to the sides. No description of this implement is necessary, as it is used quite commonly throughout the West.

LAYING OUT LATERALS.

In laying out a system of laterals to serve a farm of, for instance, 160 acres, it is important for the future saving of money and labor to run the main lateral along the highest portion of the farm, in order to command the greatest irrigable area. This sounds so reasonable it seems scarcely necessary to mention it; yet, unfortunately, many an inexperienced irrigator upon taking up a new tract of land may see in the area of his farm certain broad fields of gently sloping ground so pleasing to the eye that his very first impulse is to run a lateral from the nearest point in the main canal to the choicest piece of ground, altogether overlooking or not duly considering the worth of less favorable ground, thereby leaving excellent pieces of land high and dry above his main lateral. When the time comes in which he finds it will be profitable to expand the cultivated portions of his farm and to put every square foot under irrigation, then, instead of supplying the fields he wishes to water from his main ditch (perhaps passing near by), he discovers the necessity of going to his original source of supply and building another ditch, often paralleling his main laterals, but on high ground. If the original laterals had been properly located, instead of being obliged to build a new main ditch large enough to carry a sufficient supply for his whole farm he could have simply extended sublaterals from the main laterals already commanding his farm and proceeded to reclaim whatever part he wished of the unbroken area.

In Wyoming and northern Colorado many an irrigator can be found who realizes the advantage of having his laterals laid out with a surveyor's level in order that when the time comes to construct his ditches they may command the greatest area at the least cost and be permanent. The most emphatic advice given by old irrigators is, "See that your laterals are laid out to the best advantage at the outset and that your fields are thoroughly graded." The old adage that "work once well done is twice done" can be applied with no stronger significance than in preparing fields for irrigation.

COST.

The cost of preparing land for irrigation varies with the condition of the ground and the price of labor. An approximate estimate, including the cost of removing sagebrush, plowing, harrowing and grading, has been made from information obtained from the farmers in southern and middle Wyoming. The cost of grubbing sagebrush is based upon the supposition that one man can grub an acre a day. The contract price for such work is $1.50 an acre, based upon the fact that the usual wage paid farm hands in Wyoming is $30 a month with board, which is considered equivalent to a wage of $45 a month.

The cost of grading land depends upon the condition of the surface, but after thorough plowing and harrowing $1 per acre for grading would probably cover the cost in most cases. Thus to prepare land for irrigation the cost would sum up as follows:

	Per acre.
Grubbing sagebrush	$1.50
Plowing	2.50
Harrowing	.50
Grading	1.00
Total	$5.50

(To be continued.)

Home-Made Lateral Plow—Rear View.

THE LEWISTON-WAHA LAND WATER & POWER COMPANY'S PROJECT.

A PROMISING ENTERPRISE.

E. W. HART.

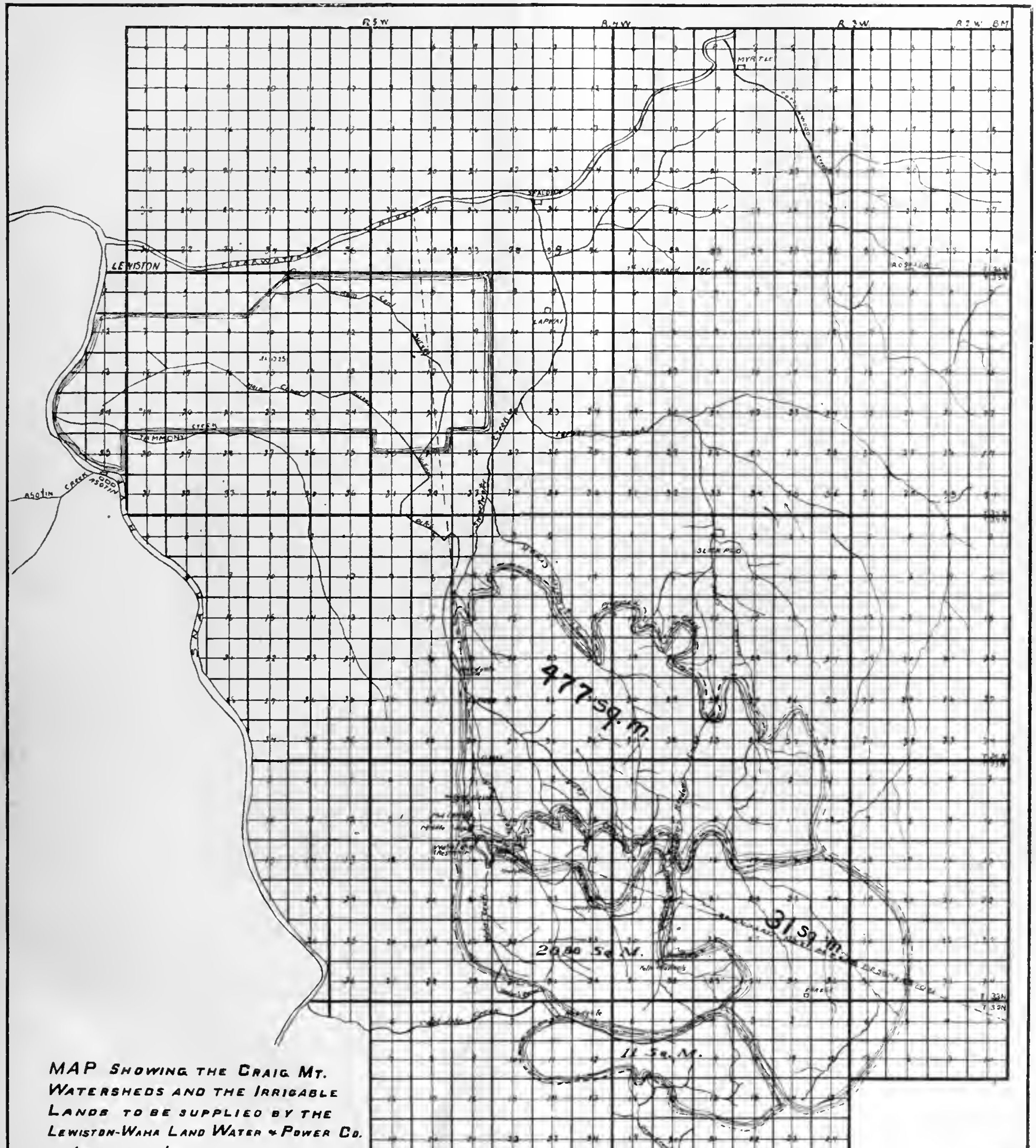
It is doubtful if there are many of the citizens of the central or eastern States who have even a glimmering of what irrigation means to this country, notwithstanding the fact that the subject has been largely exploited and advertised throughout these sections. West, which were intended to educate our readers in the central and eastern States along the right line, so they may better comprehend the situation, in case they contemplate moving into the West where they would would make a livelihood along the line of irrigation farming, or have an idea of reaching out into this rapidly growing section of the country along investment lines.

Among the many projects which have been in-

WAHA LAKE RESERVOIR, Lewiston-Waha Project

To the ordinary individual this seems a strange condition when the eastern and central States are bound to benefit by irrigation as much as those of the West. Irrigation is a large subject. It comprehends a vast amount of health, wealth, energy, happiness, economy and power. It means conquest of a fascinating sort. There is life, activity, humanity in it.

Farming has become a combination of work directed by business ability and science and this applies just as strongly to irrigation as to ordinary farming. THE IRRIGATION AGE has at various times published descriptive matter concerning projects throughout the vestigated by this publication during the past years is that of the Lewiston-Waha Land, Water & Power Company, of Lewiston, Idaho. This company was organized for developing water in the Craig Mountains by ditches so located as to gather the various branches of creeks on the mountain and store the water in Waha lake, from whence it is to be conveyed to the mesa lands in the vicinity of Lewiston, which is a city with a population of 8,000 at this time. Vineland, which is located directly across Snake River from Lewiston, is one of the best known irrigation projects in the West today, owing to its rapid and healthy de-



Lands Bounded by Dark Lines Adjoining the Snake and Clearwater Rivers and Adjacent to Lewiston, are the Lands to be Irrigated by the Lewiston-Waha Land, Water & Power Co.

velopment; was six years ago a sage brush plain. It has today 3,200 acres under water with a population of 3,500. Lewiston is located at the terminus of a branch of the Northern Pacific railway, running south from the city of Spokane, and will be an important point on the projected Northern Pacific cut-off which will run from Missoula, Mont., through the Lolo Pass and down the Clearwater River on to the Pacific coast. It is also so situated that by lines of water transportation its products can be conveyed down the Snake River to the Columbia and down the Columbia River to the Pacific Ocean. Around this city are some of the best developed irrigation farms in the world, where fruits as fine as any raised in the famed Snake River valley are produced in large quantities.

Lewiston, Idaho, is one of the oldest and richest towns on the Pacific coast, and has been built up and for much of the fruit. Most of the fruit, however, is shipped to the large mining towns of Montana, and to the cities of Dakota and Minnesota, British Columbia and Manitoba, where very good prices are obtained. This point being so much nearer than California, and the earliest in the maturing of fruits and vegetables of any point in the Pacific Northwest, they easily command the markets to the north and east. Canneries and pickle factories use the surplus. Several million bushels of wheat are marketed at this point, being bought in and shipped to the coast. Big flour mills will soon consume a large share of it. Some 10,000 head of cattle are sent out yearly; 500 carloads of fruit; 500,000 pounds of wool, etc. With the completion of the Missoula-Lewiston line of the Northern Pacific railway choice fruits and vegetables will reach the mountain towns of Montana in eight to twelve hours.

Soldier's Meadow *Creek*, One *Supply Stream*, Lewiston-Waha Project.

wholly by the trade of the great territory of which it is the natural commercial center, by reason of its location at the junction of the rivers. The opening of the great Nez Perce Indian reservation six years ago and the operations of the Vineland Company have quadrupled its population in that period. It has four banks, two newspapers, United States landoffice, State Supreme Court, county seat, State Normal School, etc. So great are the natural advantages of the location that Lewiston-Clarkston is certain to become an important railroad center, and the entire Lewiston valley is none too large for the one great town of the near future. Lewiston-Clarkston is one town commercially. Ninety per cent of the merchandise, banking and shipping business of all that region is handled at Lewiston.

Aside from the considerable home market, there is ample demand in the near-by mining towns and among the hill ranches for all the vegetables grown,

It is also in the heart of an excellent mining and timber country, it having been estimated that one hundred and fifty millions in gold have been taken from the mines in this vicinity and there are eight billion feet of white pine on the upper Clearwater, which must necessarily me handled at Lewiston.

The Lewiston-Waha Company has during the past year made surveys of Waha Lake basin and certain ditch lines, including the main canal to its irrigable lands, and in a report which was submitted to the company by Mr. James D. Schuyler, of Los Angeles, Cal., one of the best known hydraulic engineers in the country, he states: "In the area bounded on the west by the Snake River and on the east by Sweetwater Creek, extending from Tammany Hollow northerly to the Clearwater River, there is to be found more than 25,000 acres of choice agricultural land, lying in a succession of terraces of from 200 to 1,000 feet each. This land is mostly cultivated by 'dry farming' and raises fair crops of grain with no other moisture than the natural rainfall. The soil is mellow, friable loam, easily cultivated, free from a tendency to bake when wet, and very fertile when water is to be had for irrigation." It is identical with the soils similarly situated through this country which have been found particularly well adapted to the culture of deciduous fruits and berries, especially cherries, peaches and grapes.

The elevation of Lewiston is 647 feet above sea level, being the lowest point of elevation in Idaho. The natural rainfall at Lewiston, according to statistics printed by the United States Weather Bureau, is 14.2 inches. It is a frequent occurrence to harvest grapes in Lewiston Valley as late as November 24. Tree planting is carried on throughout the entire winter and strawberries are harvested as early as April 10, the climate being similar to that of Norfolk, Va.

A remarkably successful demonstration of the productiveness of this class of land has been made directly across Snake River from Lewiston at the thriving colony of Vineland. This colony of 3,200 acres is divided into tracts of two and a half to ten acres, and is practically all planted to orchards and vineyards, the oldest of which are now six years old, and producing crops which have netted their owners as high as $200 per acre. These tracts have sold at prices ranging from $125 to $400 per acre, for the raw land, with water delivered, while the improved lands with bearing orchards are now valued from $800 to $1,000 per acre. The results achieved in Vineland have stimulated a desire to duplicate these conditions on the Lewiston side of the river, where the natural situation is even more favorable. The improvements at Vineland have practically doubled the assessed valuation of property in Asotin County."

The Lewiston-Waha Company has secured options on a sufficient area of this land to make sure of at least 30,000 acres of what is, as above stated, under cultivation at the present time and produces good crops under "dry farming."

In all irrigation projects the main thing to be determined is whether the land in question is susceptible to irrigation and whether or not there is sufficient water available for that purpose. Craig mountains, from which the water supply is obtained, are an isolated range of mountain-plateau, some sixty miles long, by about twenty miles in average width, having a general summit elevation of about 4,800 feet above sea level. This mountain mass is said to be the storm center of this region, where the total snow fall in winter sometimes reaches as high as fifteen feet, and generally lies two or three feet deep all winter, and the rainfall in summer is frequent and abundant, the mountains being covered with a thick growth of the finest timber.

This is a Representative Cherry Orchard in Lewiston Country, Six Years Old From Planting. Value, $1200 *Per Acre.*

This range is drained on its northerly side into Clearwater River by Soldiers Meadow, Sweetwater and Mission Creeks and their numerous tributaries, which unite and form Lapwai Creek before reaching the Clearwater, and on the southerly side by Capt. John Creek and Deer Creek, the latter tributary of Salmon River. On the most westerly fork of Sweetwater Creek is located Waha Lake, a beautiful body of clear water, some ninety feet deep, 82.7 acres in area, entirely enclosed by high hills, whose slopes reach down to the water line. This body of water is clearly shown in our ilustrations. The surface elevation of Waha Lake is 3,200 feet above sea level. It was this lake that first suggested the Lewiston-Waha land and water enterprise on account of its lying so much lower than the bulk of the mountains that several streams of considerable size may be diverted into it by ditches, thus converting the lake into a storage reservoir of great capacity.

The surveys made show that a tunnel 2,600 feet long will tap the lake at or near the bottom. This tunnel will be eighty-five feet below the normal water level, and about 190 feet below the lowest rim of the lake basin. In addition to the streams mentioned on the Craig mountains there are a number of large springs in the vicinity of Waha Lake whose waters are available for irrigation. One in particular, which lies directly below the lake, flows 1.5 second feet; the second, the Goddard spring, located on the Goddard ranch, half a mile below the upper spring, flows about four second-feet at the present time, and the third spring, a short distance from the others, flows approximately four second-feet. The discharge of these springs for a constant supply of water can not be overestimated.

it may be said that John Riggle, of Clarkston, who recently moved into that section from the East and purchased the Brooks place in the southern part of Vineland, has made a record in fruit raising. This tract contains three acres for which he paid $1,757.50 a year ago. A Lewiston paper states that this summer the place averaged $607 per acre, or $63.50 more than the cost of the land. From one and three-sixteenths acres, which was mainly set out to berries, although it contains some peach trees, Mr. Riggle sold during the past season $721 worth of berries, which with the peach crop would bring the amount to $750.

This will give our readers some conception of what may be done with a small tract where the land is fertile and water available as it is in this locality. It is always a surprise to people unacquainted with the climate in the valley of the Snake River and Clearwater River in Idaho to be told that the tender foreign varieties of grapes grow there in as great perfection as they do in either California, Europe, or Asia. This surprise is often so great that it degenerates into

LANDS IN CULTIVATION ACROSS T
Six Years Ago This Tract Was a Sage Brush Plain. It is Now

On this account it is estimated that it will be possible to save and utilize with canals properly designed and constructed sufficient water to irrigate the entire tract. In commenting editorially on this project, the Lewiston *Idaho Tribune* states: "The 30,000 acres to be put under water will make 3,000 ten-acre tracts, which is all the irrigated land the ordinary family will want to use. This will afford a new population of 10,000 to 12,000 people, who will be producing and creating new wealth and furnish a trade area for the city greater than all else it now has. Too much can not be said in its behalf. Immigration is looking to Idaho and is looking for just such opportunities as will be within their reach through these irrigated tracts."

Our main double page illustration gives a very fair conception of the location of the city of Lewiston and the Vineland tract and shows also the mesa land, which is to be irrigated under the Lewiston-Waha project. The inscriptions on the other illustrations furnish further necessary information.

Concerning the value of fruits raised on this land,

doubt and can only be removed by occular demonstration. If one will take the trouble, however, to ascertain what is needed for the production of these grapes he will find that this portion of the northwest possesses these requirements to such a great extent as to make ideal locations for that purpose. This being true Idaho is destined to compete in the market with the extremely high priced foreign product.

FLUMES.

The lumber available on Craig Mountain within easy reach of the upper conduit is abundant and of good quality. It is suitable for flume construction. The Vineland flume was built of similar lumber and has been in use and is continuing to fulfill the duties required of it.

DUTY OF WATER.

The conclusion heretofore stated is that it is possible to store sufficient water to irrigate the entire tract and place it upon the land in question. The results which may be achieved with a careful use of this volume of water may be estimated by a comparison with the irrigation of similar lands in the Vineland colony.

WAHA LAKE RESERVOIR CAPACITY.

Contour.	Area, acres.	Capacity between contours.	Total, acre feet.
3110	5.87		
3120	23.13	145.0	145.0
3160	54.89	1,560.4	1,705.4
3200	82.73	2,752.4	4,457.8
3250	133.27	5,400.0	9,857.8
3305	200.70	9,184.2	19,042.0
3325	231.00	4,317.0	23,359.0

The elevation of the grade of the tunnel has been fixed at 3,115 feet at the upper end, and 3,110 feet at the lower end. The crest of the lowest gap in the rim of the basin at an elevation of 3,315 feet, giving a depth of 205 feet with an area of 247 acres.

CONCLUSIONS.

First: The lands proposed to be irrigated adjacent to Lewiston are of the best quality and undoubted fertility, sloping favorably for irrigation and drainage,

R FROM LEWISTON, IDAHO.
Small Irrigation Tracts. See Article for Description.

and will justify the necessary expenditure for development of water that may be needed.

Second: The power available from the constant flow, if dropped at the head of the Vollmer ditch, is an asset of considerable value to the system and worth development at an early period, as the fall available is about 1,236 feet.

Third: The enterprise is entirely feasible and worthy of the fullest investigation and study.

ORGANIZATION.

The Lewiston-Waha Land, Water & Power Company is organized under the laws of Idaho with a capital of $1,200,000 and has the following officers:

President, Harry L. Irwin; vice-president, James G. Trainer; A. G. Bagley, secretary; John P. Volmer, treasurer.

Directors—Hon. Fred T. Dubois, United States Senator; Henry Heitfeld, L. A. Porter, Harry L. Irwin, J. G. Trainer.

The officers of the company are at Lewiston, Idaho, and 218 La Salle street, Chicago, Ill.

TRUSTS NOT AFRAID.

My name is Trusts; I'm big and stout;
And, though I'm often talked about,
It makes me laugh most every day
To hear what people have to say.
I squeeze them here and pinch them there;
I drive them almost to despair;
Yet all their scolding does no harm;
There's nothing causes me alarm,
For talk is cheap.

In Congress, too, 'tis often said
That some one soon will get my head;
But well I know that I control
Both House and Senate, as a whole.
They talk against me, but, you see,
They always legislate for me;
So I can laugh while people scold,
For 'tis a proverb true and old
That talk is cheap.

But should there ever come a day
When people watch, as well as pray;
When votes are cast with purpose true;
When deeds are many, words are few;
When men for righteousness are bold,
And truth is valued more than gold,
I'll laugh no more, for I shall know
The time has come for me to go,
Though talk is cheap.

—Des Moines News.

THE HANOVER CANAL.

One of the Most Important Irrigation Undertakings in the State of Wyoming—Will Reclaim 35,000 Acres of Rich Agricultural Land.

So much of uncertainty attaches to canal construction that an investment in such an undertaking is considered by many conservative financiers as extra hazardous, the financial sea being strewn with the wrecks of such undertakings.

For success to attend the efforts put forth to promote an irrigation enterprise there must be intrinsic merit in the proposition. The supply of water for irrigation, lay of land to be irrigated, character of the soil and climatic conditions favorable for successful agriculture must each and all be considered as having a bearing upon the future success or failure of the undertaking. The land to be irrigated should be owned or controlled by the company building the canal, and the ownership of the land and canal should finally pass to the actual settler and water user. All of the settlers under the line of the canal should compose one large family, working harmoniously together, for they are interdependent one upon the other and all upon the canal, the means by which the life-giving flood is conveyed to the land of each; hence the necesity of the most cordial relationships betwen the canal builders and the settlers thereunder.

Many irrigation undertakings which are in most respects meritorious temporarily fail of completion from lack of clear-sighted and aggressive business management. The date of income from the sale of water rights is too far removed from the date of the original investment, interest eats up the principal and prospective profits, the property is sold to satisfy the mortgage and the company coming into possession completes the canal system and reaps a rich reward.

It will be apparent to the reader that a large portion of the money, time and energy so far expended in

MR. P. MAGINNIS.
Kimball, Nebraska.

promoting irrigation enterprises, like all other pioneer ventures, has been in a measure philanthropic. In the end the law of "the survival of the fittest" enforces its inexorable decrees, and those enterprises which are worthy become profitable properties, bringing wealth and prosperity to the desert wastes.

Fortunately for the Hanover Canal, the conditions surrounding it were almost ideal and success has attended every effort in its construction since its inception.

The Hanover Canal Company was incorporated in

the early part of the year of 1903 under the laws of the State of Wyoming for the purpose of taking over the Hanover Canal water right and to carry forward its construction.

The water right application was filed by John P. Arnott, the present prosecuting attorney of Big Horn County. He named the canal after his old home town of Hanover, Ind.

Work of construction was begun April 21, 1903, and has been carried forward without delay until one of the finest canal systems in the State of Wyoming has been developed.

The fine body of rich agricultural land lying under the line of this canal is located on the east side of the Big Horn River in the south part of the Big Horn Basin, its headgate being about eighteen miles north of the town of Thermopolis.

The soil is a rich alluvial deposit and is capable of producing enormous yields of all kinds of grains and grasses. The climatic conditions are favorable for the growing of fall wheat and rye; the months of July and August are extremely hot, and as a result corn makes a splendid growth. Vegetables of all kinds grow to an enormous size and the various varieties of fruits wherever tried seem to be perfectly at home. Alfalfa is destined to be one of the most profitable crops raised, consequently stock raising will be one of the chief industries of this portion of the State.

The elevation is about 4,000 feet above sea level and the land lies almost perfect for the distribution of water over its surface. The canal draws its supply of water from the Big Horn River, the largest in the State. At high-water mark this year it was flowing about 19,000 cubic feet per second of time. Mr. A. J. Parshall, of Cheyenne, under the direction of the United States Government, who has in charge the measurement of the stream, estimates that, properly conserved, the water from the Big Horn River would irrigate 1,000,000 acres of land.

It was found necessary to carry the water across the Big Horn River in a flume. The Maginnis patent steel flume was used. This is the largest one of its kind ever constructed, and it has proven an unqualified success.

The men who have furnished the money, brains, energy to push forward this great work constitute the present board of trustees and are as follows: D. T. Pulliam, president, Loveland, Colo.; Hon. W. L. Culbertson, vice-president, Carroll, Iowa; R. E. Coburn, treasurer, Carroll, Iowa; C. F. Robertson, secretary and

Flume From Intake, Hanover Canal.

general manager, Worland, Wyo., and Dr. N. B. Rairden, Omaha, Neb. These men have been connected with its management from the first and are gratified at the results they have achieved. The following letter from Governor Chatterton speaks for itself:

State of Wyoming,
Executive Department,
Cheyenne, June 25, 1904.

C. F. Robertson, General Manager Hanover Canal Company, Worland, Wyo.:

Dear Sir—As president of the State Board of Land Commissioners, having in charge the lands acquired by the State under the Carey arid land act, it gives me great pleasure to be able to congratulate you

Side View Maginnis Steel Flume on Hanover Canal, Winchester, Wyoming.

upon the successful construction and operation of a very large portion of the Hanover Canal in Big Horn County.

Your company has more than kept its agreement with the State in the rapidity with which you have pushed forward construction work. I am pleased to say that you have attained greater success, and with more rapidity, than any of the canal companies which have contracts with the State for the reclamation of arid land tracts, and the State Land Board appreciates your efforts very highly because you have given a splendid practical demonstration of what may be accomplished within the boundaries of our State under the Carey act, which means so much to the homeseeker and to the development of the rich agricultural possibilities of our State.

Wishing you and your company every success in your undertakings, I am,

Yours very sincerely,
Fenimore Chatterton,
Governor of Wyoming.

THE BOY FROM TOWN.

Last night a boy came here from town
To stay a week er so,
Because his maw is all run down
And needs a rest, you know.
His name is Cecil, and he's eight,
And he can't skin the cat.
His maw she calls him "Pet." I'd hate
To have a name like that.

He wears a collar and a tie,
And can't hang by his toes;
I guess that I would nearly die
If I had on his clo's.
He can't ride bareback, and today,
When we slid on the straw,
He ast if roosters help to lay
The eggs I pick fer maw.

When our old gander hissed he ran
As though he thought he'd bite,
And he ain't ever shot a gun
Or had a homemade kite;
He never milked a cow, and he
Can't even dive or swim;
I'd hate to think that he was me;
I'm glad that I ain't him.

He thinks it's lots of fun to pump
And see the water spurt,
But won't climb in the barn and jump
For fear of gettin' hurt.
His clo's are offul nice and fine;
His hair's all over curls;
His hands ain't half as big as mine;
He ought to play with girls.

A little whole ago when we
Were foolin' in the shed
He suddenly got mad at me
Because I bumped his head.
There's a lot of things that he can't do;
He thinks that sheep'll bite,
And he's afraid of ganders, too,
But he can fight all right.

—*Thresher World.*

(We are reproducing in this issue Chapter XVIII of the Primer of Irrigation, which appeared in our issue of October, and in which several mistakes occurred. These errors were overlooked during the absence of the editor, and it was thought better, in view of the fact that a large number of our readers are preserving the copies containing the Primer for reference, to reproduce same in corrected form, so that no mistakes would appear in records saved. Consequently we will ask those who have filed copies of our October issue containing Chapter XVIII of the Primer to destroy those pages on which this matter appears and preserve this issue, which contains both Chapters XVIII and XIX.)

THE PRIMER OF IRRIGATION.

Chapter XVIII.

(Measurement of Water.)

If we fill a gallon measure with water we know that we have 231 cubic inches of water which weighs eight and one-third pounds. That is the United States standard. We also know, because it is easy to measure it, that a cubic foot of water weighs sixty-two and one-half pounds and measures 1,728 cubic inches, equal to seven and one-half gallons.

When it comes to measure water for irrigation purposes it is difficult to ascertain the exact quantity measured, owing to arbitrary standards of what the measure should be. Besides that, the various States and countries are not agreed upon a universal standard of measurement, so that when one reads of fifty inches being required to raise a crop, his measurement may mean a much less number of inches if measured according to some other standard. Ten thousand gallons of water by accurate measurement may be run into a reservoir, and in twenty-four hours or less that number of gallons will be materially reduced, but the loss can be accurately estimated, and so can the exact quantity run out of it for any purpose be measured almost to a drop. But in the case of taking water from a running or flowing stream or ditch, various difficulties stand in the way of accurate measurement.

In measuring water from streams, ditches and running or flowing water, generally three standards, or "units of measure" as they are called, have been agreed upon. They are the inch, the cubic foot per second, and the acre-foot.

THE INCH.

The "inch" as a unit of water measurement originated with the placer miners of the West and was adopted by irrigators when water came to be used upon the land for the growing of crops. It is the volume of water which will flow through an inch-square opening or orifice with a certain other volume of water over and above it to give it what is known as "pressure." Both the opening as to size and the depth of water above it are regulated by the laws of some of the States, and in many localities it is regulated by custom—that is, by agreement. The definition given in the laws of Colorado will furnish an idea of what constitutes an inch:

"Water sold by the inch shall be measured as follows, to-wit: Every inch shall be considered equal to an inch-square orifice under a five-inch pressure, and a five-inch pressure shall be from the top of the orifice of the box put into the banks of the ditch to the surface of the water."

Of course, this opening may be larger than one inch square; for instance, six inches, or twelve inches, but in that case the inch will become multiplied into as many inches as there are inches in the opening. At six inches the volume of water would be thirty-six inches, and at twelve inches there would be delivered 144 inches of water. A simple and usual way to measure the inch and retain the pressure is to make the opening one inch wide and any number of inches long—a slot, so to speak; over this slot is arranged a sliding board that can be moved back and forth any number of inches of actual measurement with a carpenter's rule. By this device there will always be the required volume of water, or pressure, above the inch orifice.

Many irrigators roughly measure the quantity of water delivered from a ditch, or canal, by calculating the number of square inches in a cross section of the ditch and calling the result so many inches of water, but this is not a safe rule to follow, for pressure and the velocity of the stream of water are not taken into consideration, and they make a vast difference sometimes in the quantity of water delivered. The orifice measurement under pressure is the most accurate and gives better satisfaction.

The inch, however, as a standard of measurement, or unit, is of very little use except for the measurement of small quantities of water. It may be adapted to the distribution of water from small main ditches or their laterals.

CUBIC FOOT PER SECOND OR "SECOND-FOOT."

Owing to the inconveniences of the "inch" as a unit of measurement, and the limitation on the mechanical device for measuring it, the cubic foot per second or "second-foot" has been adopted as better adapted to the measurement of both large and small quantities of water; indeed, it is made the legal unit in most of the arid States and Territories in water contracts and for defining the amounts appropriated from streams. But although made the unit of measurement it is used in connection with the inch—that is, a cubic foot per second is distributed to farmers according to the number of inches it is supposed to contain. This is fixed by law and the following table will show the variations in the number of inches contained in a cubic foot per second:

In California, Idaho, Nevada and Utah fifty miners' inches equal one cubic foot per second, measured under a four-inch pressure from the center of the orifice.

In Arizona and Montana forty miners' inches equal one cubic foot per second, measured under a six-inch pressure from the top of the orifice.

In Colorado 38.4 miners' inches equal one cubic foot per second, measured under a five-inch pressure from the top of the orifice.

A second-foot is a cubic foot which passes a given point in a ditch or canal in one second of time, and to measure the number of second feet it is only necessary to multiply the number of seconds of time by the cubic feet of the stream to ascertain the total quantity of water. To make this clearer, let the reader imagine a small stream filling a square conduit or box one foot wide and one foot deep. This gives a stream the face or sectional area of which is one square foot. Now, if the water runs through this conduit or box at the speed of one foot per second of time, that will measure exactly one cubic foot per second, or one second-foot. If the water moves at a higher speed, as, for example five linear feet per second, the volume will be five cubic feet per second. If the conduit or stream is five feet wide and twenty feet deep, the area of its face is 100 square feet, and the water flowing one foot per second will give a volume of 100 cubic feet per second or second-feet; if it runs two feet per second, then the volume will be 200 cubic feet per second of time.

In measuring the flow of a stream it will be understood from the foregoing that the width, depth and speed or velocity are calculated. Streams, however, are very irregular in their measurements and the velocity of the water is not fixed. For instance, the water flows more rapidly in the center or where it is deep; along the shore where it is shallow the friction against the bank and bottom retard it quite perceptibly. Moreover, the water flows more rapidly below the surface than at the surface. In such case it is estimated that the place of the greatest motion is about one-third of the distance beneath the surface, this being the locality where the water is least impeded by friction.

It is manifestly impossible for one to stand at the delivery point of the water, watch in hand, and calculate the number of second-feet that flow, hence a simple way of measuring the whole stream is quite common. A line, say 100 feet, is laid off along the bank and each end of the line is marked by a stake. Then a light float —a chip will answer the purpose—is cast into the stream above the upper stake and the exact time it passes is noted, and also the exact time it passes the lower stake. If the float requires twenty seconds to travel between the two stakes, then the velocity of the water is assumed to be five feet per second. Other floats are necessary, for the stream runs with unequal velocity, but the average speed together with the average measurement is taken as the basis of a calculation and the number of second-feet determined from that. Thus, if the width averages twenty feet, the depth four feet, the cross sectional area is eighty square feet. Then, if the rate of flow is two feet per second, we have a volume of 160 second-feet.

THE ACRE-FOOT.

The preceding water measurements are restricted to flowing water for irrigating purposes. There are numerous methods of measuring the volume of water more accurately than in the case of the chip, and it may be said that by means of submerged floats, current meters with electrical attachments, and other contrivances and calculations based upon scientific principles, very little water will escape the notice of the company who has it for sale, and the farmer may be sure of receiving all he is entitled to for his land. By and by it will be possible for the irrigation farmer to estimate exactly the quantity of water required by his plants, and that amount he will be able to give them with accuracy and without any waste or excess.

It is becoming the practice to store unused water during the periods when there is an abundant supply—that is, to lay aside in reservoirs enough to meet any possible contingency of drought or insufficient supply when most needed. The standard of measurement of water stored in reservoirs, the unit of quantity, is designated as "an acre-foot"; that is, an amount of water which will cover one acre of ground, or 43,560 square feet to a depth of one foot. This will give, of course, 43,560 cubic feet, or 325,851 gallons. One cubic foot per second flowing constantly for twenty-four hours equals nearly two acre-feet, and from this it is not difficult to convert cubic feet per second into acre-feet and estimate the quantity of water to be stored in reservoirs for the use and requirements of crops. The reservoirs themselves may also be measured in the same manner as a tank, but allowance must be made for evaporation and absorption.

To further explain the technical units of measurements into quantities, the following table is given:

One second-foot equals 450 gallons per minute.

One cubic foot equals 7.5 gallons.

One second-foot equals two acre-feet in twenty-four hours flowing constantly.

One hundred California inches equal four acre-feet in twenty-four hours.

One hundred Colorado inches equal five and one-sixth acre-feet in twenty-four hours.

One Colorado inch equals 17,000 gallons in twenty-four hours.

One second-foot equals fifty-nine and one-half acre-feet in thirty days.

Two acre-feet equal one second-foot per day, or .0333 second-feet in thirty days.

One million gallons equal 3.069 acre-feet.

Taking water from streams and ditches open to the atmosphere and its changes, rapid evaporation, seepage and absorption, is always attended with an enormous waste, the consequence being that the farmer never knows and no man can tell him whether he is giving his crops the quantity of water they absolutely require. He can not tell how much of the water applied to the soil is utilized by the crops, or is carried off by drainage, seepage, infiltration to some portion of the land where it is not needed and generally lost for useful purposes. He knows, however, that so much water is measured out to him and that he pays for the amount that runs through the head gate, whether it is of any practical use to him or not. The returns from his crops do not represent as much as he hoped, for the expense takes away a very large slice of his profits. His water tax may represent one-third of his receipts, and though he may be well aware that he never received the water he pays for—that is, it never was utilized by his crops—there is no way out of his embarrassment, he must pay or quit. His farm belongs to him—that is, he has the deed to it—but he is paying rent on it all the time.

Chapter XIX.

PUMPS AND IRRIGATION MACHINERY.

In Chapter XII is given a calculation of the amount of water precipitated upon the earth's surface and carried into the soil. The amount is enormous, and if not carried off in the variety of ways mentioned would soon reduce the surface of the globe to an uninhabitable morass. Moreover, if the annual precipitations were uniform in all places there would not be any necessity for irrigation or anxiety about drouths and an insufficient water supply.

We know it to be a fact that all this tremendous annual mass of water poured from the clouds upon the land, or at least a great percentage of it, is carried into the soil, where it filters and seeps down by the force of gravity as far as it can, or until it encounters some obstruction, and if it can not run, seep or drain off back into surface conveyances it remains stationary, waiting for an exit.

The water from rivers and streams is a very small quantity compared with the quantity beneath the surface. It is, in fact, the "run-off" from rain, snow or saturations of the soil that is utilized in ditch and canal irrigation, and that run-off varies in amount from a flood to a thread-like, meandering stream, which is an aggravation as a source of irrigation water. Of course, there are exceptions in large streams, the great waterways of the country, some of them the main arteries of commerce and apparently inexhaustible in water supply.

We have not, however, reached the full limit of land cultivation by irrigation, and when the vast regions yet unreclaimed, but the most fertile in the world, shall have been put under water, or, rather, be ready for water, as a scientist recently observed, "Where is that water to be got?" The fact is that it would require the services of several Mississippis to supply the demand, and even then in a dry season there would be a deficiency. It was owing to the fact that there was not surface water enough, and that the reclamation of arid and semi-arid lands had, apparently, come to a standstill, that the Government has interested itself in the subject of reclamation by irrigation and turned its attention to the construction of gigantic dams, reservoirs and the sinking of wells to secure an adequate volume of water for the purpose of building an empire of fruitfulness in what has always been considered an unfertile and dreary desert.

That there is an abundance of water beneath the surface of the earth is beyond controversy. There is not a desert spot on the globe which, lurking down below its burnt exterior, does not contain natural reservoirs of water in abundance. Even the midst of Sahara is beginning to blossom like a rose with water brought from beneath its sands with very little trouble, and in our own country the great American desert is becoming a vast green pasture and orchard of thriving trees and vines through a little scratching of the surface to obtain the life-giving moisture that never fails to be where it is wanted.

All this leads to the subject of wells, but as that matter has been gone over in a fairly full manner, and as this book is not intended to be scientific or technical, but a primer of irrigation, the methods of digging wells, their variety and history may very well be omitted and this chapter limited to the means of extracting the water from them.

PUMPS.

The only suitably economical method of raising water from a lower to a higher level, as from a well, is by means of a pump. When pumps were first invented or used it is difficult to say, and, moreover, it is of very little moment to know the exact date or the inventor's name. It is quite certain that if he were able to return today and view the innumerable varieties of them, and their tremendous capacity, he would not be able to recognize the principles he sought to put in a practical form.

SUCTION PUMPS.

The ordinary pump is the suction pump, constructed upon the principle that water will fill a vacuum to the height of 33.9 feet vertically at sea level. The piston of this pump fits tight in a smooth cylinder and has a small valve in its upper end which opens upward. The piston is lowered as far as the piston rod will permit, the valve opening to allow it to descend easily. Then the piston is lifted up by means of a level to the full length of the piston rod, the valve this time being closed. By repeating this up and down motion a vacuum is created in the cylinder of the pump—that is, the atmosphere is extracted—and if there is any water it begins to come up and can be made to overflow through a spout placed at the surface. Now, water can not be "sucked" up in this manner more than 33.9 feet in a perfect vacuum, and as a perfect vacuum, that is a reservoir absolutely free from atmospheric air, the estimated height at sea level to which water can be drawn by means of a suction pump does not exceed twenty-eight feet.

The altitude above the sea level and various atmospheric conditions reduce this suction lift materially. for instance: 1,500 feet above sea level the suction lift is 25 feet; 1,500 to 2,000 feet, 24½ feet; 3,000 feet, 23 feet; 4,000 feet, 22 feet; 5,000 feet, 21 feet; 6,000 feet, 20½ feet; 7,000 feet, 20 feet; 8,000 feet, 19 feet; 9,000 feet, 18 feet; 10,000 feet, which is as high as pumping for irrigating water will probably go, water can be sucked up only .17 feet. Some engineers say that 20 per cent less would be a factor of safety in putting in a pump.

These pumps can do a great deal of work if kept constantly at it. Take a suction, single-acting pump that is, one with only one cylinder, having a cylinder five inches in diameter, and a six-inch length of stroke and it will deliver one-half a gallon per stroke. The faster the man who works the pump makes the strokes, the more water the pump will deliver. At ten strokes per minute, which may be called "leisurely," he would be able to raise 300 gallons an hour, and by doubling the diameter of the pipe or cylinder, he would increase the capacity of the pump four times and deliver two gallons per stroke. By using horse power such an ordinary pump may be made to raise six times as much water, and with a longer lift, one of ten feet, one horse power, an ordinary pump is able to raise 200 gallons per minute, an amount sufficient to give an acre of ground half an inch of water in ten hours.

WINDMILLS.

Animal power is not commensurate with irrigation on anything but a very small scale, as for a small kitchen garden with a few small fruits. Other power must be brought into requisition to attain profit in gardening or general agriculture, where irrigation is practiced. The most common and economical power, though variable at times, is the wind. It is utilized by means of a windmill, which may very properly be called a "wind engine."

The origin of windmills, like that of numerous other things of benefit to mankind is lost in the obscurity of time. About the twelfth century they came into practical use in Holland for the purpose of draining and grinding grain. This mill was of a very unique construction, with a shaft called the wind shaft, which carried four arms or whips on which long, rectangular sails were spread. The whip carrying the sail was often thirty to eighty feet long, so that the tips of the sails described a circle sixty to eighty feet in diameter. These sails came down close to the ground, and every one who has read the adventures of Don Quixote will not be surprised that his encounter with the windmill on the supposition that it was a cruel giant ended disastrously.

There is now at Lawrence, Kan., the ruins of what is said to be the first windmill of this type erected in the United States. It was erected by an English company at an expense of $10,000 upon the Holland plan. Since that time the windmill has become a thing of beauty and power, and for cheapness it is within the reach of every farmer, and is one of the most economical aids to irrigation that can be devised.

It is indeed the simplest appliance for raising water known, and as showing the capacity of a first-class modern windmill, the following table is submitted as founded on experience and positive guarantee. The "size" mentioned in the first column means the diameter of the wheel, and the "lift" expressed at the top of the columns refers to the distance of the piston to the point of delivery:

Size	.120,106	2.75	80,070	1.84	49,742	1.14
Feet.	10-ft. Lift.		15-ft. Lift.		25-ft. Lift.	
10	Sq. ft.	Acres.	Sq. ft.	Acres.	Sq. ft.	Acres.
12	37,161	.85	24,775	.57	14,768	.34
14	66,765	1.53	44,510	1.02	26,134	.60
16	85,982	1.97	57,321	1.31	34,757	.79

The table represents the number of square feet and acres the windmill will irrigate one inch deep per average day's work of ten hours. It is conceivable that a sixteen-foot mill will irrigate at least twenty acres of land, and by running double time, as some do, will store up water to supply deficiencies caused by lack of wind. At the rate of supply indicated, every acre will receive its inch of water on alternate five or ten days, which, during a growing season of ninety or one hundred days means ample to raise almost any sort of crop, provided small furrow or tight trough conveyances are used, and after cultivation practiced.

When it is considered that an inch of water on an acre of ground means 27,154 gallons, it will be easily comprehended that such a windmill working out of the growing or irrigating season will store abundant water in a storage reservoir. It means the storage of at least five million gallons that may be used for winter or fall irrigation and furnish an abundant supply for stock and household purposes.

As to the cost of such an irrigating outfit, exclusive of the cost of the well and reservoir, the following are the ruling prices complete, ready to put up and begin pumping:

Ten-foot mill, $62; twelve-foot, $97; fourteen-foot, $133; sixteen-foot, $195.

Of course, the purchaser must first find the water with which to irrigate, and plenty of it. He should avoid doing as did a friend of the author, who dug a well 108 feet deep, with about six feet of water at the bottom. After putting up a twenty-four foot mill, he began making preparations to flood forty acres of ground. In less than two hours his pump ran dry, and on investigating he found that the well was dry and it took eight hours for it to fill up again.

RESERVOIR.

The reservoir should be located on the highest point of land it is desired to irrigate, with the bottom of the reservoir above it if possible. Then plow deep around the line to avoid earth seams under the embankment. The interior should be plowed and scraped toward the line of the embankment and harrowed until the earth becomes finely pulverized. This bottom should then be carefully and thoroughly puddled. If hard pan or clay can be found, then dig down to it and establish the bottom of the reservoir on it as a sure foundation for a water-tight receptacle.

The height of the embankment depends upon the amount of water capacity, but it should not be less than four by ten feet wide at ground level, and two feet wide at the tip. The inside slope should be gradual, to prevent washing by ripples or waves, and it may be sodded or seeded down to grass until a stiff sod is formed, which will prevent any washing away of the earth.

The outer embankment may be steep or nearly perpendicular, but as there will always be some seepage, it would be wise to make it slope gently and use it for raising garden truck, small fruits, or whatever else the farmer may fancy in the way of ornament or profit.

As to size, that must be governed according to the irrigator's needs. An acre of reservoir would not be too much to accommodate a good windmill, and this according to the measurements already given, may be made to contain half a million or a million gallons. If the stored water is to be used frequently, then the size of the reservoir may be lessened.

For stock purposes, a smaller reservoir may be constructed below or away from the larger one, and into this smaller one the water can easily be run as needed for a change or freshening; the excess of unused water may be run upon any plowed ground to soak into the soil, for after all is said, where there is moisture in the soil, the labor of irrigation is easy and the quantity of water required very much reduced. After once filling the reservoir it should never be entirely emptied, for if the bottom is permitted to dry it will surely crack and then, when refilled, the water will drain out.

TANKS.

It is well to have a tank of some kind to provide against sudden dearth of water from lack of wind, or stoppage of machinery for repairs. With a reservoir however, the necessity of a tank is not so apparent unless the water is to be used for household purposes. In many kitchen or truck gardens, it is recommended to sink a barrel or square tank at various places, say, at the head of the beds where gross feeding plants are raised. Beets, carrots, onions, etc., with radishes and lettuce, or salads of any kind, like plenty of water, and when they need it they must have it. It is not always profitable to run water in a furrow over a long stretch of soil to give a few vegetables the trifle of water they may happen to need. The waste is too great to be worth while. Hence tanks come to the rescue and the water may be raised from them by means of a hand pump.

In large fields, where drainage pipes or tile are laid, and a system adopted which will merge or unite the tile into one basin or large cross drainage tile, it has already been said that by sinking openings through the soil in the nature of wells down to the subterranean tile and stopping up the outlets, the water may be made to rise to the surface or near it and be utilized by means of pumps, or through ditches or flumes if the land below is down grade, or lower than the source of supply. Instead of a cross drainage system to catch the surplus water, tanks may be sunk and the drainage tile made to end in them.

For windmill purposes to store water for household uses, tanks may be purchased ready made in cypress, pine or iron at from about $8 for a 70-gallon tank to $100 for a 5,000-gallon one. These tanks are made all the way up to 100,000 gallons capacity.

HORSE POWER OUTFIT.

Pumps are arranged so as to be worked by horse power, using one or two horses. The one-horse power pump is fitted for a 3-inch suction pipe and a 2½-inch discharge pipe. This will deliver 53.9 gallons per minute. The two-horse power outfit is fitted with a 4-inch suction pipe and a 3-inch discharge pipe, the capacity of which is 102.9 gallons per minute. The cost of the one-horse power is about $210 complete, and the two-horse power, $240.

Some prefer the horse power outfit to the windmill, because they do not consider themselves at the mercy of the shifting and variable winds of heaven. On the prairies and near the sea coast, however, the windmill is preferred as the winds are nearly constant, at least they blow with sufficient force and long enough to supply all the water needed. Wind at fifteen miles an hour is strong enough to work a windmill up to its full capacity.

GASOLINE ENGINES.

The gasoline engine for pumping purposes is growing in favor, owing to the cheapness of the fuel and the capacity and simplicity of the engine. An engine that costs about $100 will furnish about 1¾ horse power, consume one gallon of gasoline in ten hours of steady work and supply 4,000 gallons of water. Other gasoline engines ranging up to a water delivery of 10,000 gallons and more an hour may be purchased at reasonable cost, and will do an enormous amount of work at a trifling expense. These engines are suitable in the barren regions where wood and coal can not be had for fuel without great expense.

OTHER PUMPING POWER.

Where conditions will admit of them, steam, hot air and even electricity are brought into requisition for pumping water to be used in irrigating land. Coal, wood and other fuel, however, must be at hand in unlimited quantities, for all such power is a voracious feeder—the more power the more fuel.

All the appliances and machinery for irrigation are being reduced to simplicity and the saving of water. Open canals and ditches with their loss of 50 per cent of water are becoming things of the past. Economy of use is now the rule, and the farmer who understands the needs of soil and plants makes a good profit out of his farm, whereas he would cultivate it at a loss without that knowledge. Raising crops for market for profit has become a matter of dollars and cents, and a penny saved is a penny earned in agriculture as well as in the mercantile business.

To save water is the great aim of irrigators, and where there were once open leaky ditches and canals there are now cemented water conveyances. On the large farm, as well as on the small one, it is beginning to be understood that gorging plants with water and saturating the soil is not the proper system for growing crops for profit. The lessons sought to be imparted in this book, if well learned and followed, can not fail to be of benefit to every farmer who reads it. The essential principles only are given; each farmer must apply them for himself, for he can not have an apostle at his elbow all the time to guide and direct him when he is on the point of making a mistake.

We are showing in this issue, in connection with an article on the Hanover Canal, some views of the Maginnis steel flume mentioned in the article. This flume is in general use throughout the West and is giving good satisfaction among irrigation companies generally. Those who are interested in the subject can secure full information, with illustrations and printed matter, by addressing P. Maginnis, Kimball, Neb.

BROUGHT BY THE POSTMAN.

Letters from Correspondents to The Irrigation Age.

ONTARIO, ORE., Oct. 19, 1904.

Editor THE IRRIGATION AGE, Chicago, Ill.:

Dear Sir—I mailed you yesterday a blueprint map that will explain a situation in the eastern part of Oregon relating to the methods and operation of the United States Bureau of Reclamation as it is being conducted according to the ideas proclaimed by Mr. Newell, as shown in your September issue.

Along the south side of Snake River, partly in Idaho and partly in Oregon, is situated an unusually fine body of irrigable land. The exceptional character of this land is due partly to the quality of the soil, but largely to the extremely favorable climatic conditions. The productiveness of the land is remarkable, as may be shown by the results from one farm of two hundred and ten acres, the crop of the present season, 2,380 tons of alfalfa, having just been sold for $11,900—$5.00 per ton.

A portion of this area, some 16,000 acres, is already supplied with water from the irrigation ditches taken from the Owyhee River and the Malheur River, but the water supply is hardly adequate for the area already under cultivation, especially during the latter part of the season. During the earlier part of the year both of these streams carry an abundance of water, an ample supply for all the irrigable land adjoining them, but after the 1st of July the supply is problematical, and it is simply a question of the storage of this surplus discharge to bring this entire area under cultivation.

Naturally, where profitable returns can be so clearly shown and demonstrated there is an inviting field for the investment of capital, and plans and investigations have been under way now for several years by a number of corporations organized for the purpose of reclaiming this body of land.

The Malheur Irrigation Company was the first in the field and was planned chiefly to supply the lands comprising the lower portion of the area mentioned, or what is locally known as "Dead Ox Flat." This company has partially completed a system of storage reservoirs and some twenty miles or more of their system of ditches at an expenditure up to this time of probably $75,000.

The Ontario High Line Canal Company was organized on a more comprehensive plan several years ago, and contemplated the reclamation of practically all of the land on the south side of Snake River for a distance of seventy-five or eighty miles of its course and they have been carrying on during this time a very careful survey and investigation to carry out the purposes of their organization and while, up to this time, they have expended no money in construction work they have expended a considerable sum in making these surveys and making these investigations and perfecting their plans.

Last summer the Government Reclamation Bureau invaded this field and began a vigorous crusade among the people residing throughout this portion of Oregon to create a popular support for a plan that they had for irrigating a portion of this same territory.

The methods resorted to for the purpose of creating popular favor and support for this (Government) project and to create disfavor and prejudice against the companies already engaged in the effort to reclaim these lands were of the hippodrome order, flaming posters, brass bands, scores of hired claquers and boosters, etc., astonishing to those accustomed to considering the majesty and dignity of the "Government"—that institution that we are taught to honor and respect instead of regarding it in the light of a scrambling competitor not overscrupulous in its effort to get the best of it.

The area of land covered by the Ontario High Line Canal, excluding all that is now under cultivation, is approximately 146,000 acres, and the Malheur Irrigation Company's system will supply from 25,000 to 30,000 acres of additional land, making a total of about 175,000 acres. The estimated cost of these undertakings is $2,378,000 for the Ontario High Line system of reservoirs and canals and $340,000 for the Malheur Irrigation Company's system. As you will see from the prospectus issued by the Government Bureau relating to their Malheur project—a copy of which is herewith sent—the area that they propose to irrigate is 90,000 acres, which includes the 16,000 already under cultivation, leaving practically 75,000 acres of arid land to be redeemed by their scheme, and you will also see from the prospectus mentioned that the estimated cost of the Government project is $2,700,000, making the cost per acre to be about $36. The estimated cost per acre under the "private enterprise" plan is close to $15.50, a comparison obviously to the advantage of "private enterprise," and, considering the larger area to be reclaimed, obviously to the advantage of State and country. There are also other comparisons that might be pointed out quite to the disadvantage of the Government plan.

It seems to have been the chief object of the Government officials to disparage, discredit and kill off these as well as all other private irrigation enterprises in this section of the country, regardless of the time and money that have already been spent in their accomplishment. In this case it would seem to a fair-minded man that if the Government is to drive out of the field of irrigation development these private concerns they would at least offer as a substitute a better plan and one utilizing all of the land available instead of the ill devised plan they are now trying to consummate.

As a further evidence of the arbitrary and high-handed methods employed by the Government officials in this matter, they have served notice in the name of the Government on the Malheur Irrigation Company to desist from further work upon their canals on the ground that they were trespassing upon the public domain, and the application of the Ontario High Line Canal Company for a right of way for their reservoir, although made out and filed according to the provisions and requirements of the law, has been disapproved by the land office at Washington, presumably at the instigation of the officials of the Reclamation Bureau.

A recital of all the facts relating to the contest of the Reclamation Bureau against these and other private irrigation enterprises in this section of the country would disclose a condition of things calculated to arouse public indignation. Of course, up to this time the contest has been largely a one-sided one, as there has been a persistent effort made to convey the idea through the public press and by other means that the acts of the Reclamation Bureau, whatever they may be, are entirely lawful and bear the sanction and approval of the administrative authorities at Washington, which counts largely against those who have already invested and are now investing liberally in "private irrigation enterprises."

When it is borne in mind that more than one thousand and five hundred millions of dollars have been added to the public wealth through "private irrigation enterprise" and the existence of a million homes has been made possible through the efforts of those engaged in such enterprises, it would seem that the malicious attacks of the Government Reclamation officials against those engaged in legitimate efforts in this direction are untimely, ill-advised and uncalled for.

The National Irrigation Act naturally appeals to the interest of those living throughout the West and is regarded with almost universal favor in this section of the country and all are vitally interested in the successful accomplishment of the purpose and intent of the enactment, but there is a gradually increasing class of citizens coming to a realization of the fact that it is being exploited in the interest of personal ambition and for the gratification of personal vanity.

Respectfully,

ONTARIO.

LAMPASAS, TEX., Sept. 14, 1904.

Editor THE IRRIGATION AGE, Chicago, Ill.:

My Dear Sir—Having read in THE AGE for September the letter of W. A. Lee on "Sub-Irrigation" and believing it is a subject in which many persons are like myself deeply interested, I am prompted to ask for the methods for this way of irrigation. No doubt you have readers who can tell of the way found to have been the most economical and effective, some or all of whom will be willing to tell of the circumstances under or because of which they were led to try it, also how they succeeded.

Perhaps Mr. Lee can give your readers light on what to me looks to be an important subject. Can you not suggest to the executive committee of the National Irrigation Congress that one or more papers be prepared and read at the meeting to be held at El Paso in November next? That the idea advanced by Mr. Lee is of importance no one will question, but is it practical and not too expensive, other than on a small plat of ground are questions the answer for which demands a full explanation as to the how and cost.

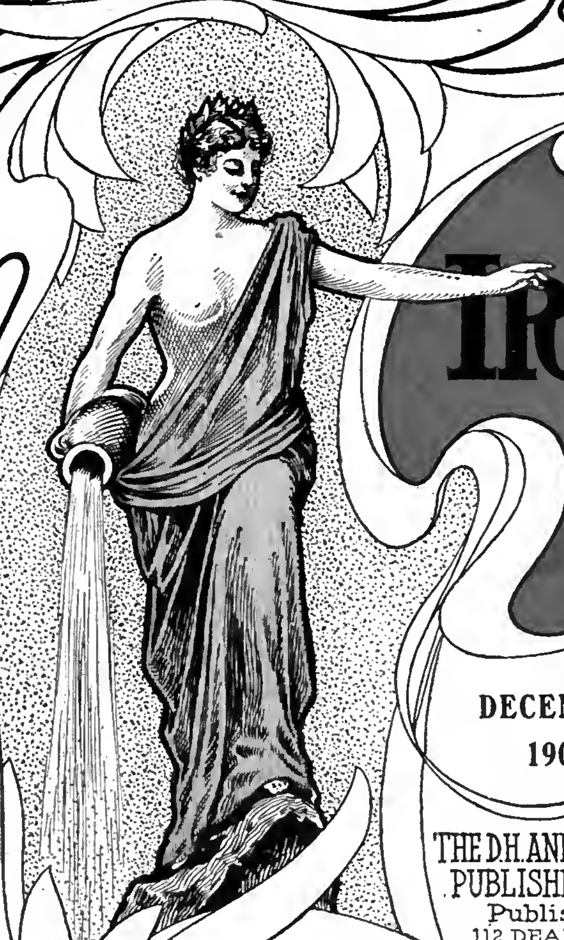
I am glad to tell you there seems to be a growing interest in this State for a large and interesting meeting at El Paso, November 15-18. Favorable rates of transportation to El Paso and for side trips have been secured.

It gives me pleasure to congratulate you on the success of THE IRRIGATION AGE. Its coming is watched for by persons who read it here, among whom is

Yours respectfully,

JOHN HALL.

Vol. XX. No. 2.



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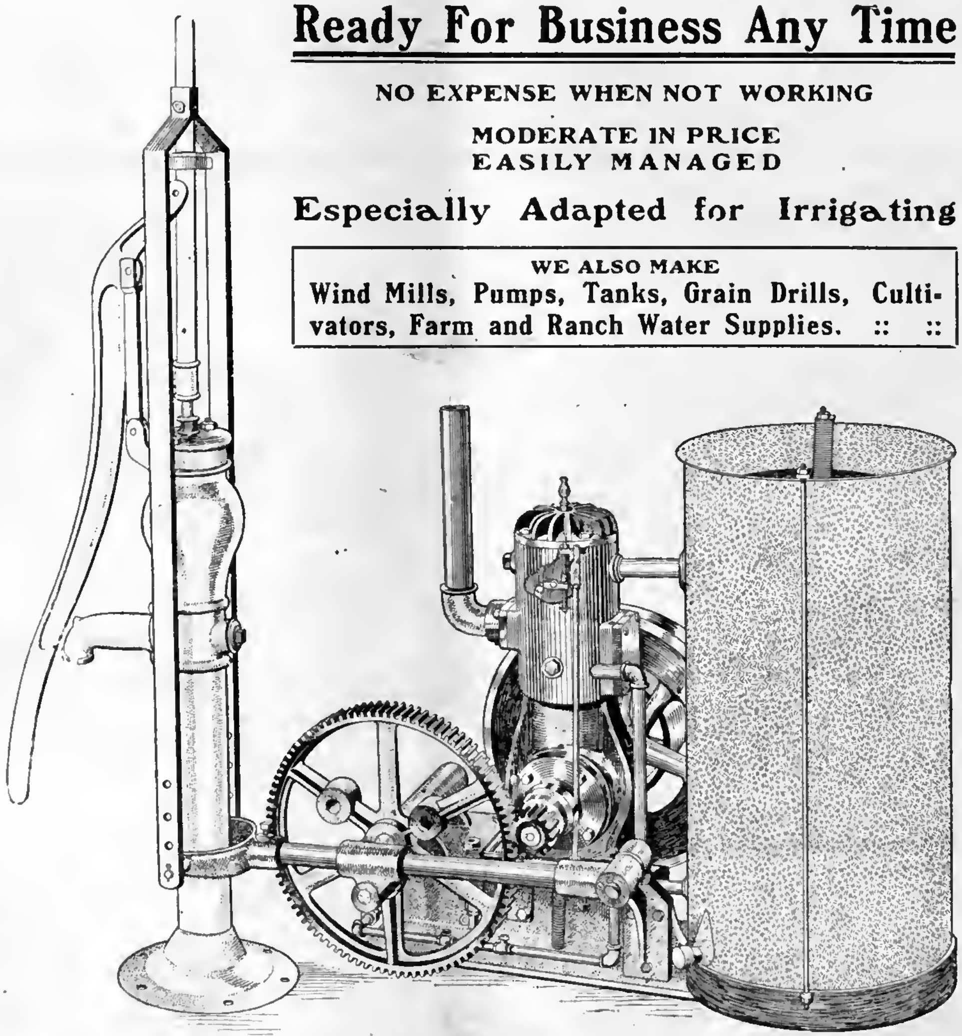

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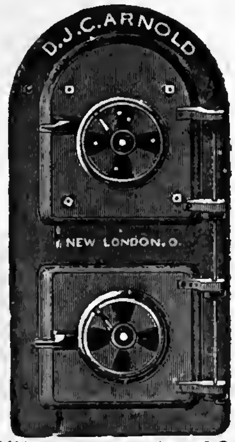

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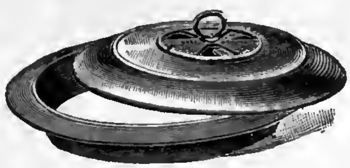

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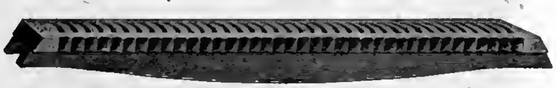

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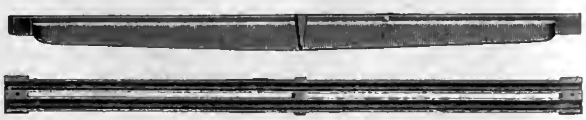

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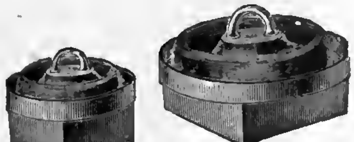

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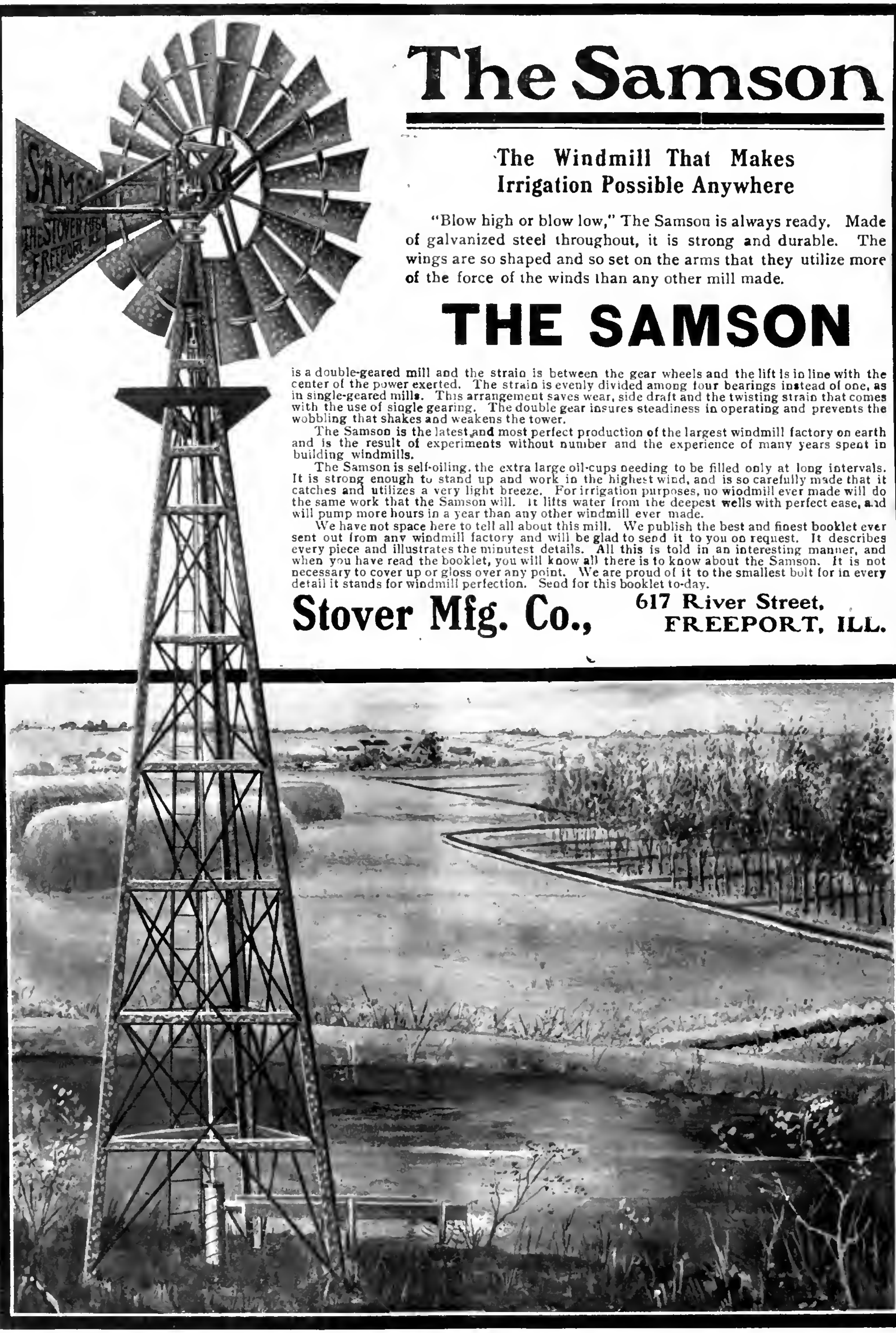

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THE IRRIGATION AGE

VOL. XX — CHICAGO, DECEMBER, 1904. — NO. 2

THE IRRIGATION AGE

With which is Merged

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ARID AMERICA — THE FARM HERALD

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EDITORIAL

The Solar Motor for Irrigating. In 1876 John Ericsson, the great inventor and engineer, made the following impressive statement: "Upon one square mile, using only one-half of the surface and devoting the rest to buildings, roads, etc., we can drive 64,800 steam engines, each of 100-horsepower, simply by the heat radiating from the sun. Archimedes, having completed his calculation of the force of a lever, said that he could move the earth. I affirm that the concentration of the heat radiated from the sun would produce a force capable of stopping the earth in its course."

Ericsson may be said to be the first of the world's great mechanics to demonstrate the vast energy stored in the sun's rays, and during the last years of his life spent at least $100,000 in his experiments with solar motors. He made them work, although he never brought them to such perfection as has been reached within the past decade, and he never forced old Father Sun to make partial amends for his sorry work in the arid regions of the earth.

It seems like helping along the law of compensation for man to harness the sun to a mechanism which shall freshen the desert places and make the green leaf take the place of the parched. This is what is being done in California and the Southwest. Satisfactory experiments have also been conducted at Denver. At the latter point the most successful ones were in winter, the water to be turned into steam being drawn from an ice-covered pond.

The makeup of the modern machine is essentially the same in all the different patents. A great steel frame is covered with a series of small mirrors, arranged in a concave form so as to focus the sun's rays upon a cylinder which is placed in the center and covered with some heat absorbent. An indicator tells when the focus is exact—that is, when the reflector is turned directly toward the sun. An automatic clock keeps the huge reflector true to its work, and everything about the machine, even to the oiler and safety-valve, is self-acting.

A boy operates the entire machine, which will be in working order in about an hour from the time the sun begins to get up steam, and will continue to pump water from an hour after sunrise to half an hour before sunset. The cost of the apparatus will not exceed $200 per horsepower.

We look for the time when such solar motors may be seen by the thousands in all spots of the earth which need irrigation—in the United States, in Mexico and even in the tillable tracts of the great Sahara. The sun will also be utilized in many other practical ways. It will yet operate machinery of tremendous power; it will not be used to stop the earth in its course, but, like the irrigating motors, to promote the welfare of that world which is, after all, a most favored child of the sun.

Colorado Decision.

Judge M. S. Bailey, of Colorado, has decided that no company or corporation can remove water from one county to another in that State. In this particular case, which was a suit brought by the Bessemer Ditch Company, of Pueblo, to remove one foot of water from the Tasènne ditch, near Salida, the court decided against the former. This was a test case, and had it been decided in the Bessemer Ditch Company's favor 100 feet of water would have been taken from Chaffee County to the headgates of the La Junta Ditch Company, which, it is said, had made arangements with various farmers to purchase all the water to be removed through the channels of the Arkansas River to southern Colorado. This would have been a serious blow to Chaffee County, as within a few years what is now populous county would have become a barren desert. This practically settles one of the bitterest fights ever waged over water in that section.

"Ozone George."

The Los Angeles *Times* of November 19 contains an article headed "Decisive Victory," concerning the resolutions on the repeal of the land laws. It also bears the inscription, "exclusive dispatch." This article in the *Times* is purely the product of George H. Maxwell, and in the article he scores a lot or reputable delegates to the congress for their opposition to the resolutions. In order to illustrate the egotism of the man we quote what he wrote:

"For a while there was almost a riot on the floor, which was stilled when President Pardee announced that if the floor was trying to run the Chair, the attempt would not succeed. Whereupon the Convention cheered the Chairman and the Convention got good. The previous question was ordered before the Convention could hear from George H. Maxwell, who had changed his mind overnight and had remained for the fray. Maxwell got the floor in a few minutes, however, to jump upon an amendment, offered by Prince, that the Congress substitute for the repeal the same colorless resolutions passed last year at Ogden through the efforts of Needham of California and Mondell of Wyoming. Maxwell's speech was of the whirlwind type, and he took the Congress with him. Then Prince's resolution was voted down and the resolutions as presented were adopted in a tempest of noise, Maxwell joyously leading the jollification, waving a handkerchief from the front row."

The tone of this whole article in the *Times* is Maxwellian and will give our readers some idea of the egotism of a man who can so highly compliment himself over a private wire and through the columns of a daily paper. We have heretofore referred to Maxwell's "boiler-plate" editorials in the Los Angeles *Times.* The *Times,* by the way, is the only paper in the West of any strength which supports Maxwell, and why its editor does so is an enigma to all fair-thinking people who fully understand the situation. There is probibly no man today who is occupying any prominent position in the United States who has written so many complimentary things about himself for publication as this fellow, "Ozone George" Maxwell. If the public generally knew the quantity of rot which has been sent out laudatory of Maxwell by his personal press bureau he would occupy a position even more ridiculous, if possible, than his present one.

THE IRRIGATION CONGRESS.

The Salt Lake *Tribune* of November 20 has the following to say concerning the Twelfth National Irrigation Congress:

"The Irrigation Congress at El Paso did very well in the selection of its officers and managers, but it seems to have placed itself crossways with the Irrigation Service and with the irrigation law. All the resolutions regarding changes in the land laws and their administration, and the repeal of the Timber and Stone Act, must be at once relegated to the rubbish heap, as ill considered and of no consequence.

"There is one resolution, however, which is of an especially evil tone. We refer to that in which it urges the passage of a law permitting States to 'organize into districts for the sale of irrigation lands and upon approval by the Secretary of the Interior to be allowed to employ engineers of the Reclamation Service.'

"If that means, in fact, what its language means, then it is something which by no possibility should be allowed or thought of for one minute. It contemplates turning over to the States, by districts, the control of the Reclamation Service and irrigation work. It is not worth while to waste time on a proposition like that, which is wholly vicious. The strength of the Service is in the general control by the National officials; to turn any part of it over to the States, with the money that would necessarily be claimed, would be not only to invite confusion and disaster, but to compel them.

"Another resolution that is not only vicious, but wholly impracticable, is the one calling for the extension of the Government reclamation work into Texas, where there is no Government land, and whatever is done the arid land fund derived from other States would have to pay for. If Texas wants this help, let her place herself on a parity with the other States by first transferring to the General Government its public lands. Until then, Texas is not in the reclamation class, and it would be a gross imposition upon the other States to take the money derived from lands sold within their borders to improve lands for a State which retains the ownership of all the public lands within its borders for itself.

"This session of the Congress, with its unwise declarations, its barrenness of good ideas, and its general tone of irresponsibility, raises the question whether it did not reach its high tide of usefulness at its session in Ogden last year, and is now going into decadence. There does not seem to be any reason to expect helpful or fruitful action by holding further sessions of this body. Its work was in fact done when the irrigation of the arid region was taken in hand by the National Government, and it might as well die; its work is done; its usefulness is past."

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

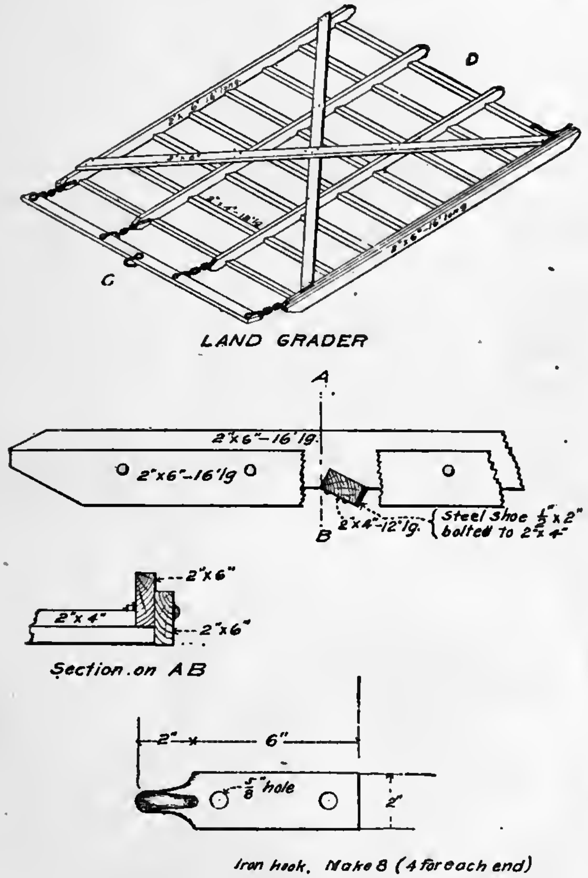
From Bulletin 145, Courtesy U. S. Department of Agriculture.

PREPARING LAND FOR IRRIGATION IN GALLATIN VALLEY, MONTANA.

In the Gallatin Valley, Montana, the greater part of the plowing is done in the fall after the crop is harvested. Ordinary walking plows, sulkies, and disk plows are used. Back furrows are avoided, if possible. In the spring the plowed land is leveled, harrowed, and seeded.

LEVELING.

A number of different devices are employed to reduce the surface to an even, uniform grade. Some of these are homemade and cheap, while others are controlled by patent rights and are more costly. Figure



Homemade land grader.

3 represents one of the homemade land graders. Each runner is made from two by six inch joist, sixteen feet long, and is bolted to another joist of the same size, but placed two inches higher, as shown in "Section on AB" in the figure. The draft attachment, bracing, and crossbars, shod with steel, are also fully shown in the drawings.

To finish off a field prior to seeding and give it a smooth, uniform grade the leveler shown in Fig. 4 is preferred. The framework consists of five four by four inch timbers, having their centers raised by wheels thirteen inches above the ground. The machine is twelve feet wide and seven feet long, and has an adjustable steel-shod share eleven feet two inches long and nine inches deep. This implement, when operated by a competent man with three or four horses, will level from ten to twenty acres in a day, providing the ground is tolerably even. Details are shown by the drawings.

When the surface is properly graded grain may be sown with a three or four-horse seeder. In this work care is taken to have the drills run in a direction to facilitate the distribution of water between the field ditches, since the water readily follows the drill marks.

In the Gallatin Valley a cereal crop grows until the plants are about six inches high before preparations are made to irrigate it. In average seasons the seed is usually in the ground by the tenth of May and the rainfall during May and June in that locality is seldom less than five inches and is often as high as seven inches. This is sufficient to maintain the vigor of the plant until it attains the height named. Cereals are irrigated for the first time early in July. In dry seasons the crops begin to suffer in June, when water must be applied, although the plants may be only three inches high. The better custom, however, and one which insures larger yields, is to defer irrigation wherever possible until the plants cover the ground fairly well.

ESTABLISHED GRADES FOR FIELD DITCHES.

On the larger ranges of the State field ditches or laterals are frequently laid out by means of the engineer's level. When the slope of a forty-acre field does not exceed eighty feet to the mile, the level is set up in a position to command the upper half. The front chainman carries a leveling rod and the rear chainman a long-handled shovel. Sometimes the chain is dispensed with and the distances are ascertained by pacing.

A beginning is made by holding the rod on the surface of the ground at the highest corner of the field and next to apply to the supply ditch. The target is then read and raised, say three-tenths of a foot, and the front chainman stretches the chain or tape to its full length of 100 feet and endeavors to find a spot of the right elevation to suit the rod reading. While the reading is being taken and the target again shifted three-tenths of a foot higher the rear chainman makes a mark in the soil with his shovel. The driver of the ditch plow follows the rear chainman, keeping at least 200 feet in the rear of the latter, and, being seated on a sulky, he can look ahead and improve on the grade location marked out by curving the ditch in order to have fewer sharp bends.

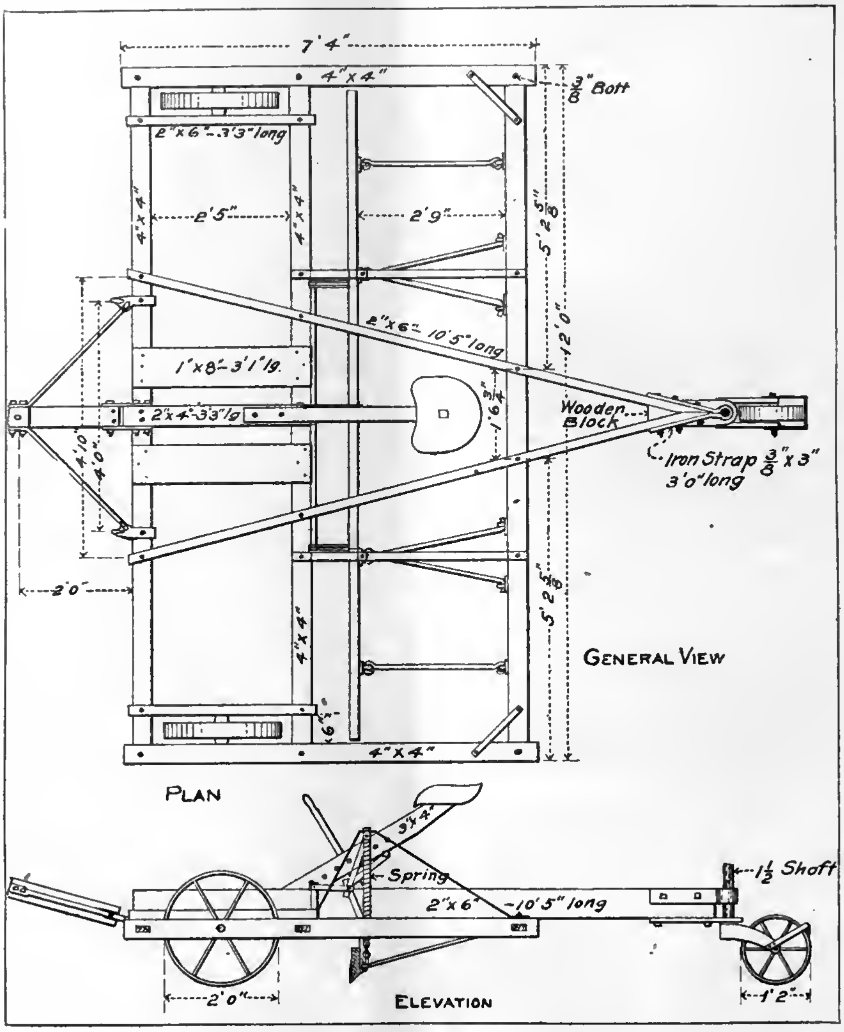
A grade of twenty-five hundredths per 100 is ample for fields that are carefully leveled, but if there are surface irregularities it is well to increase the grade to three-tenths, or even four-tenths, per 100.

The homemade level shown in Fig. 5 is pretty generally used throughout the Gallatin Valley to locate ditches and laterals. It is carried by one man, and an assistant makes marks, as in the former case, with a shovel, to guide the driver of the ditcher which follows him. The usual grades allowed are from one-half to three-fourths of an inch to the rod.

In the majority of cases no instruments are used to locate field ditches. The proprietor of an irrigated farm becomes in time familiar with the slopes in different directions. He also learns from his experience in irrigating the high and low portions. Possessing such knowledge, he can usually locate the field ditches by eye and thus save considerable trouble and expense. The inexperienced, however, should not attempt this method.

PREPARING LAND FOR IRRIGATION IN NEBRASKA.

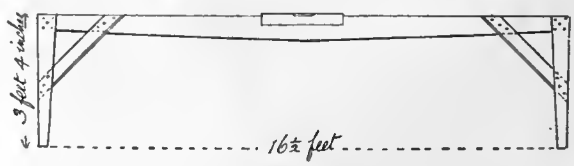
The leveling, grading, or smoothing of fields for irrigation has been little practiced in Nebraska. The natural smoothness and uniformity of the prairies has made it possible to conduct water over large areas without leveling. Moreover, under a majority of the canals in the State only a part of the land which can be irrigated has water applied to it regularly, and naturally that which can be brought under irrigation with the least preliminary expense is first used. It is undoubtedly true, however, that in many instances the outlay necessary to smooth the surface of the fields would have been more than repaid through the easier distribution of the water and increased yield of crops. Tracts which lie in or near the sand-hill region frequently abound in humps or small hillocks, which hinder the even and effective distribution of the water. Many of the irrigated tracts are also dotted by small, shallow depressions said to be old buffalo wallows. These depressions catch and hold the water which reaches them either in irrigation or from rainfall, and the drowning of the crop results. A few such fields have been smoothed, but they are small and scattered, so that no practice has been established, and representative figures relating to cost can not be secured. Work has been done on some fields in the Platte Valley to the extent of from $1 to $5 per acre.



Leveler.

METHODS OF APPLYING WATER—METHODS IN USE IN CALIFORNIA.—THE CHECK SYSTEM.

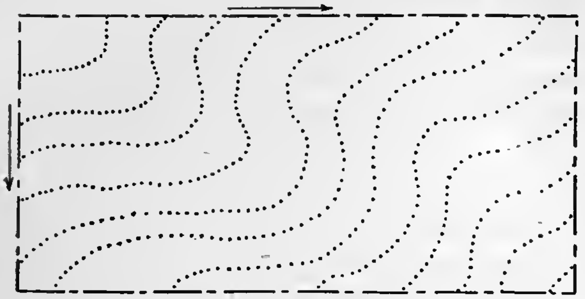
Flooding crops in checks or compartments has been practiced in various forms from the earliest antiquity. It is still a common method of applying water in many of the irrigated regions of Asia, Africa, and Europe, and was introduced into western United States by the Spaniards, Mexicans, and Mexican Indians. On the banks of the Rio Grande in New Mexico and elsewhere in the Southwest one still sees crops of grain, alfalfa, and vegetables grown and irrigated in small rectangular check beds. The small areas inclosed and



Homemade level.

the low banks which form the boundaries closely resemble the basins in irrigated orchards. There may be from ten to fifty check beds on a single acre, and the manner of flooding the check beds is much the same as that described in basin irrigation.

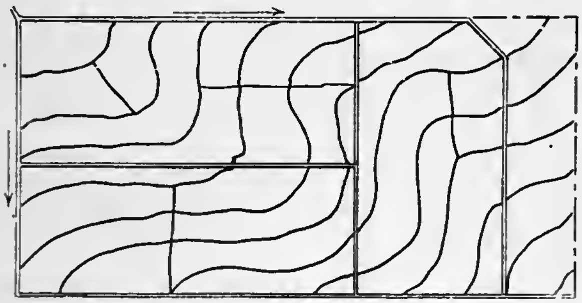
Californians, in adopting this foreign mode of irrigation, introduced many changes to adapt it to American ways of farming. Strong teams, heavy plows, and large scrapers were substituted for the hoe, spade, and mattock of the Mexicans. The owners of these farms and outfits had also large ideas of how land should be prepared for irrigation. In their opinion the small check bed, twenty by forty feet, surrounded by a ten-inch bank, might do very well to water Mexican chili,



Contour lines.

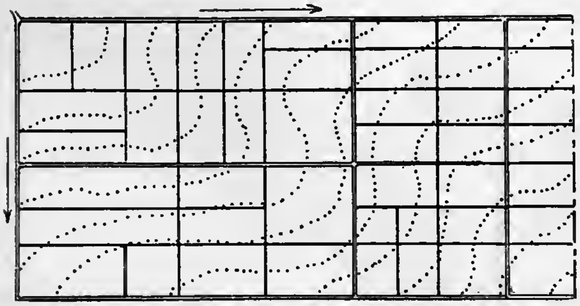
but alfalfa fields, farmed on a big scale, required to be prepared in a wholly different manner. These men, accordingly, went from one extreme to the other. From checks containing the one-twentieth of an acre they increased the size to ten, twenty, and thirty acres in each check. These large checks have proved failures from the start. The farmers who adopted this style years ago have had no end of trouble in lowering the levees and reducing the size of the checks.

The checks of from two to five acres, which the



Contour checks.

farmers around Bakersfield considered about the proper size twenty years ago, are now thought to be too large. there are, of course, conditions in which large checks may be used to good purpose. When, for example, the slope of the land is slight and the volume of water which may be turned into the supply ditch is large, there might be a small saving in having eight checks instead of sixty in a forty-acre tract. However, this

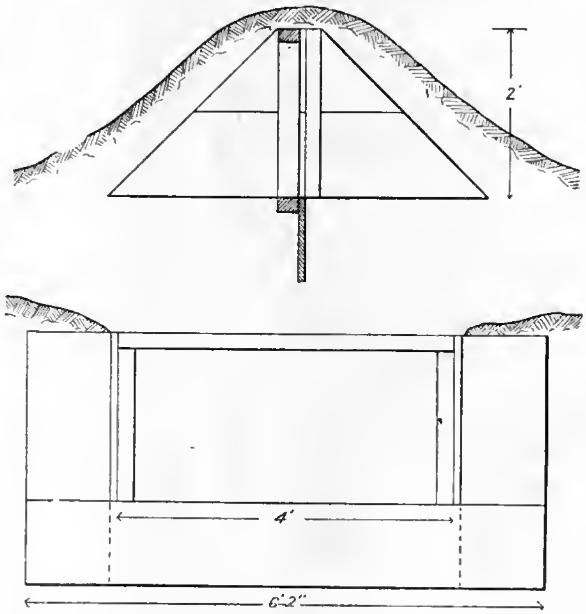


Rectangular Checks.

slight saving in the first cost of preparing the land is soon lost in the waste of water, unequal distribution, and consequent lessened yields.

Mr. Steve Luin, superintendent of the Madera Canal and Irrigation Company, advocates in the strongest manner a reduction of the present checks. which vary from three to five acres, to about one and one-half acres on all the 10,500 acres irrigated by that canal. At present the usual custom throughout the San Joaquin Valley is to limit the checks to an average of about three-fourths of an inch.

As regards arid America, the check system of irrigation is confined principally at the present time to the San Joaquin Valley. It is also used in irrigating the rice fields of Louisiana and Texas,* and a modification of the same system is to be found on the alfalfa fields



Check box, showing section across embankment at top and lengthwise of bank at bottom.

of Arizona and in the Imperial Valley in southeastern California.

There are several reasons why irrigation by checks should be so popular in the San Joaquin Valley. The soil in many parts is porous, containing a high percentage of fine sand. In such districts it is doubtful if any other method of applying water would be so successful. As a rule, the slope is also slight, which enables the farmer to form check after check with only a few inches of difference in elevation. It is due, however, to the character of the streams which furnish the water supply for the valley that the check system is so generally used. These streams head in the Sierra Nevada Mountains, where the precipitation, particularly in the form of snow, is heavy and they are all subject to floods in the spring. After these spring floods subside, the flow is often extremely low, owing to the small catchment area, the lack of summer rains, and the excessive evaporation. Irrigation works have accordingly to be planned to take care of a large volume of water during the spring months. The Tuolumne River, to cite a somewhat extreme case, frequently discharges enough water to cover 20,000 acres a foot deep in a single day in May, while the total discharge for the month of August may be little more than this. In great fluctuations of this nature not only must the canal engineer and superintendent adapt their structures to carry large volumes, but the irrigator is under the same necessity to form his checks, sluice boxes, and

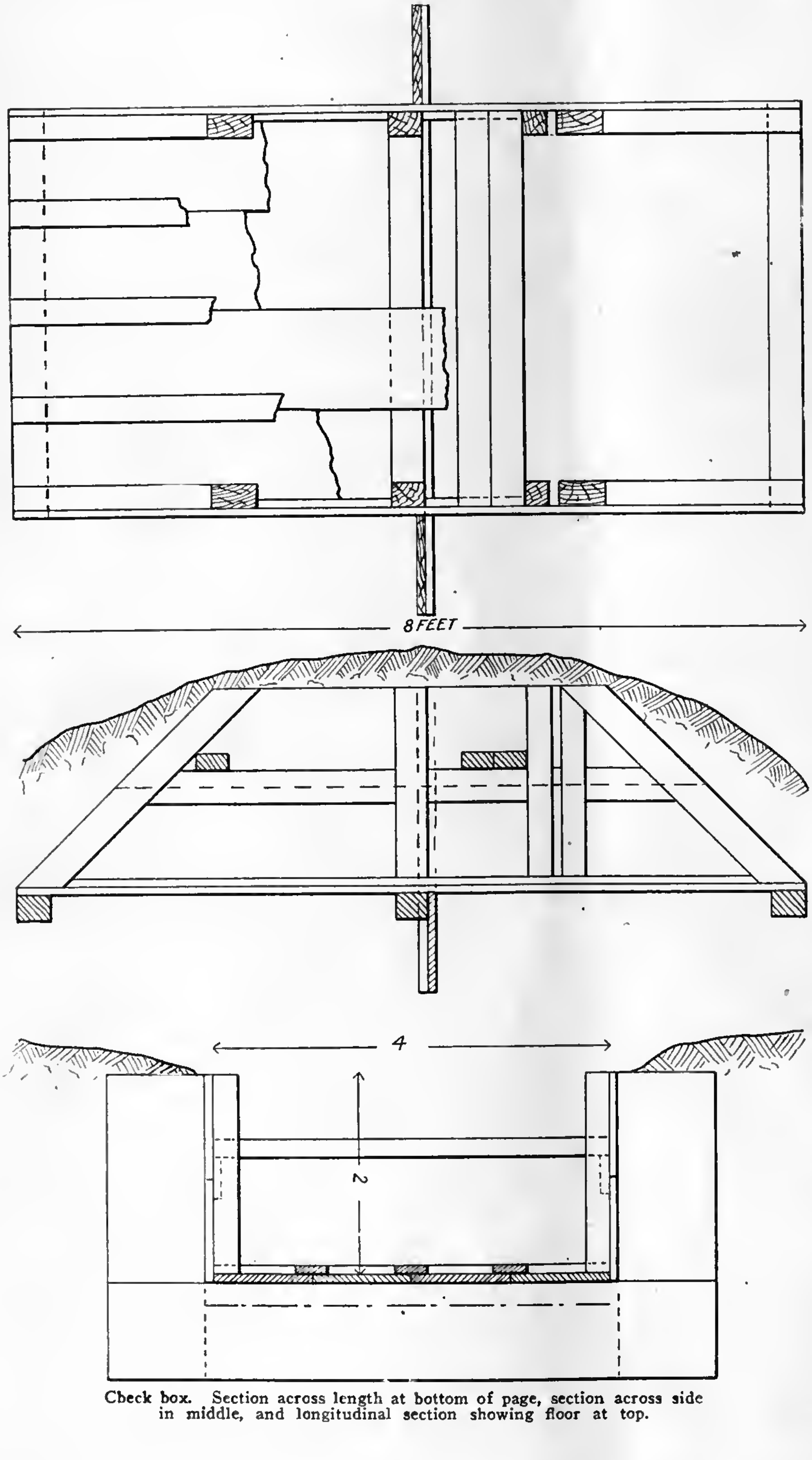
*U. S. Dept. Agr., Office of Experiment Stations Bul. 113, Irrigation of Rice in the United States.

lateral ditches in such a way as to accommodate large volumes for short periods of time. There is no other system practiced in the West which enables one man to handle from ten to twenty cubic feet per second without assistance and with such little waste.

LAYING OUT CHECKS.

The plan followed in laying out checks differs more or less in each district and on neighboring farms. It is seldom that two engineers or surveyors adopt the same methods. In the description which follows there has been given in a general way and with some changes the plan followed by Mr. F. E. Smith, of Ceres, Cal.

One man is equipped with an ordinary engineer's level, another with a leveling rod, and a third, if he is available, carries a hatchet and stakes or else a long-handled shovel. The instrument man, by taking rod readings at different points of the field, gains a general knowledge of the high and low places as well as the different slopes. He then sets up his level to command the upper end of the field, which we shall assume contains forty acres, and sends the rodman to the highest corner, where he drives a stake flush with the average ground surface and takes a reading. It is well to locate this starting point by a witness stake, on which is written the assumed elevation, so that this bench can be readily found when needed to check levels. If three-inch contours are desired, the rodman raises the target five and two-tenths feet and proceeds from the high corner down one of the margins of the field until the level line from the instrument again intersects the middle of the target, where a stake is driven to mark the beginning of the first contour. The rodman then proceeds with clamped rod to locate the first contour by shifting the rod from place to place at intervals of, say, thirty paces until the target is on a level with the instrument. These points on the contour may be marked by small piles of dirt or by temporary stakes. It is a good plan to follow the rodman, keeping about 200 feet in his rear, with some sort of ditch plow which marks each contour by a furrow. A walking plow is not suitable for this purpose, since the plowman must be elevated in order to see over the horses and improve on the line indicated by the stakes, or marks, by rounding out the angles. In like manner other contours are laid out until the forty-acre tract presents the appearance shown in Fig. 6.



Check box. Section across length at bottom of page, section across side in middle, and longitudinal section showing floor at top.

The next task is to subdivide the space between the contours into checks of suitable size and provide for the location of boundary and field ditches to convey water to each check. No hard and fast rule can be laid down for the arrangement of the ditches. The field under consideration may be subdivided as shown in Fig. 7, in which the double lines indicate the ditches and single lines levees. This forty-acre tract would contain about forty checks. If conditions were favorable and it was deemed advisable to have the checks contain on an average two acres instead of one, the same diagram would apply to an eighty-acre tract.

THE TWELFTH NATIONAL IRRIGATION CONGRESS.

HELD AT EL PASO, TEX., NOVEMBER 15-18.

The Twelfth National Irrigation Congress, which was held at El Paso, Tex., November 15-18, was interesting from many points of view. While the attendance at the Congress was not as large as expected—in fact, there were probably not to exceed 500 accredited delegates in attendance—the impression is that great good was accomplished in its deliberations, and El Paso is to be congratulated upon the manner in which she handled her end of the affair, and to the citizens of that border city is due the thanks of the many who attended for their uniform kindness and courtesy. There is no doubt but that had the Congress been managed as was the Ogden congress the attendance would have been much larger. The general feeling among the actual irrigators, State engineers and a large number of those directly interested in the subject of irrigation against the Maxwell-Booth combination had, no doubt, much to do with the small attendance.

The twelfth Congress was managed on different lines from any former affair of the kind, in that the convention met in sections at various places about the city of El Paso, the main meeting place being at the new convention hall. Considerable dissatisfaction was expressed by many of the delegates at the fact that it was impossible to keep in touch with the deliberations of the Congress, as only one meeting could be attended at a time. It is the general impression that the section system will not be adopted at future congresses.

The main convention hall was beautifully decorated with the national colors of the United States and Mexico, and the first meeting was taken up with addresses of welcome and responses. The following letters of greeting to the National Irrigation Congress from the Presidents of the two great republics of the western hemisphere, each expressing deep interest in the meeting and regret at his inability to be present, were read. We also reproduce, in this connection, letter from Mexico's Vice-President and letter of invitation sent to General Diaz, President of Mexico, by William A. Clark, president of the Twelfth National Irrigation Congress:

PRESIDENT ROOSEVELT TO THE IRRIGATION CONGRESS.

WASHINGTON, D. C., November 10, 1904.

To the National Irrigation Congress:

It is a pleasure to send my greeting to you, both as President of the United States and as a man who has lived in the West and is eager for its prosperity Whatever any man or body of men may believe as to any question in political controversy, we may all unite in the great duty of internal improvement; the duty of making every foot of soil, every stream and every other resource of natural or human origin contribute to the very utmost to the permanent prosperity of our country.

I congratulate you because you are no longer striving for what once seemed a distant hope; you are no longer engaged in a campaign of education for the passage of a reclamation act. On the contrary, your first great object is achieved. You have yet to consider what has been done and what is being done under that act by the reclamation service, to consider means to give it its largest and widest results and to discuss the broad problems of irrigation methods and practices.

It was through your efforts and those of men like you that the people of the United States, as a nation, undertook to attack the desert and to do away with it only so far as there is water now for that purpose, but to the fullest extent for which water may be developed hereafter. Such an attack can be successful only when based on accurate knowledge.

When the reclamation act was passed the essential facts as to stream flow had been ascertained in many parts of the United States, and the scientific basis for national reclamation, which otherwise would have taken years to accumulate, was already in a large part at hand. The fact that so much progress has already been made by the reclamation service is a striking example of the advantage of scientific investigation by the general Government. It may be true that to the man whose interest is limited by immediate results the admirable work of the reclamation service at times seems slow, but we are building for a great future, and it is far more important that the works built should be permanent and successful than that they should be completed in haste. There will be no unwise hurry, neither will there be any unnecessary delay. Most of the great problems of organization and methods have now been solved and progress in construction and settlement is being made with increasing rapidity.

The passage of the reclamation law was a great step toward realizing the best use of all public lands. For many of these lands their best use is to produce water for irrigation. But always and in every place the best use of public lands is their use by the man who has come to stay. There are, unfortunately, in every part of our country a few men whose interests are purely temporary, who are eager to skim the cream and go. Instead of using the natural reservoirs, upon which national irrigation depends, to the permanent loss of every agency which makes for the true development and lasting greatness of the irrigable States, such interests can not be allowed to control.

Now that your first great object has been accomplished in the passage of the reclamation law, you should make yourselves the guardians of the future and the unrelenting and watchful enemies of every attempt to waste any of the great resources in forestry, grazing and mineral wealth, the foundation stones of newer and greater West. For irrigation and every other interest which you represent, the period of exclusiveness is past. The stock interests are no longer independent of the mining interests, nor either of them independent of the irrigator. A closer interweaving than ever before is at hand among all the great interests of the whole country. One can not prosper without others. So the future growth and greatness of the other Western interests will depend, in the first degree, upon the development of irrigation, and the development of irrigation will depend upon the protection and wise use of the existing forests and the creation of new ones and the proper control of the grazing. Your work for the good of one interest is for the good of all.

THEODORE ROOSEVELT.

GENERAL DIAZ' LETTER.

MEXICO, October 21, 1904.

Hon. William Andrews Clark, President Twelfth National Irrigation Congress, New York.

Dear Sir: I have received the courteous and esteemed invitation which you were kind enough to extend to me for the interesting meeting of the National Irrigation Congress which will be held from the 15th to the 18th of next November in the progressive city of El Paso, Tex.

As much for the importance of the transcendental matters which will there be treated of as to reciprocate the kind consideration with which you favor me, I would take sincere pleasure in attending if my official duties would permit, but they are absolutely the only ones which deprive me of that great satisfaction, and I must content myself with being with you, though absent from your meeting, with sincere wishes that the most complete success may crown the intelligent and patriotic work of the illustrious congress over which you preside, and which will undoubtedly influence powerfully the solution of the many problems relating to irrigation and the forest industry. The government thus understanding it, the Department of Fomento and some of the governments of the States of this republic will be duly represented in that assembly by their respective delegations. I am, very truly yours,

(Signed.) PORFIRIO DIAZ.

FROM MEXICO'S VICE-PRESIDENT.

The reply of the Vice-President of Mexico, who was also invited to attend, was as follows:

HERMOSILLO, MEXICO, November 6, 1904.

President National Irrigation Congress, El Paso.

Dear Sir: I reply to your esteemed letter dated the 24th of last month, and thank you for the invitation which you sent me to attend the National Irrigation Congress which will be held in that city during the present month and beg to advise that I am sorry not to be able to attend notwithstanding my desire to do so. I am, with all consideration,

Sincerely yours,

(Signed.) RAMON CORRAL.

GENERAL DIAZ' INVITATION.

The letter to Mr. Diaz inviting him to come was addressed in September and was as follows, being sent to Mexico by Hon. Francisco Mallen and James Magoffin, special messengers from the Congress:

NEW YORK, N. Y., September 19, 1904.

His Excellency General Porfirio Diaz, President of the United Mexican States, City of Mexico.

Honorable Sir: In behalf of the National Irrigation Congress, I have the honor to hereby extend to your Excellency a most respectful invitation to its next meeting, in the City of El Paso, Texas, November 15-18, 1904.

The purpose of this Congress, representing the people of the various States of the Union, is to discuss, with a view to solving the many problems connected with irrigation and forestry; and, it being an appreciated fact by the organization that Mexico has for centuries successfully applied irrigation to agricultural purposes and has been foremost in thus reclaiming the desert to the use of man, it is indeed chiefly in recognition of this educational service from the people of Mexico to our own, and the hope of obtaining the co-operation and counsel of delegates from the various states of your wonderful country, as well as on account of the friendly relations so happily existing between the sister republics that the Congress has selected El Paso, on the border of both, as the place of its next assemblage.

The Congress therefore, avails itself of the opportunity to address to the governors of the various states of the Republic of Mexico invitations that they may send delegations, who will be received in full membership in the Congress.

We trust, further, that we may, without presumption, indulge in a still higher and more cherished hope, which is that your Excellency will honor the Congress by your presence at its above named session.

This invitation is respectfully transmitted to your Excellency through the favor to us of your worthy representative at El Paso, Texas, Consul Francisco Mallen, who has rendered esteemed services toward the success of the approaching assemblage, and is an influential member of the committee of arrangements.

With assurance of my profoundest respect, etc.,

WILLIAM ANDREWS CLARK,

President of the Twelfth Irrigation Congress.

The Mexican National Band sent by President Diaz figured largely in the entertainment of the delegates.

It is not our intention to publish a detailed report to the Congress at this time, but the different papers which were read in the various sections will be reproduced during the coming year in the columns of this journal. It was said by one of the delegates that many of the papers read by scientists at the Congress could not have been purchased by magazines at $200 each. All of these papers and the principal reports, as stated, will appear in the columns of THE IRRIGATION AGE. In discussing the Congress and its effects the Hon. W. W. Turney, president of the local organization in El Paso and one of the prominent citizens, had the following to say:

"While the attendance was disappointing, yet the importance of this Congress to this section of the country is a feature to be considered apart from the usual benefits accruing to us from gatherings, such as carnivals and the like.

As a matter of fact, the expenditure of money by the visitors to the city is a point which might be lost sight of entirely and still the meeting of the National Irrigation Congress here will be handed down to history as the greatest event in the development of El Paso and of the Rio Grande Valley.

In providing for the entertainment of visitors the members of the local committee had no means of ascertaining the number of visitors to be expected and were compelled to rely entirely upon the statements made by officials of the national organization. The attendance of delegates was somewhat overestimated by them, but among those who attended were some of the brainiest men in the country.

When our Invitation Committee went to Ogden last year to capture the Congress it made certain promises which the Local Committee, of which I became Chairman, felt compelled to carry out. This we have done to the letter, as is evidenced by the many expressions of satisfaction heard from all the delegates attending the Convention.

Among the substantial benefits to accrue from the meeting might be mentioned the solving of the irrigation problem of this portion of the Rio Grande Valley by the endorsement of the Elephant Butte project. A settlement of this question which has so long existed regarding an equitable distribution of the waters of the river, if settled right and in justice to our own people and our neighbors, would of itself justify an expenditure of many times the amount of money it has cost the people of El Paso to entertain the Congress.

I am not yet personally prepared to say that the proposed settlement of the rival dam questions is fair to all concerned, for I have had no time to give the subject any thought, but I do sincerely believe that much was done at this Congress toward the consummation of the great irrigation project for the valley.

I sincerely hope that the people of El Paso will take the same view that I hold concerning the great importance of the last session of the Congress and of the great good which will result."

It will be noted that Mr. Turney, as well as other citizens, was somewhat dissatisfied with the misleading claims of Chairman Boothe, who predicted an attendance of 3,000 or more delegates. It is all very well to make large claims, but it is doubtful if it was fair for the members of a crowd who are running outside affairs to mislead the citizens of El Paso in this manner.

Mr. William E. Smythe, who conducted one of the sections, rendered valuable aid and voiced the sentiment of the delegates present in thanking the citizens of Texas, and El Paso in particular, for their hospitality and kindness.

The following resolutions, some of which will be discussed later on in this journal, were adopted by the Congress:

Our thanks are due and are hereby heartily tendered to Hon. W. A. Clark for his manifold and valuable services as President of this Congress during two successive terms.

It is the opinion of the National Irrigation Congress that the National Irrigation Law be so extended by Congress as to include the State of Texas within its provisions in so far as to permit the Secretary of the Interior to direct engineers of the United States Reclamation Service to examine and report upon feasible irrigation projects, and when approved according to the terms of said law to superintend their construction to the end that Texas may have the benefit of the same service that is now extended to the other arid sections.

The full extent of the National Reclamation Act should be printed in the official proceedings of this Congress and all the proceedings of the present Congress be published in book form and properly indexed; and that such published report should include the constitution and by-laws of the Twelfth Annual Session.

The appropriation of funds for forest planting on denuded watersheds in the forest reserves is essential to the progress of irrigation, and we strongly urge upon Congress legislation to that end duing the coming session with the view of increasing the value of streams still flowing and restoring those which have disappeared.

We express the fullest confidence in the honesty, ability and capacity of the officials of the reclamation, forest and weather service and commend its impartial and non-partisan administration; and our hearty thanks are hereby tendered to the officials of the Interior Department and of the Department of Agriculture who have so ably contributed to the success of the meeting.

We heartily commend the work of the Weather Bureau in the preparation of the climatological dictionary now in progress, and we bespeak for this publication the widest possible publicity.

We repeat and emphasize the resolutions of the previous Congresses in favor of the consolidation of all Government forest work in the Department of Agriculture, owing to the peculiar fitness of that department for the work, and urge the immediate passage of the bill for this purpose now before Congress.

The presence of the distinguished delegates from our sister Republic of Mexico has strengthened the bond of friendship between the two Nations, as well as enlarged our scientific and general knowledge of this continent, and in appreciation of the cordial treatment of this Congress while we were on Mexican soil, by the officials of the State of Chihuahua and delegates to this Congress from the Republic of Mexico, we cordially invite the Republic of Mexico to send a delegation of her citizens to the National Congress to be held in Portland, Oregon, in 1905.

We endorse the policy of the Government in the construction of a ship canal along the west shore of the Sabine Lake in Southwest Texas with the view to opening to navigation the Sabine and Naches Rivers, which, in addition to opening the inland fresh water harbors nearest Kansas City and St. Louis, has aided in conserving the fresh water supply of these streams for rice irrigation, and we urge that similar work be extended to the localities throughout the Nation where practicable.

It is the sense of this Congress that the remaining public domain should be sacredly preserved to all the people of the United States and should be rigidly reserved for the benefit of actual homeseekers who will live upon the land and in good faith cultivate the soil. We recognize that much has been accomplished to this end; and under the provisions of the national irrigation law, forty million acres of agricultural land has been withdrawn from entry except under that act and from the operation of laws which permit the absorption of public lands for private speculation, and eighty million acres of timber land has been withdrawn from entry in order to protect the watersheds, thereby increasing the source of water supply and conserving the public good.

In further pursuance of this wisely established policy of preserving the public domain in the interest of the entire people we urge the repeal of the timber and stone act, of the desert land law and of the commutation clause of the homestead act.

As a substitute for the timber and stone act we favor the adoption of a bill passed by the upper branch of Congress at the last session, repealing the said act and providing for the sale of stumpage and for the application of the proceeds thereof to the reclamation fund.

As a substitute for the desert land law and the commutation clause of the homestead law we recommend an arid homestead law, which shall limit the entry of any one individual to one hundred and sixty acres, which shall permit a reasonable intervening period for reclamation before requiring continuous residence, provided, however, that after reclamation the occupant shall be required to live in the land five years before securing title as settlers are required to do under the National irrigation law. We also recommend the repeal of all acts permitting the selection of lieu lands, including any and all laws authorizing the issuance of any kind of land scrip, and recommend legislation for the valuation and purchase by the Government, if necessary, of all lands in private ownership within the limits of the forest reserves.

We fully recognize that the funds now available are inadequate to the realization of the National irrigation policy upon a scale commensurate with the opportunities of the West and the needs of the Nation, and we favor a non-interest bearing loan by the Government to the reclamation fund, to be used in the construction of projects approved by the Secretary of the Interior and to be repaid by the owner of lands benefited, in accordance with the provisions of the present law.

But we would not have the West depend alone upon National aid in the development of its resources, and urge the several Western States and Territories to adopt legislation providing for the formation of irrigation districts, which shall be able to raise funds by the sale of bonds, said districts to be organized only upon approval by the Secretary of the Interior, who shall employ the engineers of the reclamation service in the construction of district irrigation work. By this means the reclamation fund will be supplemented to the extent of millions of dollars by every State and Territory, while the benefits of National administration will be vastly extended. We commend this subject to the earnest attention of the Legislatures of our Western States and Territories.

It was generally understood that the Maxwell crowd would urge the passage of resolutions favoring the repeal of the commutation clause of the homestead act, the desert land act and the timber and stone act, but it is not to be supposed that these resolutions will have much weight with the national congress in view of the exposé made of the motives of Maxwell and his crowd.

New Union Passenger Station, El Paso, Texas.

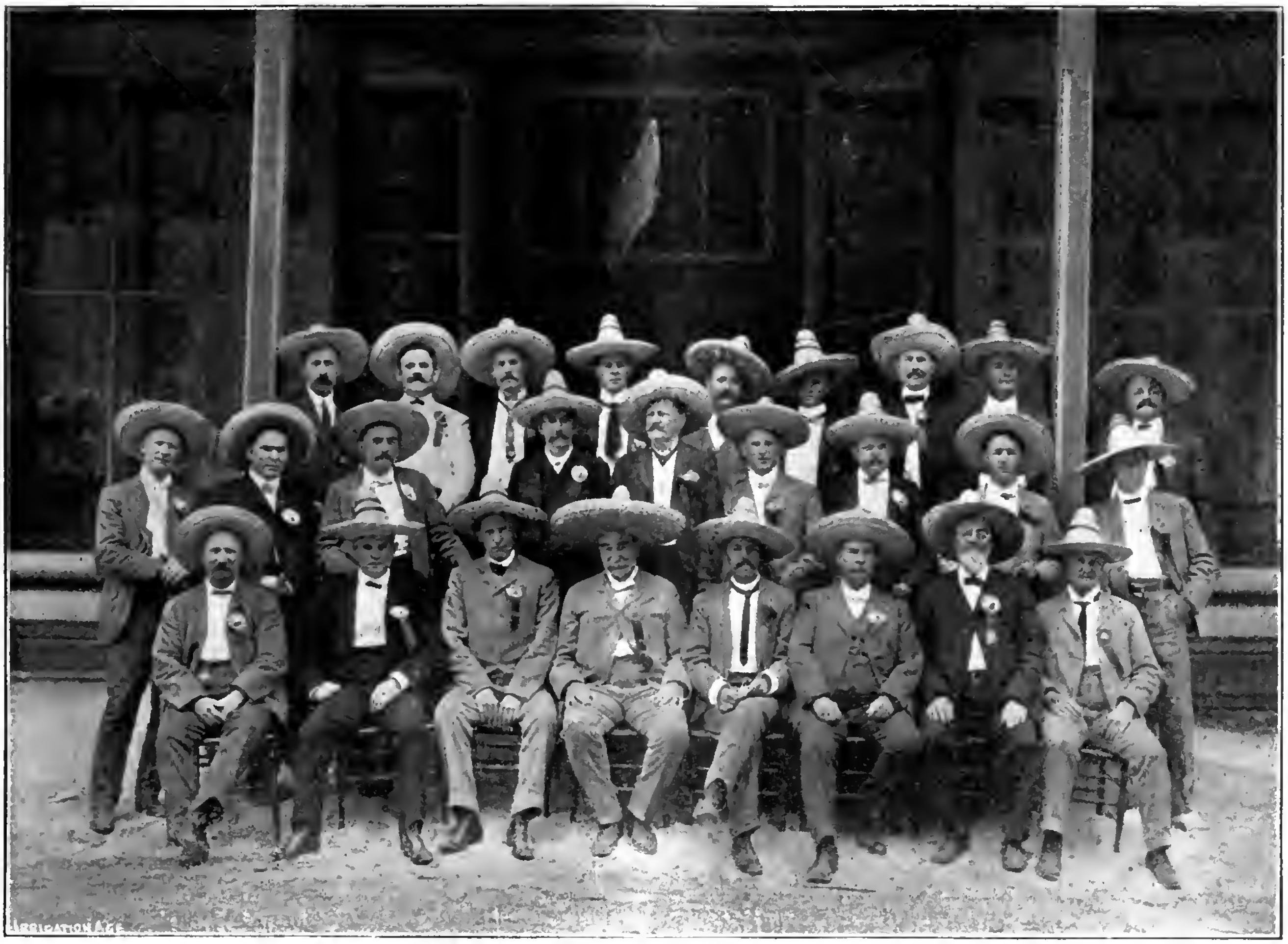
The following resolutions were adopted favoring the Elephant Butte dam site for the reclamation of the Rio Grande Valley:

At a meeting of the representatives of the Rio Grande Valley of New Mexico, Texas and Mexico, in attendance upon the Twelfth National Irrigation Congress, held at El Paso, Texas, November 15 to 18, 1904, the following resolutions were unanimously adopted, the Mexican delegates not voting because of absence of instructions:

Whereas, the question of an adequate water supply for domestic and irrigation purposes for the Rio Grande Valley has for years been a question of the highest importance and an issue concerning the public interests paramount to all others; and

Whereas, the Reclamation Service of the United States, by its splendid and valuable work and investigations, has demonstrated that the only feasible manner in which a full supply of water can be secured is by the erection of a dam or reservoir, under the provisions of the Reclamation Act, at a location known as the Elephant Butte site, at or near Elephant Butte, New Mexico; and

Whereas, it has been demonstrated by scientific research and investigation that a sufficient supply of water to supply the needs of irrigation in the Rio Grande Valley, in New Mexico, Texas, and Mexico, can be had through the erection of the said Elephant Butte dam, now, therefore


Group of El Paso Citizens who Captured the Congress at Ogden.

Be It Resolved, in consideration of these facts, that we do hereby sincerely, unanimously, and heartily approve the splendid and valuable work of the Reclamation Service under the Department of the Interior at Washington, and its officers in the Rio Grande division in New Mexico and elsewhere, and we heartily endorse and approve the proposal of building said Elephant Butte dam as a happy solution of the vexed question that has heretofore embarrassed the parties interested, and we unitedly pledge ourselves to do all in our power to assist the said Reclamation Service in any way required of us to enable the Department to erect the said Elephant Butte dam at the earliest possible date; provided, that an equitable distribution of the waters from said reservoir be made with due regard to the rights of New Mexico, Texas, and Mexico.

Governor Pardee, of California, was elected president of the Thirteenth National Irrigation Congress, which will be held at Portland, Ore. A list of the vice-presidents and members of the executive committee will be found elsewhere in this issue. The executive committee, or a small portion of it, met immediately after adjournment of the congress and elected Boothe chairman for another year. The report is that Mr. Boothe protested, but we fear that the gentleman bringing the report must have been slightly misinformed, as there is no record of Mr. Boothe ever having entered protest against an appointment of any character. J. Tom Richardson, of Portland, Ore., has been made secretary of the thirteenth congress.

In this connection we are showing a birdseye view of El Paso, also illustrations of the new Union Depot, which is in course of construction, and a view of the proposed convention hall, in which congresses which meet in El Paso in the future will convene. We are also reproducing half-tone showing group picture of the El Paso delegates who captured the twelfth congress at Ogden in 1903.

NOTES ON THE CONGRESS.

Much dissatisfaction was expressed by visitors at the rates charged by some of the hotel people. At one hotel a rate of $8 a day was asked for one person occupying room with bath. As this is so much higher than the usual rate for the same room, it is reasonable to suppose that those who were asked to pay it will not be likely to patronize that hotel again, should they visit El Paso in the future.

The delegates and newspaper men who visited El Paso were all pleased with the kindly manner in which they were treated by the local newspaper men. El Paso has three good daily papers, all of them conducted by men of ability and public spirit, and that city should feel proud that she is represented to the world at large by papers of such strength and attractive appearance. Mr. Slater, editor of the El Paso *Herald,* delivered a very pleasing address at one of the early sessions of the congress.

"Ozone George" Maxwell came into El Paso on the second day of the congress from Arizona, where he met such overwhelming defeat in his efforts to elect Mr. Flower as a territorial delegate to Congress. From the reports of the Arizona delegates the people of that Territory are thoroughly disgusted with Maxwell and his methods. The people of Arizona feel that "Ozone George" should have kept his fingers out of their fight, and it is said that he has made the statement that he will not mix up in any way again with Arizona or its people. This statement, if true, should be exceedingly pleasant news for the good citizens of Arizona.

We are showing in this issue, in connection with our report of the irrigation congress, photos of Mr. A. L. Klank, elected vice-president of the irrigation congress from Illinois, and Mr. William Hale Thompson, who is executive chairman from Illinois. Both of these gentlemen are progressive and are actively interested in irrigation and will prove efficient officers.

BIRD'S EYE V

Mr. Klank is industrial commissioner of the Chicago & Eastern Illinois Railway Company, part of the Frisco system, with headquarters at Danville, Ill. Mr. Thompson is a Chicagoan of more than ordinary prominence, having been at one time alderman of the Second Ward, and at the present time is county commissioner of Cook County. He has been interested in the West and consequently in irrigation, having been at one time engaged in the cattle business in Wyoming and Montana. Mr. Thompson is also president of the Illinois Athletic Club and is prominent as an athlete, as well as being one of Chicago's politicians of the cleaner sort. The delegates from Illinois, to whom the appointment of these officers is due, are to be congratulated on their selection.

HON. F. W. MONDELL ON LAND LAW REPEAL RESOLUTIONS.

The *News-Journal*, New Castle (Wyoming), prints the following under date of November 25:

"Congressman Mondell was asked by the reporter for the *News-Journal* whether, in his opinion, the resolution recently adopted at the National Irrigation Congress, held at El Paso, favoring repeal of the Timber and Stone Act, the Desert Land Act, and the Commutation Clause of the Homestead Law, would have any influence on Congressional action.

"Congressman Mondell said:

"'I do not think it will. The action taken by the late Irrigation Congress at El Paso was discounted in advance. It was a part of the scheme of the repealers to secure a meeting at El Paso in order that the land grant lobby, which had no end of railroad transportation to distribute, might pack the Congress with the view of securing the passage of such resolutions as they desired. It has been notorious for months that Mr. Maxwell, head of the land grant railway repeal bureau, and those in his pay, were drumming up delegates largely from States where irrigation is not practiced and to which the National Irrigation Law does not apply, and offering free transportation to El Paso and return for such delegates as would vote for anything that Mr. Maxwell proposed. Those delegates not favorable to the schemes of the repeal bureau paid their fare or stayed at home. The outcome was just what all who were conversant with the situation had expected.

"'While the discussions in the Congress largely related to the work under the National Irrigation Law, the meeting was held in Texas where the law does not apply and on the border of Mexico, and to cap the climax of inconsistency this Congress, meeting in a non-public land State just across the Rio Grande from foreign territory, recommended the repeal of those laws which are the principal sources of income of the National Irrigation Law. If the recommendation of the Congress were enacted into law not a single new enterprise could be started under the National Irrigation Law and those already projected and for which only partial apportionments have been made from the Irrigation fund would remain incompleted. The entire procedure is conclusive of the fact, well understood by those who have studied the methods of Mr. Maxwell's land grant land law repeal bureau, that it is and has been from the beginning hostile to the aims, purposes and provisions of the National Irrigation Law.

"'In view of the fact that the objects of the Maxwell-Boothe repeal crowd are well understood the true friends of the National Irrigation Law can view with equanimity the ridiculous attitude in which their packed Irrigation Congress placed itself in recommending the cutting off of the sources of income of the National Irrigation fund before a single acre of land has been reclaimed under it.'"


'ASO, TEXAS.

THE PRIMER OF IRRIGATION.

Chapter XX.

IRRIGATION OF PROFITABLE CROPS.

The crops a farmer should raise on his land with profit to himself depend upon numerous conditions, many of them variable. No matter what his desires may be, no matter what his neighbor may do or raise, or how much he may succeed, every farmer is a tub that must stand on its own bottom. He must say to himself: "What is my land fit for? What are my means of cultivation, my water supply? What does the market demand, and how can I reach that market without paying out all my profits in transportation?"

If all the conditions are unfavorable to the raising of crops with profit to himself, the author's advice to him is to raise nothing in the way of crops for market, but raise all the produce possible on your land and feed it to stock—cattle, sheep, hogs, poultry. There is always an unvarying demand for these products of the farm, and though the market may be glutted sometimes, yet on the whole, all the year 'round, the farmers always come out something ahead.

It appears to be the destiny of a farmer to always try experiments, put seed into his ground, and then toil and perspire to make it grow to maturity, and then get nothing for his pains. A farmer will put certain seeds into his ground, and, as this appears to be inevitable, the only thing that can be done is to help him realize on his expectations.

CEREALS.

Every farmer plants wheat. He is bound to do so or feel that he is not really a farmer.

MR A. L. KLANK,
Vice-President for Illinois, 13th National Irrigation Congress.

or beginning of December, the wheat may be plowed under after sowing the surface, and this at any time during September and October. It is good dry farming to do so, and even if the grain is to be irrigated the effect is to have a good stand by the time water is

View of Proposed Convention Hall, El Paso, Texas.

This grain should always be sown on high ground and not in a deep, mellow soil, for it is not a deep-rooted plant. In the arid and semi-arid regions, where the rains do not fall until late in November

put upon the land. The first rain that comes sprouts the seed and sends it up three or four inches, where it is ready for another rain or for an irrigation. It is the same with all other cereals.

This system would never do, however, in a moist soil. In such a case the soil should be carefully plowed shallow and harrowed and the seed drilled in, about a bushel to the acre. If the ground is surface dry it should be flooded, say two inches, then in twenty-four hours harrow and drill in the seed. Do not roll land where irrigation is practiced, because it is liable to cake, and this means evaporation. When the grains are up two or three inches it is good to run a light harrow over the field. It loosens the soil and does not harm the grain, even if it does pull up a few plants; there is always too much sown, anyway. Twenty to thirty days apart will be enough irrigation—the first one when the grain is five or six inches high, say two inches, and a month after that one inch. In hot climates it is beneficial to give a third irrigation when the grain is heading or when it is in the milk. The condition of the soil, as well as that of the plant, must be considered and the quantity of water gauged according to that. Digging down six inches will tell the condition as to moisture, and breaking off a stalk or two tell the condition of the plant. If "well" the stalk will be juicy and damp to the touch. If dry, yellowish, and breaks easily, give it water as soon as possible.

The Chinese and the Japanese plant their grain in ridges about twenty inches apart and use only about ten pounds per acre. But an acre will produce more, at least just as much, as when drilled or sown broadcast. One grain of wheat will "stool" out into sixty, and sometimes eighty, healthy stalks in this way. There are some small farmers who plant wheat along the borders of their vegetable and small fruit beds and give it careful cultivation. If planted farther apart, so as to admit of the passage of a cultivator between the rows and cultivated like corn, the result is most astonishing. The fact is that when a bushel of wheat can be grown in as small a space as a bushel of corn or potatoes there is no reason why wheat should not be grown in that manner, at least on small farms. One thing to be considered where wheat is concerned is that an excess of water spoils the food value of the grain. For feeding or forage purposes it does not make so much difference, as water in abundance increases the nutritive elements in the husk.

BARLEY.

Barley is the standard crop for forage, or "hay," in the arid and semi-arid regions. It will grow on almost any kind of soil, and being a deep-rooted plant it does not depend so much on irrigation as wheat. It will grow a good stalk and form a good head for hay with six inches of rainfall and produce good, marketable grain with ten inches and no irrigation.

The soil should be plowed deep and well pulverized, then drilled in either in the fall or spring, or sown broadcast. To raise it to perfection, and it repays the labor of doing so, it should be given water when about four inches high and another irrigation when the heads are in the milk. It is a very profitable crop to raise for brewing purposes, the demand for malting barley being constant and increasing. Moreover, the price is much better than that for wheat. It will grow two miles above the sea level and flourish in alkali soil that will kill a sugar beet.

OATS.

Oats, fall or spring planted, require plenty of water and attention, or they will refu-- to grow. There is one exception, however, and that is the case of the "oat hills" in southern California, where a crop of fine oats springs up spontaneously every spring. The stalks grow as high as a man's head, with well rounded heads, juicy and succulent. Just before the fall rains the ground is cleared of the old stalks, a treetop or a harrow dragged over it roughly, and then left to itself; the grain comes up in about three days after the first rain of the season and does not require any irrigation at all. The origin of this singular exception to the rules relating to oats is in the old padres of the missions, who, when traveling about on their ponies for many hundreds of miles, always carried a bag of grain at their saddlebow, and when they came to a spot that

MR. WM. HALE THOMPSON,
Member Executive Committee for Illinois, National Irrigation Congress.

looked fertile they scattered the seed with a blessing that it might grow. For over a hundred years this grain grew and there was no man to harvest it, so it ripened and returned back into the soil whence it came, and now, to this day, it keeps on sprouting and never ceasing, the soil below being dry and the seed sprouting when the moisture reaches it.

However, many farmers irrigate oats frequently under the supposition that they need more water than any other cereal, and the proof of it is that the crop is enormous when well irrigated.

RYE.

This is a hardy annual that will grow to full maturity and give a good harvest with very little care and irrigation. A medium irrigation when about half grown and another when heading is sufficient. Cultivation, however, should be deep and the soil well pulverized.

CORN.

Corn is a deep-rooted plant and hence the soil should be plowed deep and care taken that there is moisture in the subsoil. There is no need of surface moisture, wherefore deep furrow irrigation, with after-liberal cultivation and soil pulverization, will produce a fine crop.

A side hill where there is seepage water is most favorable for all the varieties of corn. In some instances small fields of corn on a side hill have produced marvelously by merely filling a ditch at the top of the slope and allowing it to seep down into the root zone. On flat land, with subsoil moisture, one watering when the plant is tasseling will be ample.

In the arid and semi-arid regions corn is plowed under dry, as is the case with wheat and other cereals. Five or six grains are dropped in every third furrow a good step of the plowman apart and left to itself with a good deep cultivation when about a foot high, the earth being thrown over against the stalks.

Corn does remarkably well in deep, rich soil, but will grow very well in any soil provided the roots can reach moisture. The manufacture of starch in the plant ecomony demands great drafts upon the chemical laboratory of the soil. The bottom of the stalk of a young shoot of corn is as sweet as sugar cane, which is proof that the plant is drawing its food far below the surface, and that it is preparing to manufacture the starch which is afterward found in the ripened grain.

Corn grows better in ridges than in hills, even when not irrigated. In all cases the earth must be pulled up around and close to the stalks, not only for the purpose of mulching against evaporation of the moisture, but to shield the process of converting sugar into starch, a process quickly stopped by exposure to the elements or to desiccating atmospheric air.

All of the foregoing cereals may be grown for forage, and if cut when in the milk they are productive of good flesh on cattle and will grow at the rate of from four to six tons to the acre. Where dry farming is practiced, and the season is unfavorable for the perfection of the grain, the plant is cut for fodder or hay and fed to the cattle, and in the case of corn it is fed green to milch cows.

RICE.

This is an amphibious plant; some call it aquatic. However that may be, the ground is prepared for it as for wheat, by thorough tilling and pulverizing. The rice is sown about eighty pounds to the acre and then harrowed and rolled. Left to itself. it sprouts and grows up to about five inches without showing any aquatic properties. But the farmer then puts about an inch of water, perhaps two inches—that is, covers the field under one or two inches of water—and as the plant grows he adds more water until the field is buried six to ten inches deep. The plant grows. vigorously, and when the grain is in the milk the water is run off, and by the time the rice is ripe the ground is dry enough to harvest. It is harvested very much the same as wheat—put into bundles and piled up to be cured and ready for the separator or thresher.

In its wild state rice is essentially aquatic; the plant roots never find themselves in anything but mud. From time immemorial the Chinese have treated it as a semi-aquatic plant. and if any one has ever tried to raise it like wheat the author has not been able to learn. Perhaps it might be so grown and produce a new variety and be an addition to our valuable list of cereals.

COMMERCIAL PRODUCTS.

OISER WILLOW.

The oiser willow is used in the manufacture of baskets and its culture may be made very profitable if near the market of a large city or basket manufactory.

Some years ago Mr. G. Groezinger, a vineyardist near Yountville, Napa County, Cal., sent to Germany for some cuttings. He received about fifty and planted them along one of his lateral ditches, which always contained water, more or less of a good supply. The cuttings took root and grew beautifully, and the next year he pruned the plants down to stumps and planted the cuttings all along the ditch for several hundred feet. They grew bunchy, with thick clumps of long, slender branches drooping over the ditch and made a delightful shade. Calling the attention of a San Francisco basketmaker to them, the latter bought the supply on the ground and sent men out to prune the plants. They cut off the long branches and cast them into the ditch to soak in the water, and in a week or so came out again and stripped off the bark, leaving slender, white, pliable branches. which were speedily made into fine, marketable baskets of all sizes and shapes. After the fourth year of his planting the original cuttings Mr. Groezinger received more than $1,500 per year income from the cuttings, the purchaser doing all the work of harvesting them.

The plant will grow in any climate, provided it has abundant water during the growing season. Along a ditch is its habitat.

FLAX AND HEMP.

These two textile fabric plants, so to speak, may be raised to perfection by irrigation. They require, however, a moist soil, and for that sub-irrigation would be the proper system of irrigating them. They are deep-rooted plants and may be planted in drills or beds. Both plants are profitable for their fiber and for their seeds, the latter yielding up to twenty bushels per acre about a ton or two tons of fiber. The latter must be soaked in a ditch or other receptacle to separate the fiber from its hard envelope.

HOPS.

This plant should find a place in every garden and on every farm, if not for market purposes at least for household uses. It is very easily grown, being a deep-rooted perennial which needs a moist subsoil. The plant is propagated from cuttings, three eyes to each piece planted. At least four inches is the proper depth to plant the cuttings, and they will speedily come up and spread runners out in every direction. They should be pruned down to a few and then poled.

COTTON AND TOBACCO.

These two valuable products belong to field culture on an immense scale. Cotton may well be said to be "king" and tobacco its "heir apparent." There are no two plants in the world so necessary—that is, cotton for its economical uses and tobacco as an article of luxury. Cotton is a deep-rooted plant requiring a moist soil. Where irrigation is necessary the soil is irrigated preparatory to planting the seed and once again when the balls begin to form. The plant needs very little care. and in that respect it is the very opposite of tobacco. *(To be continued.)*

ASPINWALL POTATO MACHINERY.

Among the many standard lines of machinery on the market today in the agricultural world, none is more universally recognized for its superiority than the Aspinwall Manufacturing Company's complete outfit of potato implements for the potato grower. Thirty years of interrupted success in the great potato sections of this country and abroad has amply

Aspinwall Potato Digger on Southern Plantation.

demonstrated the merit of the Aspinwall Potato Planter, and the other machines put on the market by the Aspinwall Company from time to time, in-

Aspinwall 4-row Sprayer.

cluding Cutters, hand and power Sprayers, Diggers and Sorters, have met with full favor and constitute the most practical, accurate, modern and up-to-date automatic machines made for the economical handling of the potato crop.

Aspinwall Potato Planter.

The Aspinwall Company state that their business has increased to a remarkable degree the past few seasons, until it has been found necessary to materially enlarge their manufacturing facilities to meet the demand for the goods.

Speaking briefly of the various machines, we would say that the Potato Cutter materially lessens the labor of preparing seed for planting and enables it to be put in the ground at once, which is conceded to be the safest method. All danger of careless work or cut and bleeding fingers is eliminated.

In the use of the Potato Planter the entire work is accomplished. No additional operators, supplementary attachments, feed wheels, spouts, tubes, or other makeshifts are required. Strength and durability, simplicity and compactness, combined with the accuracy that is only found in mechanically correct and automatic machinery makes the Planter perfect.

The four-row Sprayer is automatic in action and effective in use and has demonstrated its value throughout the potato sections of the country. Inexpensive in price, light and compact, as well as free from the objectionable features of other machines, it is a favorite with the grower. Primarily a four-row Sprayer,

Aspinwall 4-row Sprayer in 80-acre strawberry field of R. M. Kellogg Co., Three Rivers, Mich.

it is frequently used for spraying tomatoes, cabbage, tobacco and other plants and vines. The Aspinwall Potato Digger is essentially an all-purpose machine, constructed to do the highest grade of work under all the varying conditions of digging that are to be found throughout the country. It has been aimed to make the machine of light draft, only a team of two horses being required in its operation. It is strong and substantial and does not cost a fortune to keep in repair nor require special attachments for different localities.

As to the Potato Sorter, the Company state that responsive to the earnest solicitation of many large growers, shippers and commission houses, they put on the market some seasons back a sorter which combined every element of success, one capable of a wide range of work, yet adapted to the use of the small grower or shipper. The hearty endorsement of this machine is evidence of its superiority.

The Aspinwall Company have recently issued a very attractive, beautifully illustrated, potato machinery catalogue, also an illustrated testimonial pamphlet, both of which can be had for the asking, and we would advise our readers to write for it.

BROUGHT BY THE POSTMAN.

Letters from Correspondents to The Irrigation Age.

LONDON, OHIO.

Editor THE IRRIGATION AGE, Chicago, Ill.:

Dear Sir—The writer discussed in a former number of THE IRRIGATION AGE the velocity of flow and the discharge in cubic feet per second of tile drains under a given head and diameter. It was there shown that the velocity of flow in feet and the discharge in cubic feet per second, approximately, was 2.27664 feet for the flow and 0.4458984 of a cubic foot for the discharge, per second, of our 6-inch tile drain.

The reader was informed that many things conspired to make all computations of the velocity of flow in feet and discharge in cubic feet, per second, of tile drains, mere approximations. Here let another be named. The internal circumference friction of a 6-inch tile drain is half as much as the circumference friction of a 12-inch tile drain, while the cross section area of 6-inch drain is only one-fourth that of the 12-inch. Here the 6-inch has half the friction of the 12-inch and only one-fourth its working capacity.

If the reader desires to witness the fidelity and honest working of our 6-inch drain during varied rainfalls let him don his waterproof and hat to make believe it rains and hie away with the writer to the field in which our 6-inch drain of 2,640 feet length and 12 feet head is at work. Now, as our 6-inch drain may be "conceity," let us figure out what our drain would do with a downpour of two inches of rain per hour. To simplify our work, let us take the discharge per second of our drain at 0.446 of a cubic foot. The discharge of 0.446 of a cubic foot of water per second would equal 26.76 cubic feet per minute and 1605.6 cubic feet per hour. There are 43,560 superficial feet in an acre and a downpour of 2 inches of rain upon these 43,560 superficial feet gives us a number of cubic feet of water equal to the one-sixth of 43,560, equal to 7,260 cubic feet and as one-half of these 7,260 cubic feet is supposed to be taken up by the soil, there remain 3,630 cubic feet per acre to be carried by a drain. Our 6-inch drain is 160 rods long and must have a strip one rod for an acre and on this acre, 2,640 feet long and 16½ feet or one rod wide, there fall in a downpour of rain of 2 inches per hour 3,630 cubic feet of water to be carried away by a drain. Can our 6-inch drain do it? No. Above you see our drain can only carry 1,605.6 cubic feet per hour, instead of 3,630 cubic feet. This takes the conceit all out of our 6-inch drain.

Now, let us see what the diameter of a drain must be to carry, as they come, these 3,630 cubic feet of water falling on an acre strip 2,640 feet long and 16½ feet wide. The discharging capacity of tile drains are to each other as the squares of their internal diameters. This gives us the proportion, as 1,605.6 cubic feet of water carried per hour by our 6-inch drain are to 3,630 cubic feet to be carried, so is the square of 0.5 of a foot to the square of the required diameter. The square of 0.5 of a foot is 0.25 of a foot, and multiplying 3,630 feet by 0.25 gives 907.5 cubic feet for a product and these 907.5 cubic feet divided by 1605.6 gives a quotient of 0.5645 of a foot for the square of the diameter of the required drain to discharge 3,630 cubic feet from our strip 160 rods long and one rod wide. The square root of 0.5645 of a foot is 0.75 of a foot, or 9 inches, the required diameter.

Next let us see how wide a strip 2,640 feet long our 6-inch tile drain can do the work for. To get this we must state as 3,630 cubic feet coming upon the acre strip per hour are to 1,605.6 cubic feet discharge of our drain per hour so are 16½ feet width of acre strip to width of strip our drain can carry, that is 3630:1605.6::16½:7.3 feet, nearly.

Now, suppose it were necessary that our 6-inch drain, 2,640 feet long, should drain a strip 8 rods or 132 feet wide, what continuous rainfall per hour could our 6-inch drain do the work for? To answer this query we must compute how deep the water would be if 1,605.6 cubic feet of water carried by our drain were uniformly spread over 8 acres or 348,480, the superficial feet in 8 acres. Dividing 1,605.6 cubic feet by 348,480 superficial feet gives as a quotient 0.0046074 of a foot in depth of water over the 8 acres or 1.77 thirty-second of an inch per hour, which is equal to 1⅓ inch per 24 hours. So you can see our drain can carry away the half of a rainfall of 2⅔ inches in 24 hours.

Suppose it is and has been raining at above rate and our drain has fully got its harness on, let us go to its outfall and see how it is working there. Just see! The tile is running not more than half full, just as might be expected. The acceleration of velocity of flow in our tile has so attentuated the volume of flow as to reduce it one-half. See that barrel of molasses with its faucet 4 feet above the floor. The merchant sets his measure under and turns the faucet and a stream of molasses issues nearly half the thickness of your wrist. But see! At the measure the acceleration of gravity has attentuated the stream to the size of a goose quill. The cause is the same. Suppose we have a field of 80 acres, twice as long as wide, of comparatively level land, with a serpentine swale running somewhat centrally through it the long way. What size tile and how deep should it be laid in the swale? Since it would have to become a main to laterals and sub-laterals in the swale the tile should be laid to a depth of not less than 6 feet and deeper where the cutting across the tapering end of a swell would materially straighten the ditch and if the laterals are let in at about uniform distances, the first 40 rods at outlet of main should have 12-inch tile, the next 40 rods 10-inch, next 40 8-inch, and upper 40 could do with 6-inch or less, this supposing no water comes from the land above. If water did come on our field from the land above it would have to be provided for according to its volume. There are riparian water rights. You are above. You can not divert the natural flow of a stream of water onto the land below if the owner objects. If below, you must take the water as it comes if the owner above so desires. You have your remedy. If the land above is benefited it must assist the land below in drainage. Pardon digression.

All laterals should be let into Ys in the main on side and never into Ts. The flow of water in a lateral let into a main by a T tends to expend its force of flow on the inner opposite surface of the main and the flow of the volume of water in the main is impeded by having to overcome the inertia of and set in motion at right angle to its former course the volume of water entering it from the lateral.

The lateral entering our main should start at a depth of not less than 4 feet, increasing to 5 feet or more at the main.

Once more in regard to deep under drainage. Some farmers advocate the laying of tile at a depth of 20 to 24 inches for the reason, they say, that in a downpour of rain the water can reach the tile and away so much quicker than if laid so deep. That the water could reach the tile quicker is true, but with little head to force it on its way, compared with the deeply laid drain. The advantage of tile drainage laid to a depth of 4, 5 and 6 feet over drainage to a depth of 20 to 24 inches does not end with the readiness with which the water can reach the drain. Whether hot or cold, rain or shine, snow or blow, day or night, the deeply laid drain is ever at work, so long as any water remains in the soil its capillary pores can not hold.

The air entering this deeply drained soil aerates it, slakes it like lime and makes it porous and it becomes a vast sponge, ready to drink up a downpour of rain before any water can reach the drain to put it to work. The air, composed of oxygen and nitrogen, partners in the chemical laboratory of Nature, entering a deeply drained soil, even of hard pan, thus freed from superabundant moisture, aerates it and produces in the soil those conditions necessary to plant growth. Is this all? Nay, verily. There can be no all to a thing, illimitable. Many of our soils are alkaline. With these as bases, acids form salts. Many salts are deleterious to plant growth. These salts and water have a great avidity, each for the other. Superabundant water entering a deeply drained soil absorbs these salts and in solution hies away with them adown the drain, brook, creek and river to Mother Ocean's salt storehouse. So alkaline lands by deep under-drainage in time become salt neutral.

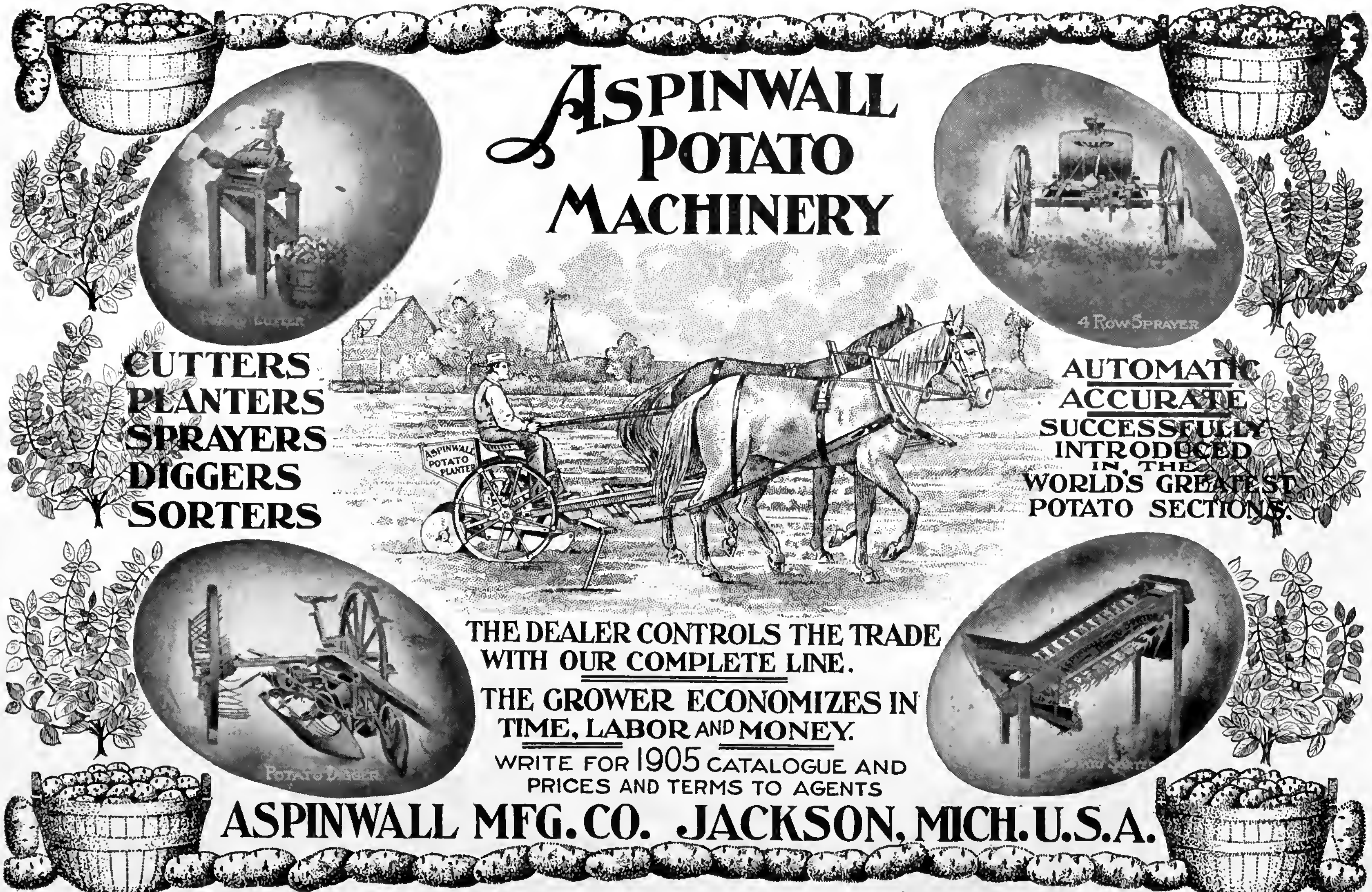
J. ARNETT.

NEW YORK CITY, N. Y., Nov. 7, 1904.

EDITOR THE IRRIGATION AGE, Chicago, Ill.

My Dear Sir—Having a deep personal interest for many years in irrigation, and being called upon now and then to write upon the subject, I am impelled on reading your anniversary number to say that I have never been able to find any publication but THE IRRIGATION AGE that would keep me thoroughly informed regarding irrigation matters. I am always glad to see THE AGE and only wish it came more often.

Very truly, CHARLES C. JOHNSON.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AUTOMATIC
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SUCCESSFULLY INTRODUCED IN THE WORLD'S GREATEST POTATO SECTIONS.
4 ROW SPRAYER
ASPINWALL POTATO PLANTER
POTATO DIGGER
THE DEALER CONTROLS THE TRADE WITH OUR COMPLETE LINE.
THE GROWER ECONOMIZES IN TIME, LABOR AND MONEY.
WRITE FOR 1905 CATALOGUE AND PRICES AND TERMS TO AGENTS
ASPINWALL MFG. CO. JACKSON, MICH. U.S.A.

. The *Sioux City Journal* prints an item from Hot Springs, S. D., stating that George Trimmer, who owns one of the most prolific nurseries in South Dakota, harvested a fourth crop of alfalfa from a patch of ground this year.

Mr. Trimmer's orchard and alfalfa fields are irrigated by water from Fall River. In this orchard large and handsome pears grow, and their flavor can not be excelled.

Trimmer is the father of fruit growing in the Black Hills.

There is only one other pear orchard in the State, that being at the Soldiers' Home. Peaches are also grown in this orchard, which was set out by Colonel Linn when he was commandant at the Home.

IRRIGATION ASSOCIATION MEETS AT MODESTO.

MODESTO, Oct. 18.—The California Irrigation Association is holding a two days' session in this city. Hon. A. M. Drew, the president of the association, is presiding. George T. McCabe and John I. Stafford, of Modesto, are the secretaries.

Delegates from all parts of the State are present, among them being some of the best California authorities on the use of water. Prof. Elwood Mead, of the State University, is taking a very active part in the proceedings. The association will be in session tomorrow, closing the convention tomorrow evening.

IRRIGATION FOR TRUCKERS.

DALLAS, Oct. 22.—Owing to the demand for property along the interurban line between Dallas and Fort Worth, the owners of large tracts are dividing their holdings into small truck farms and offering them for sale on easy terms. The most novel idea thus far carried out by an owner of a large farm was to divide it into small tracts and make arrangements for irrigating them. A large reservoir is being constructed on the place and it is being ditched in order to distribute the water. A number of artesian wells are being dug and the water from these will be pumped into the reservoir for storage. This farm is in the neighborhood of Arlington.

CHEYENNE, WYO., Oct. 22.—A party of Buffalo citizens headed by W. P. Keays has secured the segregation of 57,000 acres of land in the center of Johnson county and will construct a large irrigation canal and a series of reservoirs to reclaim the lands which are now arid and unproductive. The reservoirs will be constructed at the snow line.

Charles F. Lummis, the noted writer on Southwestern life, says that the Indians on some of the reservations in southern California are in danger of starvation, owing to the fact that no rain has fallen to start their crops and no water is on hand for irrigation purposes.

Similar reports have come at different times from the Southwest, and they would indicate that the Indian who is trying to make a living by agriculture in the arid and semi-arid regions needs material assistance in providing himself against drouth. As a rule the Indians who have taken farms in severalty try hard to make themselves self-supporting. But in many instances the support of the Government seems to be withdrawn too soon. These simple people can not make expert farmers of themselves at once. The white man has found years of patient study and effort necessary before he has even begun to conquer the problems of farming in a country where everything must be raised by irrigation.

The Government is spending millions in vast irrigation works for the white farmers of the West. This money will all be paid back through the sale of the lands benefited. Why should not the same plan prove successful when applied to the Indian reservations? A system of storage reservoirs on the California reservations of which Mr. Lummis speaks would doubtless have kept the Indians from their present suffering. The building of a storage reservoir or a practical irrigation canal is generally beyond the uneducated Indian's comprehension. But there are engineers among the Indians who are now being turned out of the Carlisle and other schools, and a system of irrigation reservoirs and canals on the reservations would give these young men and other able-bodied Indians plenty of work to do.

It is the aim of the Government to make the Indian self-supporting, and what greater step toward this end can be taken than the permanent improvement of the red man's land?

The letters sent by President Roosevelt to the irrigation congress which assembled at El Paso show that he has lost none of his interest in the reclamation of arid lands and appreciation of the importance of this work.

The influence of his administration will be exerted in behalf of the far West in this connection, and through him the whole country will be taught to recognize the claims of this section upon the good will not alone of the national Government, but of the people of the East and Central West as well.

When the country learns that every

acre of irrigated land is worth in productive possibilities two acres farmed by ordinary methods, the greatness of arid region agriculture will be more clearly recognized. The reclamation work which President Roosevelt encourages and endorses will promote this end. Possibly in the aggregate the national reclamation of arid lands will make fertile a much smaller area than that reclaimed by private enterprise. But it will do far more than all private effort that may be put forth to direct public attention to the opportunities of this section.

There remains the possibility of one error which we hope President Roosevelt will discern and so far as may be possible prevent. We refer to the interjection of national reclamation where private enterprise is prepared to carry on the work. There has been some complaint of more or less pronounced interference of this kind by persons connected with the reclamation bureau. To what extent these charges are well founded we are not prepared to state, but the fact that complaint is made suggests the existence of some friction, all cause for which should be removed. The proper sphere of national reclamation is the prosecution of enterprises for which, on account of their magnitude or for other reasons, private capital can not be procured.—*Denver Republican.*

NOTHING FINER FOR CHRISTMAS.

Any honest, responsible farmer or other responsible person can now buy a genuine Victor Talking Machine direct from the Talking Machine Company of Chicago by paying only $5.00 down, balance of $15.00 being payable

"HIS MASTER'S VOICE"

in six monthly installments of $2.50 a month. No guarantees from third parties, no deposits, leases or chattel mortgages are required from responsible parties. A free trial of the instrument at your home will also be permitted, as the Talking Machine Company will take back the instrument without charge if it is not entirely satisfactory. Note the advertisement in another column. Details can be learned by sending for catalogue and list of 2,000 records to the Talking Machine Company, Dept. 107 East Madison Street, Chicago, Ill.

When writing to Advertisers, please mention THE IRRIGATION AGE.

Vol. XX. No. 3.

THE IRRIGATION AGE

PUBLISHED IN THE INTEREST OF IRRIGATION AND DRAINAGE

JANUARY, 1905.

THE D. H. ANDERSON PUBLISHING CO., Publishers.
112 DEARBORN ST., CHICAGO.

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ESTABLISHED 1885
WITH WHICH IS MERGED
THE DRAINAGE JOURNAL
ESTABLISHED 1879

SPECIAL FEATURES

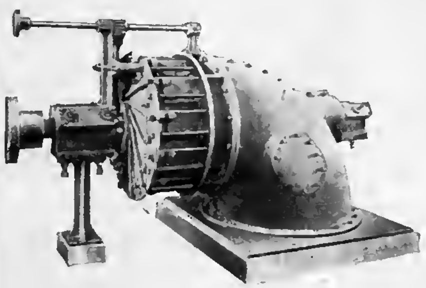
Non-Repeal of the Land Laws

Current Wheels

Report of Drainage Commission

Preparing Land for Irrigation

CHARLES A. COX CHGO.



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IT IS EASY TO SELL LANDS THROUGH ME BECAUSE I NEVER MISREPRESENT CONDITIONS

THE Cadillac Tract is a body of about 25,000 acres of splendid farming and fruit land. The soil is ideal for this latitude—a warm, sandy loam underlaid with clay and gravel—and produces abundantly all staple crops characteristic to the Temperate Zone. It is not a hard job to remove the stumps, and, when they are disposed of, you have virtually an old field. Blue grass and clover are indigenous to this country and spring up without seeding wherever the land is cleared. For root crops like potatoes, rutabagas, turnips, carrots, parsnips, also onions, cabbages, and for live stock and fruit, it is surpassed by no other part of the country in natural advantages. Our climate is equable and healthy. The presence of large bodies of water moderate both heat and cold; it is not so hot in Summer nor so cold in Winter as in Indiana. We can prove this by U. S. Weather Bureau Reports.

The lands of the CADILLAC TRACT lie within one-half to six miles of the City of Cadillac, population 8,000—no dead ones—along the lines of the Grand Rapids & Indiana and the Ann Arbor, parts of the Pennsylvania and Wabash Systems respectively.

These Lands are Sold at $5 to $15 per Acre on Easy Terms

Markets are high priced and close. We have fine schools and churches. Taxes are very low. Our roads are free, many of them gravel pikes. Water is clear, pure, soft and easily reached. Beautiful lakes and streams abound with trout, bass, pickerel, pike and perch.

Drop me a line today for illustrated booklet with map, giving detailed information and containing letters of settlers from many different states who prefer our lands to any they have seen. Kindly mention that you saw my advt. in the "Irrigation Age."

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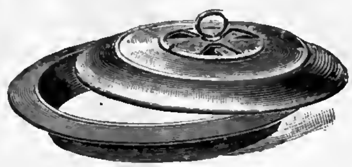

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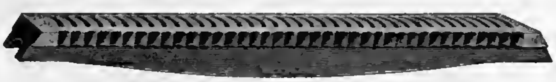

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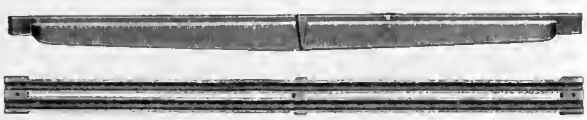

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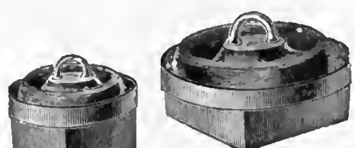

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THE IRRIGATION AGE

VOL. XX | CHICAGO, JANUARY, 1905. | NO. 3

THE IRRIGATION AGE

With which is Merged

MODERN IRRIGATION
THE IRRIGATION ERA
ARID AMERICA
THE DRAINAGE JOURNAL
MID-WEST
THE FARM HERALD

THE D. H. ANDERSON PUBLISHING CO.,
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Entered at the Postoffice at Chicago, Ill., as Second-Class Matter.

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

EDITORIAL

Current Wheels.

We are publishing in this issue an article on Current Wheels by R. A. Farnum, a student in the Iowa State College, which is illustrated by drawings furnished us by Mr. Farnum. His article will prove interesting to all those who have been studying the matter of utilizing the current of streams for the purpose of lifting water for irrigation.

New Plymouth Colony.

We are presenting in this issue four half-tones illustrative of the development along irrigation lines under the system of the New Plymouth Land & Colonization Company, Limited, Payette, Idaho. This company has done good work in lifting barren lands into a state of fine cultivation and much of the good work accomplished by this company is due to the active member of the concern, Mr. C. E. Brainard.

Price of Wyoming.

We are presenting in this issue a half-tone portrait of Mr. J. W. Price, of Mina Grove ranch, Casper, Wyo. Mr. Price is an active irrigationist in that hustling State and is the man who first exposed the intrigue of the combination which contemplated killing the irrigation congress by merging it with the trans-Mississippi congress. He has followed closely the fight in favor of clean irrigation development in the West and has at different times rendered valuable aid. He also fought against the repeal of the land laws at the Ogden congress. In a recent communication from Mr. Price he states: "It is my opinion that the resolutions adopted at the Twelfth National Irrigation Congress at El Paso did not injure the cause of irrigation development in the arid States, as the method taken to obtain these resolutions was only too clear to every thinking Western man, as well as to the Government officials, so much so that they are looked upon with great suspicion." Mr. Price also states that an effort was made to kill the goose that lays the golden egg and the resolutions could not have been passed excepting in a State a long distance from the center of irrigation activity, a State to whose lands the National Irrigation Act does not apply.

Mr. Paul Thieman Talks.

Mr. Paul Thieman, whoever he may be, says something in a recent issue of a Denver paper which is pat and to the point. We herewith reproduce the first few paragraphs of his article:

When one beholds the complacent failure to comprehend the nature and condition of far Western irrigation, it is maddening. I have seen one man, who is thoroughly posted, almost break into wild tears of rage over the ever recurring evidences that the people at large, the people right here, the National Government, the State Governments, do not appreciate National irrigation, and that the public information and the individual knowledge of the subject at this time are strangely dense. The public is fed constantly with lovely articles about the grand National irrigation works under way, while the fact is that all the great values, mentioned by Judge Parker, for example, in his letter of acceptance, in that part of his remarks concerning reclamation of the arid region, are the result of private initiative and enterprise and capital.

Few people understand that the National irrigation fund is nothing but a bulk of capital which may be ADVANCED to build reservoirs and ditches, upon a guarantee that the owners of the lands to be irrigated will repay the cost to the fund. The National fund is not to be depleted, but must be replenished by the payment back of the cost of the work, as assessed by the Government engineers, and if signatures to such pledges can't be secured, the works proposed will not be built.

Knowing that all Government work costs vastly more than if done by private capital, and the United States failing to guarantee the limit of the cost, lots of land owners won't sign, and there you are. Meantime, the Government officials knock private enterprises and warn the people against them, when, as the situation stands, it is only private enterprise, in promoting irrigation district bonds, in Colorado, at least, that is really doing anything.

Echo of Congress.

The Denver *Republican* of December 16th contains the following editorial headed "Mondell and the Irrigation Congress." It will prove interesting reading to those who are acquainted with the subject.

The criticisms of Mr. Arthur Francis upon the attitude of Congressman Mondell toward the Irrigation Congress which met in El Paso were ill-timed and unwise. Had Mr. Francis been correctly informed he would not have made them, for the attitude of Mr. Mondell was clearly correct.

The Congress which met in El Paso was by no means representative of public sentiment in Colorado or any other of the leading States of the arid region. It was engineered by George Maxwell and certain other men who for a long time have favored the absorption of reclamation work by the National Government, and who have recently been strong advocates of the repeal of all the land laws except the one authorizing homestead entries.

It is claimed by these advocates of repeal that it is for the purpose of retaining the public lands for actual settlers, but back of this stands the fact that for years Maxwell and his associates have been maintained in their work by a large fund provided for by certain leading Western railroads. The purpose of the effort to secure the repeal of the land laws is to make a better market for railroad land. Should all but the homestead law be repealed, the people would be so far restricted in their endeavor to secure homes on the public lands that they would be compelled to turn to the railroad land grants. It is very clear why the roads owning these grants should wish the land laws repealed and should maintain a big lobby in Washington with that object in view.

The claim that frauds against the land laws are so numerous and so great that the laws themselves should be repealed is without value, since the thing needed is not the repeal, but the enforcement of the laws. The success which has attended recent prosecutions of persons connected with frauds on the public lands shows that the remedy lies in that direction and not in making it more difficult for the people to secure homes on Government lands.

Mr. Francis attended the Irrigation Congress from Teller County, a part of the State in which there is no irrigation and little knowledge of the subject. The fact that some of the best informed men in the arid region in regard to irrigation were not in sympathy with the purposes of the men who controlled the El Paso Congress is shown by the fact that the State engineers refused to attend. No one who knows anything about the subject can seriously question that among the best informed men in the arid region concerning the needs of irrigation are the State engineers. Certainly they are better qualified to speak intelligently on the subject than the miners of the Cripple Creek or any other mining district. The fact that they ignored the Irrigation Congress should have suggested to Mr. Francis that the meeting was not in line with the best interests of irrigation in this and other States.

How About This?

THE IRRIGATION AGE has been making an investigation through one of its representatives of the matter of forest land grabbing and the uses put to what is known as lieu land scrip or forest reserve scrip. One peculiar feature of the forest lieu land scrip law was that it had the appearance of an exceedingly clean measure and at the time of its passage there is no question but that the members of Congress who voted for this law believed that they were doing a good service to their constituents. All of our readers are no doubt acquainted with the intent of the law. Prior to its passage, however, a clause was added to the law which was so worded that in case settlers had holdings in any tract reserved, they were to be given in lieu of their holdings scrip which would be applicable for entry on any part of the public domain, regardless of its character. There is no question but that this clause was placed in the bill purely for the benefit of holders of large areas of valueless lands which it was their intention to turn in to the Government in lieu of scrip which could be sold later to timber men for entry upon Government land on which was located large quantities of pine and other timber. Some way or another the land grant railroads and heavy land men throughout the country, speculators and others held enormous tracts of land of inferior quality in what was set aside as forest reserves. Wherever this land was poor it was immediately turned over for scrip, which was entered on the best timber lands in the Northwest. The representative of THE IRRIGATION AGE, who is at present investigating this subject, is looking into the transaction whereby the Atchison, Topeka & Santa Fe Railway Company were able to dispose of something like one million acres of scrip which it is alleged was issued to them under this clause and for which they subsequently, it is alleged, obtained from $3.00 to $5.00 per acre, the purchasers being speculators in paper of this character, large lumber men throughout the Northwest, many of whom are to be found in Minneapolis, Duluth and elsewhere, the scrip being entered on very valuable pine land throughout Minnesota as well as the Pacific coast pine regions. It is our intention to carefully investigate this subject and learn exactly the character of land turned back to the Government as forest reserve by the Atchison, Topeka & Santa Fe Railway Company, in lieu of which they, or their agents, received the right to make entry upon land of valuable character as above indicated.

If it is true that the Santa Fe Company turned large areas of land, as has been stated by some readers, land which had not enough timber on it to enclose the land with a rail fence, there is some sort of "a nigger in the wood pile." One writer in Arizona has stated that to his certain knowledge there were large areas of land turned in to the Government as forest reserve under the lieu land clause, on which could not not be found enough timber to place a rail fence around the entire tract. This is rather a pitiable condition of affairs, to put it mildly. The Secretary of the Interior has made a request for information along these lines from certain individuals, and that information, it is expected, will be forwarded to him at no distant date, when no doubt the Government will commence investigations. If, as is alleged, the Santa Fe Railway Company lifted from three to four million dollars of good money on the transfer of this land, would it not place the officials of that railway in rather a difficult position?

Was it not the duty of Gifford Pinchot, Forester of the United States Department of Agriculture, to learn something about the character of the land turned in under the forest reserve clause? If the statements which we have quoted above are correct, will not Mr. Pinchot be placed in a position to make explanations? This is one of the reasons why THE IRRIGATION AGE has continually harped on the fact that neither Mr. Newell, of the Reclamation Service, nor Mr. Pinchot, of the Forestry Bureau, is beyond reproach.

In a recent article in the Prescott, Ariz., *Herald*, it is stated that few in Yuvapi County, or Arizona, for that matter, realize the immensity of the act of Congress, which on March 12, 1872, awarded the Santa Fe Railway every odd section of land within fifty miles of each side of its right of way throughout the Southwest. As a result of this Congressional act the old Atlantic & Pacific Railway, which was afterward absorbed by the Atchison, Topeka & Santa Fe Railway, received no less than six million acres of land in Arizona alone. Some of this land extended south from the railroad to within ten miles of Prescott, the nearest point being at the Point of Rocks and running in easterly and westerly directions from that point. It is stated that the Santa Fe Railway Company received no less than 40,000 acres of land in Yuvapi County, for the most of which they received scrip from the Secretary of the Interior.

The Prescott *Herald* further states that the Santa Fe, instead of taking up every odd section of land, took up its grant in the forest reserves, and instead of giving them possession, the Government paid them in scrip which the railroad company is allowed to dispose of in whatever manner it sees fit. This journal also states that most of this scrip is sold to settlers. THE IRRIGATION AGE does not agree with them in this connection. The scrip is usually disposed of to speculators, or timber men, as stated above. This article goes on to say that the object of the Government in having the railway take up its grant in the forest reserve is because it could be handled better than that which is not included in the reserve and concludes by saying that it is estimated that as a result of the six million acres awarded to the Santa Fe Railway in the Territory of Arizona, they are not less than $25,000,000 to the good, as at the lowest estimate the scrip for each acre sells for $4.50 and at this figure, it would mean much more to the railroad than the figures given.

If, as some of our writers allege, the Santa Fe Railway Company has turned in barren lands under the forest reserve clause on which scrip has been issued that has been sold for entry upon fine timber lands in the Northwest, this company may possibly be asked to make some explanation to the Department of the Interior.

Which would be the most beneficial to the country at large, to allow the Santa Fe Railway Company to dispose of scrip for entry on land that is presumably worth $25,000,000 and place that sum of money in their treasury, or allow say 30,000 citizens of the United States to take up the land on which this scrip was entered and pay into the United States Treasury $12,500,000, which would be about the sum the Government would receive on that amount of land entered under the Timber and Stone Act, and allow the settlers, or those taking up the land, to secure the benefit of an equal amount, or the difference between $25,000,000 which the Santa Fe secured and the $12,500,000, which they would have paid into the Government when these entries under the Timber and Stone Act were completed? As it is, the Government does not receive one dollar for the land which is taken up under this scrip provision. On the contrary, the United States Government is under heavy expense in making out papers, employing agents to investigate, etc., etc.

J. W. PRICE.
Casper, Wyoming.

HON. E. H. LIBBY.

Mr. E. H. Libby, whose portrait appears on another page, has the reputation of being the organizer, president and manager of the most successful irrigation enterprises in the Pacific Northwest and one of the most successful on the Pacific Coast. The lands irrigated are known as Vineland (postoffice, Clarkston), Washington, directly across the Snake River from Lewiston, Idaho. The enterprises include not only the land-irrigation company, but also the municipal waterworks system, a $110,000 steel bridge across Snake River (said to be the finest exclusive wagon bridge on the coast), also an electrical company which lights and furnishes power to three towns. About $1,500,000 is now represented in these various enterprises, all organized and managed by Mr. Libby and all dependent upon the parent irrigation company. Plans are now under consideration for the investment of large additional sums in power and water enterprises in conjunction with the present concern. Mr. Libby's constant effort has been to develop other industrial enterprises to create home markets for the fruit growers and gardeners under his canals, and the consequent higher values in the real estate for the benefit of his investors.

WORK OF PRESS BUREAU.

George H. Maxwell's press bureau has been very busy recently sending out reports to the daily papers throughout the country stating that the national irrigation law is menaced by politicians in the suggestion that a commission be appointed to investigate all projects recommended by the Reclamation Service under this act. This press bureau states that if the fund is ever left open to spoilation it is certain that millions will be expended with nothing to show for it. The statements of Maxwell and his crowd will have very little weight with congressmen who know their motives. While the expenditures of the irrigation fund up to the present time have been in accordance with the recommendations of the officials of the Reclamation Service, it is a question in the minds of many as to whether Chief Engineer Newell is capable of deciding on the location of large reservoir sites or the carrying out of building dams and other work appurtenant to the position. It is a noticeable fact that all of the engineers of national reputation are very reticent about expressing their opinion on work that has been undertaken by the Reclamation Service. One of the best known consulting engineers in the United States informed THE IRRIGATION AGE recently that it would be well to give Newell and his men an opportunity to show what they can do. This is all very well so far as the actual work of construction is concerned, but it should not apply to the selection of sites for Government projects where the Government work handicaps or interferes with the work of private corporations already begun or established. There is a decided tendency on the part of the Reclamation Service to throw obstacles in the way of private irrigation projects.

Our correspondence in recent issues shows a very narrow and almost malicious spirit among some of the Reclamation Service officials. This is particularly true of cases in Idaho, Washington and Wyoming. Would it not be well for Mr. Newell and his crowd, including Maxwell, to confine their operations to sections where governmental work will not interfere with private projects already in operation?

There are at present in Washington gentlemen who will place before the proper officials information which will lead to investigations along the lines suggested, and there is no doubt but that President Roosevelt will be fully informed within the next thirty days concerning the actions of officials of the Reclamation Service in certain territory. And we may be assured that the President will not tolerate any unfairness on the part of these officious gentlemen. It is only a matter of bringing it to his attention when it is reasonably certain that he will take steps to correct abuses.

THE NON-REPEAL OF THE LAND LAWS.

T. S. VAN DYKE.

The report of the committee against the repeal of certain land laws shows there is something in the question beyond the land-grabber that is likely to thwart or greatly delay future efforts at repeal; also that there is something besides boodle.

First.—Government is not going to do all the future building of irrigation works, and ought not to. There are too many in which there is too much uncertainty and which might bring the whole thing into discredit with the East if there should be some failures. There are also many too small, very many of them too small, for Government to bother with. All such are fit only for private capital that can do the waiting and take the risks.

Second.—It will make too great a reduction of the revenue for building irrigation works. Those who think the money is going to be repaid to the Government fast enough to replenish the fund would better wait a bit. Several people have been badly left in supposing they could get a settlement started by giving first settlers land at cost of water. They discovered that what poor suffering humanity that can't get a farm, because the land-grabbers have it all, principally wants is wet land at a dry price. What for? To raise alfalfa or oranges? Sometimes, yes; but quite as often to raise tenderfeet. People want to show the possibility of the ditch and sell the land at the wet price or very near it. Now, when the victim has bought dry land at the wet price, but one thing remains for him to do, and that is to get water for nothing to make it worth what he paid. Hence he will refuse to buy water just as long as he can. Excuse my positiveness, dear reader. I have been there and seen many others hung up on the same snag. If you think they would not play the same game on our respected Uncle Sam, you would better go and study up a bit of human nature as developed under irrigation works.

Third.—To succeed, irrigation works must be built out of the increased value of the land, out of the increase made by the water itself, and can not be built as city waterworks are in reliance on a rental that will pay an interest on the amount invested. This is now too well known to need any proof. Hence capital that understands its business will not attempt to build irrigation works unless it can have the cutting of a clean piece of cloth. A few old patches, here a homesteader demanding money for right of way, there another declining to buy water at any figure or else just enough to enable him to stay on the land and hold the balance to sell at a wet price to some tenderfoot, will spoil the whole thing. Hence there must be some way that capital can control the situation, either by compelling settlers to buy water or getting land to cultivate in case it can not sell water. This also is too well known to need discussion.

During all this fuss over the repeal of the land laws it seems tacitly assumed that the homesteader is a gentleman and a scholar who wouldn't do such a mean trick as to hold out land against his worthy Uncle and try to sell it dry for the wet price, leaving Uncle Sam to reimburse the best way he can. Oh, no! He will only do that against private capital. It is tacitly assumed, also, that he wants to irrigate instead of to sell. Of course. You wouldn't have any town clerks, real estate men or guttersnipes looking up a chance to turn an honest penny by sleeping out two or three nights in a year in a dry goods box or hiring some one to do it. Oh, no!

It is amazing that any one should be ignorant of the fact that the homesteader is in one way the worst of land-grabbers. He can stick and hang to the driest piece of land on which he can find or haul water enough for domestic use, while under the arid land law one must do something toward making the land irrigable or let go of it.

No, there is no more opening for fraud under the arid land law than under the homestead law. I have lived west of the Mississippi for thirty-eight years and west of the Rocky Mountains twenty-nine, have lived in the country most of the time and been in it most of the rest, and have seen something of fraud. The

HON. E. H. LIBBY.
Clarkston, Wash.

trouble is not in the laws, but in the fact that men whose word is as good as their bond in any business transaction will walk up to the land office and swear that so-and-so has resided on such a piece of land for five years continuously and cultivated and improved the same, when it is utterly false according to the spirit and intent of the homestead act. I have all my land rights yet, and have been laughed at many a time for not homesteading a piece of land that some city chap was certain to take from under my nose in a short time and make a stake out of it without living on it an hour or ever intending to. My answer that I happened to know what constituted perjury was always received with the reply: "How is it that you are so very wise when everybody else is doing it?"

There is but one way to check this, and that is to make all fraudulent patents void in the hands of any assignee and cancel a lot of them. There is little hardship in this, because the assignee generally knows they are fraudulent. And if he doesn't, why not put him on his inquiry? There is plenty more land he can get if he must have some. And if the assignment is for a debt he is generally no worse off than before. Perhaps fraudulent patent could be canceled now in the hands of an assignee, certainly in the hands of one not giving any new consideration. But it is not done. A little doing of it would be enough to prevent much fraud.

I know not how it is elsewhere, but under our officials of the land office in Los Angeles fraud under the arid land act is very difficult. As such entries are generally in groups, it would be no great task to

First Crop on Sage Brush Land, near New Plymouth, Idaho.

have an agent of the Interior Department investigate all cases on the ground. I think it will be found that the compliance with the requirements of the arid land law is generally more in conformity with the spirit of the act than in case of the homestead law on similar lands. I have known many cases where parties unable to comply have given up their filing. I am now working out an irrigation proposition where some thirty claims, all but one, were thus abandoned to the Government again. There were no homesteads, but it is safe to say they would not have been abandoned. If a man don't abandon to the Government under the arid land act he is very likely to do it in favor of some one who will water the land, because he knows his holding of it is too precarious under that act. But he knows equally well that under the homestead act all he needs is a few hundred feet of cull lumber and a couple of friends to make the title good. And they don't have to be strong friends, either. I have not yet seen the man so poor, so mean or so unpopular that he could not get witnesses of respectability in the community to prove up his homestead claim, no matter what the real facts might be.

Those who demand the repeal of the arid land law are right in saying it is in the way of the Government irrigation works. And so is the homestead law. But there is no reason why either should be. There are hundreds of thousands of acres that will never be reclaimed except under the desert land law, especially so in the artesian belts, whose exploration has yet hardly begun. It is about the same with all pumped or developed water, all too small for Government to bother with, as well as too uncertain. There will be danger enough to the Government enterprises from the clamor of different sections to have some of that money put in circulation where it will "do us some good," without regard to the future outcome and repayment of the money. And these will be backed up by other sections on the principle of "you tickle me and I'll tickle you." So that Uncle Sam can't afford to risk anything on a lot of small propositions. For if the East and South once get the notion that the irrigation service is being abused the whole thing may be repealed.

The withdrawing of large areas of arid land goes far toward meeting some of the objections, but not far enough. It seems to me that a law something like the following would protect the land without cutting off too much of the revenue of the Reclamation Service. I offer this, not as perfect, but merely as a suggestion for perfection. I have submitted it to some experts in this matter, and they can see no fault in it. I should like to have any one point out any objection that can not be quickly met with an amendment.

I believe, too, that a law like the following would unite enough members of Congress from each side to secure its passage, whereas it may take a struggle of years to repeal the desert land law, and in the meantime much of the mischief will have been done. The following is the proposed bill:

"All public land hereafter entered under any act of Congress shall be subject to the following conditions:

"To be used by the United States, in whole or in part, for reservoir sites, rights of way, for all main ditches and laterals, including drainage ditches, with right of ingress and egress for cleaning and repairs.

"To the use for reclamation of arid lands of all water rights of every kind now appurtenant to said land, with the right to divert water to other watersheds or on lands not riparian.

A New Farm, Payette Valley, Idaho.

"To be made a part of any irrigation system undertaken by the United States, and, therefore, to the payment to any such additional sum as may be assessed upon other lands under the same system for the repayment of the cost of irrigating the same, or any other liabilities to which such other lands may be subject for the purpose of securing water through the aid of the United States.

"Said lands to share with the other lands in the ownership of the irrigation works when turned over to the landowners after payment and in the service of water for irrigation in the meantime, but subject to the regulations of the Reclamation Service as to the amount of water to be actually delivered to any one holding. And the fact that a larger area has been paid for or is held liable for payment shall not entitle such extra area to water so long as the title thereto remains in the original owner of the whole."

Add to the above some provision for paying for improvements where a party in good faith has obtained water sufficient for the proper irrigation of a tract, or else allowing him to sell to some other landowner his share of the water due from the Government's system.

Now who can be hurt by such a law? It is certain that the Government is not going to build waterworks except on desert or something very near it. Any one of sense can quickly measure the probabilities of the nation doing anything on a certain tract. If he settles there for the purpose of reaping any benefits, then the above ought to apply to him. If he does it in ignorance, then he can not be much damaged if he is allowed to sell the water the land has to pay for.

A bill of that sort introduced in Congress would at once test the sincerity of those who want the laws repealed. I can not imagine a railroad man so unwise as to imagine that private capital will build waterworks with every alternate section out of market, or that any settlement that could be made by individual waterworks would amount to anything compared with what private capital can do where it can so control the whole land that settlers have to buy water instead of holding the land dry for speculation. Nor can I imagine any one so rabidly in favor of Government works only as to believe that the Government should take up every small proposition in the country or take up every dubious one. Nor does private capital interfere with the joint ownership of land and water to

First Crop Under Irrigation, Payette Valley, Idaho.

any such extent as is imagined. Most waterworks are now built with the intention of turning over the stock to the landowners when enough has been sold, or else the water is sold or contracted subject to a fixed annual payment. How one man owns the land another the water when the landowner has a perpetual contract for the water at a fixed price is too much for my feeble intellect. You might as well say the Camden & Amboy railroad still owns the Pennsylvania's line between New York and Philadelphia. It was only leased for 999 years.

Very few waterworks are now built subject to a fluctuating annual payment. And where they are it is fixed by supervisors, who are as likely to favor the folks who have the votes as those who have the money. Where they are fixed by contract they are generally no more, often less, than the cost of good maintenance, or enough more to cover risks. The water-right price is generally little more than the cost of getting the water on the land after all the contingencies which the engineers failed to figure on have continged—something

Payette Valley Orchard. Second Year After Planting.

they are sure to do. All this talk about "water barons" and the immense profits from the sale of water is pure nonsense. Money is made, but it is generally on the rise in value of the land which parties interested in the company have bought. And, instead of holding this out of the reach of that mass of poor suffering humanity we read about, they are only too glad to sell it to them mighty quick for far less than any settler, or combination of mere settlers, could put the same amount of water on the land with the same certainty and the same cheapness of maintenance. The money made merely by building waterworks and selling water is largely in your eye. I have made a little in that way, but I don't want any more at the same figures. It was the dearest money I ever bought. Most of the money others have made is in stocks and bonds put up as collateral in some bank for money to maintain the waterworks. And if they don't finally break the bank, the bank is in luck, for most of them are utterly unsaleable in a pinch. I have been at both ends of the line and also in the middle. And for sure coin and sound sleep give me the hoe-handle end every time.

Now this is a matter in which none of us can afford to have our motives impugned. The rainy part of the country is watching the irrigation movement, and the first mistake in it will be the signal for a howl that may increase until it means something. If we let slip the present means of revenue we may have trouble in getting it again.

CURRENT WHEELS.

BY R. A. FARNUM,
Iowa State College.

When a farmer enters a new country where irrigation is necessary he must determine, first, how he may best deliver water to his land. The agricultural land in the semi-arid regions of the West is nearly always smooth and usually has a gentle slope with and toward some natural drainage channel. The stream from which he proposes to draw his supply of water has a large fall, so that a ditch taken from it with a moderate grade can recede rapidly and hence cover a large area in a short distance. But in many cases these ideal conditions do not prevail, or where only a small irrigator wants to tap a stream in such instances some other resources must be put into use. Water wheels and motors unnumberable have been installed to accomplish this purpose. All of them have their advantages and disadvantages. The devices used to accomplish this work must be those whose power of operation is furnished by the current of the stream and not affected by high or low water. The theory of the current wheel, or the way in which it receives its power, is by the impulse or dynamic pressure of moving water. In its simplest form a current wheel consists of a large skeleton roller made of wood, with paddles projecting beyond its rim. It is hung on a shaft and supported at both ends by piers or posts, so as to allow the wheel to dip into the water to the width of the paddles. The simplest device for raising water with such a wheel is a row of buckets placed on the rim so as to fill at the bottom of the wheel and empty into a trough near the top. A more complicated way is to connect the wheel to chain and bucket gear, or to a pump of some sort. These more difficult methods of construction are necessary in all cases where it is desired to raise the water to a height greater than the diameter of the wheel used. However, these wheels should be so constructed in a simple and practical manner, relieved of all complicated mechanical devices, so that any farmer or ranchman can operate and keep in repair the same as he would any piece of farm machinery owned by him.

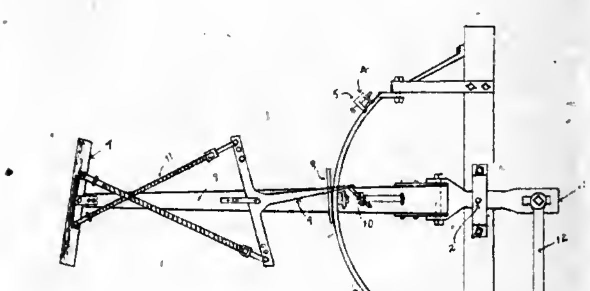


Fig 1 Top View

A very simple current wheel in operation on the Grand Valley Canal, in Colorado, as shown in Fig. 9, raises water thirty feet for irrigation of forty acres of orchard. The wheel is thirty-four feet in diameter, the paddles being eight feet long and two feet eight inches wide. The spokes are secured at the center by means of castings and are set at such angle to the shaft that they come to a point on the rim of the wheel. To provide sufficient rigidity a system of braces is adopted, making a very substantial construction. Braces are also run from paddle to paddle and between the arms of the wheel, so as to form a system of six or eight circular rims. The bucket consists of long boxes made of 1-inch stuff, set at such angle on the rim of the wheel that they will fill nearly full and raise the water within two feet of the top of the wheel. Under ordinary conditions this wheel will raise about 0.25 cubic feet per second. This wheel is estimated to have cost in the neighborhood of $400.

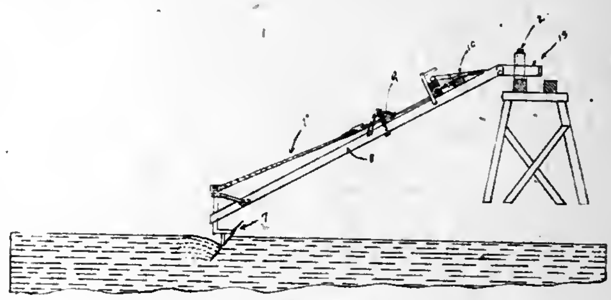


Fig 2 Side View

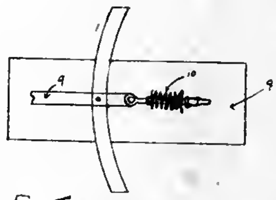


Fig 3 Tripping device

Fig 4 Slide block

CURRENT MOTOR

Another device for lifting water is the chain and bucket apparatus shown in Fig. 9. It is run by a 5-foot overshoot wheel of ordinary construction. The elevator consists of two endless chains running over sprocket-wheels, each chain carrying twelve galvanized-iron buckets, as shown in drawing. The lower sprocket-wheels are thirty-two inches in diameter on a 1⅝-inch shaft. The sprockets are set eighteen inches apart and the distance between shafts is twenty feet. The apparatus cost about $250. This arrangement makes it easy to place the whole apparatus near the bank of a stream, or, if desired, the elevator could be placed at any convenient distance.

The current motor, another device for lifting water, or, rather, pumping it, differs considerably from the above described. The motive power of this apparatus is deflection and leverage. Fig. 1 of the drawing is a view looking down on motor. Fig. 2 is a side view of motor. Fig. 3 is a view of tripping device and Fig. 4 is a cross-sectional view of slide forming portion of tripping device.

The operation of the current motor is as follows: The current coming in the direction of the arrows A (shown in Fig. 1) strikes the blade 7 at an angle. This resolves the force into two components, one in the direction of the swinging pendulum 8, which is received by the pin 2, and the other at right angles to the said pendulum, which causes the same to swing in the direction indicated by the arrow B until the slide 3 comes in contact with the bumper 4. The bumperhead 5, striking against the said slide 3, carried upon the pendulum 8, allows the said pendulum 8 to swing underneath the slide 3 until the said pendulum strikes against the limiting portion 1 of the said slide.

Fig 6 section through hub and axle

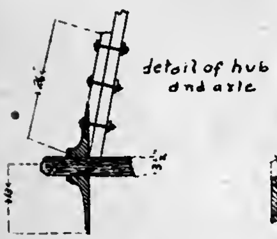


Fig 7

Fig 8

WATER WHEEL

This movement swings the T-9 to the opposite side of the pendulum 8, it being held in position by spring 10, thereby maintaining in its changed position until the pendulum again swings to the opposite bumper when the operation repeats itself. Upon the slide striking the bumpers and the T-9 being thrown over to the other side of the pendulum, the links 11, 11, attached to the other end of the T member 9, cause the blade to swing in the opposite direction and to a reversed position to that it had prior to the time when the slide strikes the bumper; this always presents the blade to the stream in such an angular position that the force of the stream will be resolved into such components as will cause the blade and pendulum to swing back and forth. The swinging motion is communicated to pumping mechanism or other machinery by means of the connecting rod 12 connected to the pendulum by the pivoted member 13. All parts of this machine are above water, thereby making it an easy task to oil and keep in repair. It can be successfully operated in shallow as well as deep water. It adjusts

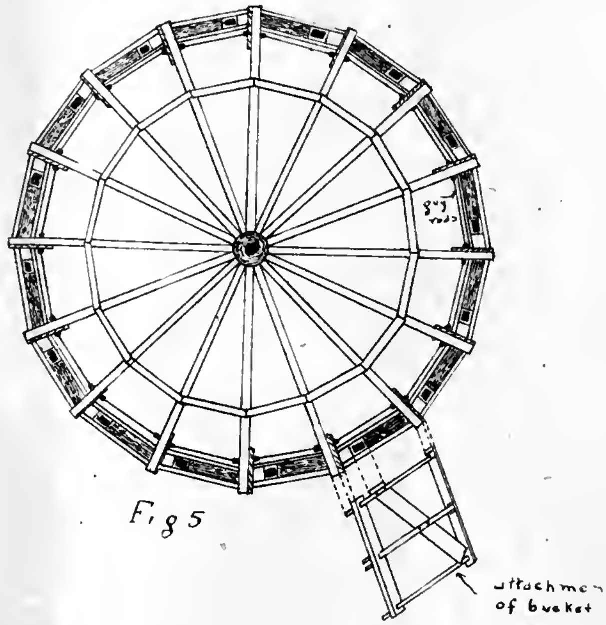


Fig 5

itself to the stage of water in the stream. This apparatus is much less expensive than the other two described devices; the device is manufactured by the

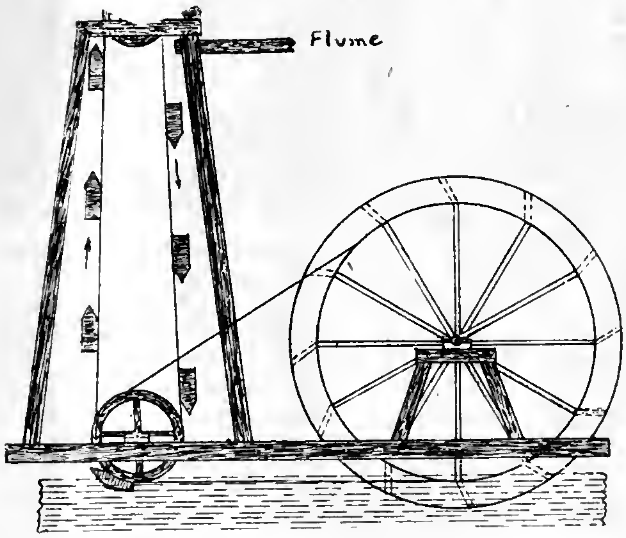


Fig. 9. CHAIN and BUCKET.

Current Motor and Irrigation Company, Spokane, Wash.

Besides the above described devices, there are many others in use for lifting water, but they are very closely constructed to one of the three named above.

REPORT OF DRAINAGE COMMISSION.

By George A. Ralph.

Mr. George A. Ralph, Chief Engineer of the State Drainage Commission of Minnesota, has furnished his annual report to Governor Van Sant, which shows that 129,860 acres of State lands and 241,860 acres of other lands have been benefited by the drainage ditches constructed in the State since 1893. The total acreage benefited by the State ditch is 370,860 acres. The State has expended $100,000 since the work started. Below is given part of Engineer Ralph's report, which will prove interesting to those of other sections who are studying the subject of drainage.

The report says:

"All of the ditches constructed by the Commission are in good condition, and no expense is necessary at this time for repairs; in fact many of the ditches have been enlarged to double their size. This enlargement is largely due to the fact that much care has been exercised in getting the proper outlets.

"The benefits resulting from the construction of these ditches have been much greater than the original estimates show. Lost River ditch in Polk and Beltrami Counties, 3.7 miles long, has transformed an impassible bog of several thousand acres into rich meadow and tillable land. Badger and Skunk Creeks in Roseau County, 8.5 miles long, will afford an outlet for a drainage system covering upward of fifty square miles. and has made salable thousands of acres of land at prices averaging $8 an acre, which prior to the construction of the ditches, had no market value.

BIG PROFIT FOR STATE.

"New Solum ditch in Marshall County, nine miles long, has also been a very profitable investment for the State. Every acre of State lands affected by the construction of this ditch has been sold since the work was begun at prices ranging from $8 to $16 an acre. These lands were not wanted at any price before the ditch was begun.

"Gun Lake ditch in Aitkin County, nine miles long, has made salable 5,000 acres of State lands at an average price of $8 per acre.

"Besides the direct benefits to the State and other lands, which in most cases is more than double the cost of the ditch, the benefits in an indirect way, such as making possible the construction of public roads, furnishing outlets for other ditches, admitting the convenient location of public schools and churches, assisting in the immediate development of an otherwise backward locality, and general benefit to the county and State, are considerations which are important in determining the benefits derived from the construction of these ditches.

SURVEYS ARE DIFFICULT.

"The work of making the surveys for these ditches has been generally a difficult task, owing to the fact that the ditches are usually located in the worst bogs and swamps in the State.

"Lost River swamp in Polk and Beltrami counties was always known as an impassable bog before this ditch was constructed, and it is doubtful if it had ever been crossed by a human being, except when frozen up, before the survey for this ditch was made.

"The survey of the Memidji and Shotley Brook ditches was made over swamps inundated to a depth of from two to three feet. The survey of the Two Rivers ditch in Roseau County had to be made from an offset line, owing to the numerous small lakes and dangerous sinkholes along the line of the ditch.

"The engineering expense covering a period of four years has amounted to less than nine per cent of the whole expenditure. The engineering expense in examining and locating the ditches has been less than ten per cent of the total expenditure. In every instance the price paid for State work has been as low, or lower, than was being paid for similar work in the same locality by county and local authorities."

STATE DRAINAGE NEEDED.

The report of the engineer showing the rapid strides of the work is seconded by the report State Auditor Iverson will make to the next legislature. He says on the question of drainage:

"It will be readily seen that the management of our swamp lands is one of the serious problems confronting us. A start should be made looking to a comprehensive system of drainage of these lands. It will cost considerable but it is safe to reckon that every dollar spent in drainage will be returned tenfold. Not alone will it be profitable; it will be doing a justice to those sturdy, hard working settlers who are endeavoring to establish homes in the northern frontier townships. The work should be started. Chapter 90, General Laws 1901, creates a drainage commission and clothes it with ample authority. An appropriation should be made sufficient to make a general survey of the country affected and to begin the work of reclaiming the lands."

THE STATE DITCHES.

A table attached to the report shows the work accomplished by the commission in the construction of ditches. Counting the extension of all ditches in the State, there are at present twenty-four ditches, with a total length of 88.78 miles. A summary of the table follows:

Name of Ditch—	Cost.	Benefit to State and other lands. Acres.
Two Rivers, Roseau County	$5,493.37	31,200
Two Rivers, Kittson	5,837.10	35,000
New Solum, Marshall	5,795.77	25,000
New Solum, Ex.	2,445.87	15,600
New Solum, 2d Ex.	2,269.10	7,400
Grand Marais, Polk County	1,867.14	5,000
Grand Marais	3,746.50	10,000
Emardsville, Red Lake	3,232.65	16,000
Good Hope, Norman	5,287.77	10,000
Good Hope, Ex.	1,653.36	2,000
Wild Rice River, Norman	424.15	5,000
Wild Rice River	770.19	5,000
Bemidji, Beltrami	2,639.96	8,000
Shotley Brook, Beltrami	2,212.28	11,200
Lost River, Polk and Beltrami	3,867.24	27,400
Morken Ex., Clay	1,992.20	10,000
Silver Leaf, Becker	878.75	7,400
Tamarac. Becker	125.00	2,700
Yeager Lake. Wadena	5,128.54	33,000
Metz. Wadena	968.96	7,280
Toad River, Otter Tail	1,078.23	6,200
Wing River. Otter Tail	3,682.77	8,480
Gun Lake. Aitkin	5,886.60	25,000
Badger and Skunk Creek. Roseau	13,261.96	46,000
Totals	$81,545.03	370,860

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, courtesy United States Department of Agriculture.

Many farmers prefer to go to extra expense and to handle more surface earth in order to have rectangular check. Fig. 8 shows the same field laid out in rectangular checks as nearly uniform in size as the nature of the ground will permit.

In building the levees around the checks scrapers are generally used. All high parts within each check are first scraped down and the material thus obtained is dumped along the levees. The balance of the earth required to complete the banks is obtained from the highest parts of the interior of the checks, which leaves this space quite rough, but fairly level.

The field is then plowed and harrowed in the usual way and the seed sown. The time of sowing alfalfa extends from November to April, but in the central part of the valley many prefer the first week in March. The soil is then moist from winter rains and no irrigation is necessary until the plants cover the ground. From twenty to twenty-five pounds of seed are sown to the acre without any nurse crop.

After plowing and before seeding the levees should be well harrowed and in some cases dragged down so as to present the appearance of low embankments having a wide base. In nine cases out of every ten the sides of the levees are left too steep. The width of the base of a levee, as a rule, should be eight times the height of the crest. Thus a levee nine inches high should have a base width of six feet. The height depends on the difference in elevation of the contour lines and the depth of water to be applied in one irrigation. With four-inch contours when completed and settled the levees are usually nine inches high. This leaves a margin of safety between the surface of water in the check and the top of the levee, providing the depth of water applied does not exceed six inches, since a portion of the water is absorbed by the dry soil before the check is filled.

Furrow Irrigation of Sweet Potatoes

CHECK OR SLUICE BOXES.

The check or sluice boxes, through which the water is admitted into the checks, vary in width from one foot to ten feet. They are rectangular boxes passing through the earth embankments, and so arranged that flashboards can be readily and quickly inserted and withdrawn. The boxes must be water-tight, inexpensive, and so made and placed as not to obstruct farm implements.

The sketch in Fig. 9 was made from a medium-sized box which was designed and used by Mr. Joshua Cowell, of Manteca, Cal.

Fig. 10 shows a cheaper box which is common in Stanislaus County.

FLOODING CHECKS.

Many of the canals in the San Joaquin Valley are operated in a manner to meet the needs of the check system. Instead of delivering a small stream for a long period, the practice is to deliver a large volume of water for a short period. On land that is checked one man can handle, as a rule, four times as much water as he can in flooding from field ditches. Under this system a flow of ten cubic feet per second is not unusual for a forty-acre tract of alfalfa; and since this amount would cover a farm of this size six inches deep in twenty-four hours, the time required for one irrigation is usually brief. On sandy soil, where the surface is checked, a large volume is much the best. The space inclosed in each check can then be rapidly flooded and the water evenly distributed. In admitting small streams to a check much is absorbed at the entrance end, the distribution is not uniform, and a larger percentage is lost by evaporation and seepage.

COST OF CHECKING LAND.

The owner of an irrigated farm can prepare the surface, providing he has the necessary teams and implements, for much less money than it will cost to hire it done. Work of this nature is usually done during the winter months in California. Field labor on the farm can be performed with more comfort in January and February in the San Joaquin Valley than it can in

May in the State of Illinois. A farmer who is fairly well provided with help and teams can check his land with only a small cash outlay for lumber to build check boxes. Those who are obliged to contract for the work pay from $7.50 to $20 per acre. The various items of cost are shown in the accompanying table of prices submitted by Mr. Joshua Cowell, of Manteca, Cal. Mr. Cowell has had a wide experience in this kind of work and his figures aim to represent average prices as they existed in 1900. The estimate also includes the price of alfalfa seed in the ground.

Estimated cost of checking and preparing twenty acres for irrigation:

Scraping with scrapers, 4 horses, 48 days, at $4.	$192.00
Plowing for scrapers, 2 horses, 7½ days, at $3.	22.50
Surveying contour checks, 3 days, at $4......	12.00
For 4-foot check boxes, No. 2, redwood lumber, 1,666 feet, at $24 per 1,000 feet.........	40.00
Labor and hardware for boxes...............	25.00
Six-horse team, plowing, 5 days, at $5........	25.00
Four-horse team, harrowing, 2½ days, at $4...	10.00
Three hundred and twenty pounds of alfalfa at 10 cents..........................	32.00
Sowing, 1½ days, at $2....................	3.00
Total	$361.50

Average cost per acre, $18.08.

The figures given in the following estimate of cost represent the actual amounts expended by Mr. S. Richardson, of Tulare, Cal., in checking and seeding 160 acres in Tulare County. It will be noted that the cost of the check boxes is not included.

Cost of checking and seeding 160 acres:

Survey (main laterals only)................	$ 7.50
Labor, at $1.15 per day, and board..........	435.33
Teams (mules at 50 cents a span per day)..	294.00
Provisions, feed, etc.....................	156.87
Lumber for headgate, on main laterals only..	60.00
Repairs on tools..........................	15.84
Plowing	155.00
Alfalfa seed, 10 pounds per acre, at 11 cents.	170.50
Water rental	230.00
Cost of irrigating (twice)................	68.00
Total	$1,593.04

Average cost per acre, $9.96.

Average size of checks, about three-fourths of an acre.

Assuming that two men, each working 12-hour shifts, will irrigate on an average fifteen acres per day, and that their wages, board and implements cost the owner $5 a day, the cost of one irrigation per acre would be 33 1-3 cents. Mr. Richardson's expense for this was slightly more.

THE BORDER METHOD.

A modification of the check system as used in the Imperial Valley of southeastern California is described on this page. A similar method of preparing land and applying water is practiced in the alfalfa fields of Arizona and in the vicinity of Stockton, Cal. The prominent features of this method are a large head ditch and the division of the field into long, narrow strips, by borders of earth. These low ridges, or borders, serve to confine the water within each strip as it slowly traverses the field from top to bottom.

In Imperial Valley the soil consists mainly of fine sediment, and the slope of the surface varies from one to five feet per mile. The rectangular checks are laid off with the long side in the direction of the steepest slope. These checks are from 60 to 100 feet wide and from one-eighth to one-fourth of a mile long. A deep ditch is built at right angles to the long side of the checks, and a wooden box is inserted in the ditch bank to supply water to each check.

The wing plow is most frequently used to make the borders, or levees. This implement differs from the ordinary plow only in having a large curved moldboard to throw the dirt further.

Where the slope is excessive or very irregular, contour checks are used. The fall between contours is usually three inches. Contour basins inclose an area of from three to twenty acres. These large basins, whether rectangular or curved according to contour lines, while possessing some advantages, can not be recommended. The chief objections to such basins and the manner of flooding them may be summed up as follows:

1. A large head of water is necessary.
2. A large stream often removes the soil from the upper end and deposits it over the crops at the lower end of a basin, the results at both ends being injurious.
3. In order to cover the higher portions, too much water is frequently used on the lower portions, thereby damaging both crop and soil.
4. There is great waste in attempting to spread water over so large a surface.
5. A temporary lake is formed at the lower end of the basin, or else the water enters the drainage ditch, which, in consequence, must be large.
6. The distribution is not uniform, the high spots receiving too little water and the low spots too much.

The remedy for these defects can be readily applied. It consists, in brief, in forming smaller checks. This would, of course, increase the cost for the first year, but the gain in subsequent years would much more than pay for additional expense.

FURROW IRRIGATION.

There are few irrigated farms in Western America where furrow irrigation in one form or another is not practiced. In regions devoted chiefly to the production of fruit it is usually the most common mode of irrigation. In other colder regions, where the staple crops are grain and hay, it is mostly confined to root crops, vegetables and small orchards.

FURROW IRRIGATION FROM EARTHEN DITCHES.

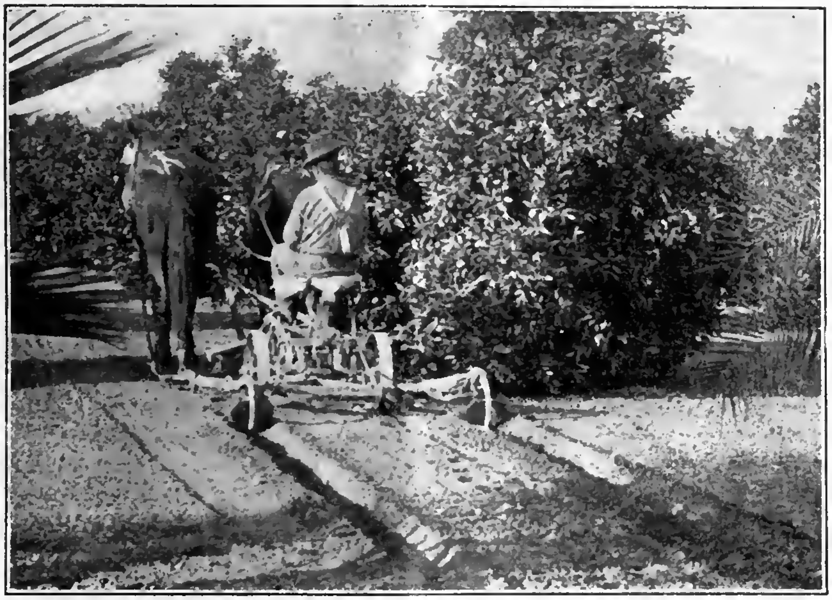
Briefly described, the most inexpensive, inefficient and at the same time the most common method of furrow irrigation is from earthen ditches. A small ditch, often parallel and adjacent to a permanent ditch, extends across the upper boundary of the tract to be irrigated. In one embankment of this small ditch openings are made with a long-handled shovel, and the water conveyed by the ditch issues through these openings and flows down the furrows. Theoretically this is all that is required for proper distribution, but in practice there are difficulties that can not be successfully overcome. It is impossible, for instance, to divide an irrigation stream equally among a large number of furrows by such means. This is shown in Fig. 1 in an attempt to divide water between the rows of sweet potatoes. A skilled irrigator may adjust the size and depth of the openings so as to secure a fairly uniform flow, but constant attention is required in order to maintain it. If the water is permitted to flow for half an hour unattended the distribution is likely to become unequal. The banks of the temporary ditch absorb water and become soft, and as the water rushes through the openings erosion enlarges them, permitting larger discharges and lowering the general level of the water in the ditch so that other openings may have no discharge. Even if it were possible to divide the flow of the ditch equally between a certain number of furrows the difficulty would not be overcome, because the number of divisions would invariably be too small. In using such crude methods it is difficult to divide a stream of, say, forty miner's inches into more than about ten equal parts, but good practice frequently calls for a flow in each furrow of from one-fifth to three-fourths of a miner's inch, which can not be secured by this method.

In irrigating such crops as corn, potatoes, sugar beets and vegetables, all of which are planted in rows, the usual practice is to make furrows midway between the rows with a light plow or cultivator. Openings are then made in the ditch bank at the head of each furrow. Sometimes, however, one opening feeds two or more furrows. The latter is the common practice when the head ditch is permanent. Before water is admitted to the furrows on the strip to be irrigated a check dam is placed in the head ditch opposite the lowest furrow of the strip. The check dam may consist of earth or of manure and earth combined, but it is more likely to be a canvas dam or some one of the many kinds of tappoons. The purpose of this check is to hold the water in the head ditch at the desired elevation and to distribute the flow between the furrows. The number of furrows which should receive water at one time will depend on the crop, the volume of water in the head ditch and the smoothness and texture of the soil. With the crude appliances of this method constant attention is required in order to distribute the water somewhat equally among the furrows and to see that the stream flows down each furrow without damming and flooding a portion of the crop. As soon as the soil is sufficiently dry the furrows are filled in and the space between the rows cultivated.

Fig. 11 shows a sketch of the "V" scraper or "crowder." This is one of the most convenient and serviceable home-made implements for making head ditches, whether permanent or temporary. In the sketch shown the shorter arm is hinged to the longer and the "V" can be adjusted to suit ditches of different sizes.

Some consideration is given to the best way of watering a field at the time of planting. If the steepest slope is likely to cause erosion, the rows are run diagonally. When the surface is rolling, the rows, particularly if they consist of fruit trees, follow the contours on the desired grade.

In this kind of furrow irrigation one man will irrigate from two to six acres in a day, and the cost of one irrigation, including the making of furrows and head ditches, will vary from about 50 cents to $1.50 per acre.

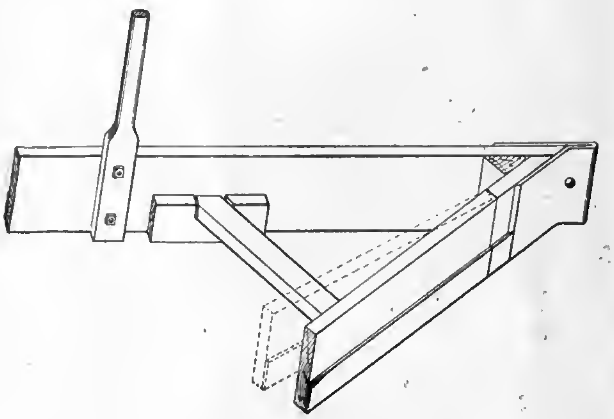


Implement for making furrows in orange orchard.

THE USE OF SHORT TUBES IN FURROW IRRIGATION.

In furrow irrigation, as ordinarily practiced, one of the worst defects, as has been already stated, is the difficulty of dividing a stream equally among a large number of furrows. A simple remedy, which is both cheap and effective, is described below, and its general adoption in all sections of the West where no better appliances are in use is recommended. Short tubes or boxes are inserted in the lower bank of the head ditch a trifle below the surface of the water, and each tube furnishes a supply for one or more furrows. In permanent ditches with a clearly defined high-water mark the boxes are placed at the same distance below this mark, but in a new ditch, where there is no such mark, the boxes may be placed so that the bottom of the openings will be slightly above the bottom of the ditch. The flow is rendered fairly constant by means of a small gate at the upper end of each tube. The tubes are usually made of wood, are from twelve to thirty-six inches long and nearly square in section, while the area of the opening left for the passage of water varies from one to twenty square inches. In some localities short lengths of discarded pipes from one to two inches in diameter are used.

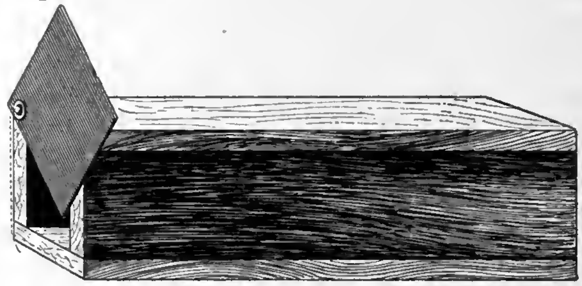
Fig. 12 represents a common form of tube, which was designed by Mr. B. F. Knapp, of Mountainview, Cal. It is made of four pieces of ¾x3¾-inch redwood boards fourteen inches long, nailed together in such a way as to leave an opening two and a quarter inches wide and three and three-quarter inches high. On one end of this box a sheet of galvanized iron 4x5 inches and about No. 22 in weight is fastened by means of a leather washer and a 6-penny wire nail. The flow of water through a box is regulated by means of this plate, which revolves around the nail. The boxes were made and used by Mr. Knapp to irrigate his peach. apricot and prune orchards in the vicinity of Mountainview. The water supply is obtained from a pumping plant, with a capacity of 1,000 gallons per minute, located in the orchard. Ordinary ditches in earth extend from the pumping plant to the upper boundaries of the various orchard tracts, and the boxes are used to divide the water equally among a large number of furrows.



Adjustable "V" scraper or crowder.

Mr. Knapp prefers deep to shallow furrows and uses a smaller number between the rows of trees than would be required if they were shallow. These furrows are made with a double moldboard plow attached to a sulky frame. This implement loosens the soil to a depth of ten inches and makes a large and well-defined furrow. When it is desired to loosen the subsoil of the orchard and allow the irrigation water to penetrate to a considerable depth a subsoiler made by the local blacksmith is attached to the plow and also to the sulky frame. This combination loosens the soil to a depth of fifteen inches. Water turned into furrows of that character is speedily and readily distributed to the deeper roots of the tree without any appreciable loss by evaporation. Soon after the water is applied the soil is smoothed over with a spring-toothed harrow. When the boxes are properly set and the furrows run, the work of irrigating is much less than by the common method and not more difficult than when costly appliances are used. With the comparatively large boxes herein described the water may be divided with fair accuracy among from 10 to 100 furrows by properly controlling the openings.

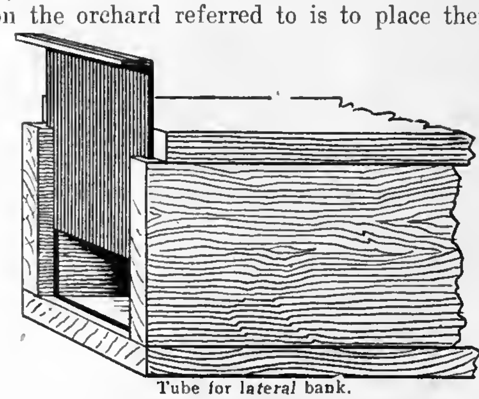
At the time of the writer's visit to the locality, July 31, 1903, two men were irrigating a 28-acre field of sugar beets on an adjacent farm with boxes loaned by Mr. Knapp. The water was conveyed from Mr. Knapp's pumping plant through an 8-inch canvas pipe and delivered at a corner of the field of sugar beets. From there it was carried in rather a steep supply ditch across the end of the field. The volume carried was about sixty miner's inches and was divided among about half as many rows of beets. One man



Tube for diverting water to furrows.

inserted the checks and the boxes and the other looked after the distribution of the water in the field. While the water was retained by one canvas dam, a second canvas dam was inserted 50 to 100 feet below, the distance depending on the grade, and a box was placed opposite each furrow. When the beets were irrigated as far as the first dam it was removed to a point below the second one nad the operation of putting in boxes and irrigating repeated. An extra supply of boxes was kept on hand, so that there was no necessity to use other than dry boxes.

In the nurseries at Fresno, Cal., a similar device is used in irrigating nursery stock. The stock is set out in rows four feet apart and seldom more than 500 feet long. A furrow from three to four inches deep is made on each side of a row of young trees and about nine inches from their base with a small walking plow drawn by one horse. Water is conveyed to the nurseries in ordinary earthen channels, but the distribution is made by small wooden boxes made of common pine lath. The opening is so small that there is no need of a gate. One of these lath boxes placed with its center two inches below the surface of the water in the supply ditch would discharge 0.7 miner's inch; if placed three inches below the surface, $^8/_9$, and if four inches, a trifle more than one miner's inch. The practice on the orchard referred to is to place them about



Tube for *lateral* bank.

two inches below the surface and to divide this stream equally between two furrows. It requires about twelve hours for this small stream, 0.35 miner's inch, to reach the foot of the rows, 500 feet distant. The cost of each tube in place does not exceed 3 cents. The nursery stock is irrigated every two weeks from June to September, inclusive.

THE PRIMER OF IRRIGATION.

(20th Chapter Concluded.)

Tobacco requires a soil very carefully prepared. The plants are raised from seed in frames and set out the same as cabbage and tomatoes, carefully puddled in and the rows irrigated by a small stream until the plants take root, which they will do in a few days. Frequent and thorough cultivation of the soil is necessary, but water must be applied sparingly, one irrigation during the middle period of growth being sufficient, provided the cultivation is thorough and the subsoil moist. When the soil is dry and warm, irrigation may be applied every ten days after the first month of growth. In the arid region top or leaf spraying is necessary, but tobacco is not recommended as a plant profitable in arid soil, it thriving best in a warm, moist climate.

STATISTICS OF PRODUCTION.

It may be of interest to know the amount of the foregoing profitable plants produced in the United States. The following is an approximate of quantities as nearly as can be ascertained from the means of information:

Wheat	753,460,218 bushels
Barley	178,795,890 bushels
Oats	736,808,724 bushels
Rye	30,344,830 bushels
Corn	2,522,519,891 bushels
Rice	283,665,627 pounds
Cotton	5,384,000,000 pounds
Tobacco	500,000,000 pounds
Hops	20,000,000 pounds (about)
Flaxseed	5,000,000 bushels (about)

The total value of which was in the neighborhood of two thousand million dollars ($2,000,000,000).

CHAPTER XXI.

IRRIGATION OF PROFITABLE PLANTS.

(Continued.)

It has been impressed upon the mind of the reader in the preceding chapters that plants draw their food from moisture and not from water. True, moisture comes from water, but the meaning sought to be conveyed is that moisture is a food solution, a preparation for nourishing the plant—its "pap," so to speak. When water is applied to the soil it attacks the various soluble salts, both organic and inorganic, and causes a chemical change to take place, or, rather, a series of chemical changes, and in that way the elements in the soil are converted into food. There are fermentations, transformations and many radical changes effected, until the water converted into moisture can not be recognized as water at all or any more than vinegar, wine or potatoes can be called water, although they contain water as an element in their composition, as an ingredient.

This fact can not be overestimated, because on its understanding hinges the art of irrigation. There are air plants which have no rooting in the soil, yet they could not live without moisture. There are also plants which flourish in the desert, where the soil is entirely dry for a hundred feet below the surface, yet these could not live without moisture. The question is, Where do they get it? They certainly do not require water, for there is none within reach of their roots or leaves. They obtain it from the atmosphere, and this atmosphere is an element that must be reckoned with by every irrigator. We know that there is always a certain quantity of moisture in the atmosphere, which is better known by the name of "humidity," and this humidity can be easily measured.

When the atmosphere is charged with 80 to 100 per cent of moisture, or humidity, that moisture is precipitated upon the soil in the form of rain, snow, etc. From 50 per cent to 80, when the air is cool, we have dew, fog, etc., visible to the eye. When the air is warm, however, the moisture is not perceptible to the eye, but it is there nevertheless.

Now, with the atmosphere weighing or pressing upon the earth's surface about fifteen pounds to every square inch, there is not a nook, cranny or opening that it does not penetrate, and it carries with it the moisture it contains, and when it comes in contact with any absorbent, as the soil undoubtedly is, it leaves its moisture there. It is for this reason that it is insisted upon so strenuously that the farmer must keep his soil open to the air—the soil should be aerated as much as possible. This done carefully and constantly, the labor of irrigation is rendered easier, and its effects more perceptible; likewise less application of water will prove adequate to the raising of any plant.

The necessity for this aeration of the soil is the same in the cereals alluded to in the last chapter as in the root plants and tubers. In the case of cereals, however, taking a wheat field as an illustration, it is impossible to cultivate the soil because the plants cover the surface of the ground closely. What can and should be done is to till the soil as deep as possible before planting and harrow after the plants are up, say two or three inches. If any other sort of cultivation is attempted the wheat and other grain must be cultivated as in corn, by being planted in rows. The production per acre would be greater than when sown broadcast or drilled, but that method is not convenient, at least it is not in vogue in the United States, and probably never will be in large field culture, it being easier and less laborious to flood the soil with water to create the requisite amount of moisture.

But in the case of vegetables, roots and tubers there is no excuse for not aerating the soil, since these plants can not be planted so close together as to entirely cover the ground, except in the last stages of their leaf growth, when the crop is assured. Running ground vines even may be cultivated almost to the point of ripeness, and when, as in the case of watermelons, cucumbers and the like, or strawberries, the vines have covered the ground, a few rills of water permitted to find their own way beneath is better than a flooding, for the latter is apt to reach the stalks or stems and either rot them or bake the ground and choke off the air, thus killing the crop or injuring it materially. All this can be provided for at the last run of the cultivator, or stirring of the hoe, by leaving small furrows or depressions here and there for the water to run in as channels when cultivation is no longer possible without tearing up the plants.

VEGETABLES.

Potatoes and tubers generally favor a moist, cool soil, although in the arid regions under a very hot sun they grow to perfection and to an immense size. A 15-pound Irish potato or a 30-pound sweet is pleasant to look upon, but not so well adapted to culinary requirements as those of a smaller and more convenient size. With too much water or an abundant supply potatoes become watery, for they are gross feeders—gluttons, in fact—and they must be restrained.

It is not desirable to plant potatoes in hills where irrigation is practiced; better plant in rows on level ground and then run water in a furrow between the rows, which may be from three feet to four feet apart; the closer the rows the better, for then the vines will shade more surface and retain the moisture longer. In the rows plant the eyes from two to two and one-half feet apart. In the arid and semi-arid regions it is a good plan to plow under every third furrow, the plowman dropping several cuttings at every long step in the furrow. Of course, the soil must be well tilled preparatory to planting, and in a moist condition, then well harrowed and pulverized afterward. When the plants are up about an inch or two, run the cultivator through, or a small plow would be better, so that a small furrow can be left between the rows, the earth being thrown up against the plants. When the plants are up a foot and tubers begin to form, run water through the middle furrow for an hour or so and the next day run plow back and forth, throwing the earth over on the wet soil to form a ridge. The day after level the ground with a cultivator and let it alone for a week. After this, one more irrigation when the tubers are about the size of a hazelnut, or filbert, will be sufficient to mature the crop. The soil should always be kept open and the moisture near the surface, for the potato has a tendency to crowd out of the soil. In the arid regions a singular peculiarity of the early potato is to grow to maturity before the plant is ready to flower. This is owing to the rapid underground growth and is of no consequence except that the tubers are all the better for absorbing the nourishment that should go into the flowers. Sweet potatoes have this curious habit also. One case which has been called to the attention of the author is that of a 2-rod row of sweet potatoes. The vines refused to grow more than an inch or two above the ground; they did not become vines at all, but grew straight up as far as they grew at all. Thinking they needed water, they were irrigated liberally, and every few days for three months water was applied and the soil kept loose. Wearied with the efforts to make these vines grow, a wise neighbor was called in, and after studying the matter for a few minutes and listening to what had been done to encourage their growth he took a spade and dug down into the head of the row, unearthing a 30-pound sweet potato or yam. Continuing this exploration all along the row, at least 100 sweet potatoes were dug out varying from thirty pounds down to five pounds. The growth had all been under ground, the tubers taking all the nourishment, leaving none for the tops. Cooking disclosed the fact that they were very coarse and rank, unfit for human food but pleasant to the palates of a pair of hogs which devoured them with a relish and asked for more in their peculiar language.

For tubers generally, keep the water away from them and give them moisture. This may be done by permitting the furrow water to soak into the soil and then throwing it over toward the plants. Sub-irrigation is very favorable for the growth of tubers, and when the land is drained and the soil kept well open and finely pulverized there need be no fear of failure to raise a crop. Sandy loam is the best soil, although rich, well manured ground, consisting of mixed clay and sand or loam, is productive of good crops, but the richer the soil and the warmer, unless there is very quick, almost hothouse growth, is liable to cause rot or other diseases peculiar to tubers.

Sweet potatoes may be grown to perfection, that is they will grow to be sweet potatoes out of which the sugar will bubble when baked, if planted in almost pure sand. This, of course, in the humid regions, for an arid sandheap would cook the cuttings before they had a chance to sprout.

Turnips, beets, carrots, parsnips, salsify and other root crops will grow in any kind of soil if properly tilled and well irrigated, but if succulence is an object plant the seeds in rich, black loamy soil, plowed deep and well pulverized. They may be irrigated at any time the ground shows dryness by cutting a deep furrow within a foot or eighteen inches of the plant, taking care not to let the water reach the crown or rot will ensue. Flooding should not be practiced except in the case of field beets, and then only when the leaves shade the ground. Clean and thorough cultivation is necessary, and in the case of small roots moisture rather than water should be supplied by running water in a furrow at least twelve inches distant and then drawing the moist earth over toward the plant the next day, covering the furrow immediately upon completing the irrigation to prevent evaporation and baking of the soil.

THE KITCHEN GARDEN.

Here is where irrigation can be made to shine like a gem in a barren waste. Our markets are filled with tasteless vegetables, unfit for table use. Without flavor and stringy, the housewife buys them every day because they represent green things and look plump, as if filled with succulence. But they are like apples of Sodom, or like the book St. John ate—sweet in his mouth and bitter in his stomach.

The soil of a kitchen garden must be rich and extremely well tilled. It should be thoroughly broken up and pulverized after plowing under well-rotted manure. Fertilizers are unobjectionable, certainly, but they do not tend to open the soil as does ordinary barnyard manure. Besides, it is better to furnish the soil with the elements out of which the plant can manufacture its own food than furnish it with ready-prepared material. They know what they want better than man, and if it is not ready at hand they manufacture it. As is said in a preceding chapter, a plant and the elements in the soil constitute a perfect chemical laboratory, and any attempt to interfere with nature is apt to "boggle" the creative power of the plant. It does not want help; it must have material.

For the purposes of irrigation the land should be level and slightly elevated to permit the flow of water. Rather than flood the ground, as is a common practice, it would be better to run a number of close furrows and then turn the earth over as soon as the water stops running. This will moisten the ground and put it in better condition; moreover, it will give infiltration and capillary action a chance to operate and create moisture.

The salads and radishes require a good supply of water and this may be given them by small furrow irrigation and hoeing or cultivating over, or the rows may be sprinkled. If sprinkling is begun it must be continued, for the roots will come up near the surface for the moisture. These plants, however, are short-lived; a few weeks and they are ready to harvest.

Sub-irrigation is better adapted to celery than any other system. With rows of tiling ten or twelve feet apart, or less, any number of plants can be grown on an acre. By planting close, a few inches apart, and irrigated plentifully they are self-blanching, though to reap all the benefit of garden culture the old way of planting in furrows and drawing the earth up around the plant is the better method where flavor is desired. If the celery patch is small, a circular or cylindrical shade of cardboard or straw matting may be put around the plant. Lettuce is treated in this way to make it grow up long and blanched, which gives the well-known "salade Romaine."

Beans and peas are deep-rooters, the former growing deeper than the latter. Both love a sandy loam and may be planted in drills, the rows about twenty inches or three feet apart. If the soil is dry they should be irrigated between the rows when the first true leaves appear, and at least twice more before the flowers appear, at which period they should receive a plentiful supply of moisture. Once a week is not too often for irrigating these and all other leguminous plants.

Tomatoes may be well soaked when young and then left to themselves, giving them about three irrigations at regular intervals until the fruit sets. Too much water will cause them to run to vines, and, moreover, cause rot. Where there is any rainfall during the period of growth after the first irrigation, cultivate constantly and suspend water applications.

Melons and cucumbers require warmth, and hence if the water be cold the plants will be set back, particularly if young. Good soil moisture is all that is necessary with thorough cultivation, and when the vines cover the ground careful flooding will be beneficial. Keep the earth up around the plants and the water away from them, as they need plenty of air.

In the case of cabbages and cauliflowers the young plants should be puddled in and this followed by a good furrow irrigation close to the plants, followed by cultivation, throwing the earth against the stalks. After the plants show signs of heading, irrigate in furrows between the rows and the next day or so cultivate the moist ground over against the plant, or without touching it if possible.

It would require a volume to detail all the plants useful as food that may be grown in the kitchen garden. The main object of this book is to give the outlines of irrigation, and not how to plant, or specify varieties of plants. The rules to be observed are general, but in every case they may be adapted by using good judgment. Thus: When the sun is hot, if irrigation is necessary run the water in furrows, not so close to the plants as to wet the stalks or crown of the roots, then by cultivation the moist ground may be thrown close enough to the plant roots to enable them to reach it. If the day is cloudy and no indications of a hot sun, less care is required. Then it does not make any difference whether the plants are wet or not, but they must be hoed or the earth must be loosened around them to prevent hardening or baking, which is always detrimental in the case of every plant, whether hardy or tender.

To ascertain whether there is moisture enough in the soil, do not wait for the plant to tell you by drooping or twisting its leaves. Then it may be too late and the plant will have stopped growing, or the subsequent crop will be poor. Bore or dig down into the soil say one foot, and if the earth feels damp, or will slightly pack in the hand when squeezed, there need be no immediate application of water. But if comparatively dry, so that it will not soil a clean handkerchief, water must be applied, and the best way is to furrow the ground in small furrows and run the water in rills, cultivating as soon as possible; or if the plants are large, like sweet corn, cabbages, beets, parsnips, etc., cut a large furrow between the rows and run it full of water, permitting seepage, infiltration and capillary motion to carry it to the right place, the root zone. Whether it is doing its work properly can be ascertained by thrusting the hand down near the plant, the soil being supposed to be pulverized sufficiently to reach at least three or four inches down; if not, it must be made so.

Nothing has been said about weeds, because the supposition is that no farmer will permit a weed to grow on his land. Two plants can not very well grow in the same place, and in the case of the weed it will destroy the plant as quickly as vice will a man of good morals. As the story goes: A man planted pumpkin seeds with his corn, but the corn grew so fast that it pulled up the pumpkin vines. The reader is at liberty to doubt this story, but the idea of it is to avoid trying to make two plants grow in the same spot.

ONTARIO, ORE., Nov. 3, 1904.

EDITOR THE IRRIGATION AGE, Chicago, Ill.

There is at this time existing here a very popular impression that the Reclamation Bureau of the Government is going to make this section of country a veritable garden of Eden and that it is going to make a millionaire out of every citizen of the country and every one opposing them in any respect is regarded as a public enemy and so openly pronounced. An extensive and active "press bureau" has subsidized the local press and has kept constantly before the people the most glaring and extravagant (and absurd) representations as to what the Reclamation Service is going to do for the people of this section of country. In this course they are assisted and encouraged by a coterie of land grabbing speculators who expect to reap large personal benefits from the undertakings of the Government in this field. While a large number of the citizens of this section of country are misled and deceived by these misrepresentations there are some of the more discerning ones that realize the improbability, if not the impossibility, of carrying out the imposing and extravagant plans announced by the Reclamation people. However, the worst feature of their policy, so far as we that are on the outside are concerned is their malicious interference and persecution which has seriously interfered with our legitimate business. We have not in any way interfered with their plans or business nor do we wish to, but they do not act in that way with us, as they have followed us into other branches of our work, that is, work entirely outside of the irrigation field, and have used the prestige that they enjoy by reason of official positions and the free use of the columns of the local press, to seriously injure and interfere with our business. My associate has come to dread their opposition and does not wish to incur their further displeasure. Personally I do not care and am disposed to fight.

The information conveyed to you in my former communication is relative to only one instance and there are at least a half dozen others even worse in every respect that I might cite. I am curious to know how long the people will stand it. I am interested in your efforts to put this matter correctly before the people and will gladly help you in any way that I can. I am Respectfully yours. "ONTARIO."

DEVELOPMENT OF THE UNDERFLOW.

The Experiment Station Well.

PROFESSOR J. J. VERNON,
Mesilla Park Agricultural Experiment Station, New Mexico.

The development of the underflow for irrigation is one of the methods that has been adopted in certain sections for relief during drouthy seasons.

The people of the Territory fully appreciate the value of any investigations which are intended to assist in the solution of the difficult problems connected with the development of the underflow for irrigation in New Mexico, and it is, therefore, unnecessary to dwell upon this feature of the question.

The great necessity for information along this line led the authorities of the Territorial Experiment Station to inaugurate experimental work. One feature of the question taken up for solution was that of pumping for irrigation. While an abundance of water was to be had at fifteen feet below the surface of the ground, to secure a well that would furnish a sufficiently large quantity of water for irrigation purposes seemed, at first thought, to be impossible, if the cost was to be kept within the limits of practicability, since the water-bearing beds under the experiment station farm, as well as those under the whole of the Rio Grande Valley, were thought to be composed of almost pure sand. An open well situated only a few miles from the experiment station farm had cost upward of $10,000 and was capable of supplying only from 1,000 to 1,200 gallons per minute.

Before the experiment station well was begun an investigation was made of some wells of the valley, in order that we might profit by a knowledge of the difficulties encountered by others. This investigation led us to believe that in the formation of the valley lands gravel strata had been laid down, and that possibly a gravel stratum might be found of sufficient thickness to make the development of large quantities of water possible at a reasonable cost. The well on the experiment station farm was begun with the avowed purpose of proving or disproving this supposition. The theory proved correct.

A standard pipe, six inches in diameter, was sunk to a depth of forty-eight feet, penetrating a stratum of gravel twelve feet thick, which was intermixed with from 20 to 50 per cent of sand. A slotted strainer, made from 16-gauge galvanized iron, closed at the bottom, was lowered inside of the pipe. The pipe was then jacked up until the whole slotted portion of the strainer was exposed. Each of the slots in the strainer was 1½-inch long by ¼-inch wide, the intervening spaces being of the same dimensions. This form of strainer allows water and sand to freely enter the well, but restrains the gravel, which, after the sand is removed, as is indicated below, forms a very porous water-bearing stratum.

When water was first pumped from the well it was loaded with sand. This continued for several days. Probably two carloads of sand were pumped from the well before the water became clear. From this we conclude that the sand mixed with gravel around the strainer had been removed for several feet in every direction.

The quantity of water furnished by this small well has been far beyond our most sanguine expectations. We hoped to secure a flow of from 400 to 500 gallons per minute, but one of the pumps, being tested, produced 1,085 gallons per minute. This quantity of water, supplied by only a 6-inch well, at first thought seems almost incredible, but upon looking into matters a little more carefully the reasons for this large flow are readily understood. Since the slots in the strainer occupy nearly one-half of the total area of the walls of the strainer, it is evident that the strainer offers little obstruction to the passage of the water through its walls, and since the sand mixed with the gravel has been removed for several feet, perhaps ten, possibly twenty-five feet, in every direction, we may reasonably say that we have, in a measure, the results that would be obtained by an open well from twenty to thirty feet or more in diameter, twelve feet deep.

When the matter is looked at in this light we can readily understand that the quantity of water which can be secured from such a well is enormous and the flow is probably only limited by the carrying capacity of the pipe through which the water must be drawn.

The total cost of the well, including curbing, pipe, strainer and sinking, was not to exceed $150. This very small cost, in consideration of the large quantity of water secured, seems to indicate that what was considered a very difficult problem—that of securing large quantities of water for irrigation from the underflow—has been solved for all localities where a gravel stratum of sufficient thickness can be found. For sections where no gravel strata can be found, other methods must be tried.

IRRIGATION IMPLEMENTS.

The Department of Agriculture recently issued a pamphlet containing a very interesting article by Elwood Mead, chief of irrigation investigations, concerning the preparation of land for irrigation and methods of applying water. Not the least interesting feature is a series of illustrations, which are reproduced elsewhere, showing some of the novel implements used. Mr. Mead finds a diversity of irrigation methods in use on Western farms, which he attributes to the early training and environment of the irrigators, and further says:

"Among the 120,000 irrigators of Western America are to be found nearly all classes and nationalities. Each settler from another State or from a foreign country introduces on his farm some custom or practice common to his old environment. This is particularly noticeable in the conservative Chinese, who irrigate the truck gardens near towns and cities in Chinese fashion. The same is true of the Italians, Spaniards and Mexicans, who imitate for a time at least the ways of their forefathers. It also applies, but to a less degree, to those who come from humid States. The farmer who lives until maturity in the Mississippi Valley and then moves West onto an irrigated farm does not as a general thing adopt new ways of farming until crop failures compel him to do so. Even then the old ways of doing things are mixed with the new.

"Then, apart from the influence which early training may exert, there is always present the vital question of money. Many new settlers have not the means to prepare fields for easy and efficient irrigation. They are compelled to resort to crude methods, which rob them of a part of their possible profits.

"The large stockmen pasture cattle and sheep on public lands and irrigate only sufficient native meadow and alfalfa to supply the needs of their stock in midwinter. With this class irrigation is a side issue and seldom receives the attention which it deserves.

"Others again have another excuse for their poor methods. They are tenants and wish to obtain the greatest immediate returns for the least possible expense. At the other extreme one finds the so-called "agriculturist," who makes his money selling merchandise in the city and spends it on his farm in the country. This class is content with small returns for large outlays; for to such people farming is a pastime. The size of the farm has also much to do with the manner of irrigating it."

FEDERAL IRRIGATION.

The San Francisco *Call* of December 23 has the following to say concerning subjects and individuals with whom all of our readers are familiar:

The National Irrigation Association, which seems to be an alias for Mr. Maxwell, is largely in evidence in an attack on Senator Hansbrough, of North Dakota, one of the authors and promoters of the Federal irrigation law. Mr. Maxwell in his incorporated capacity has memorialized Congress in a general attack on the Senator, and belabors him with the same fervor he used in attacking the Modesto and Turlock districts in this State, to prevent their completion of one of the finest irrigation plants in the world, which is now fertilizing a quarter of a million acres of land.

The Federal irrigation fund now amounts to about $30,000,000. It is to be hoped that it will not come to be consideerd a companion pork barrel to the river and harbor bill. It is growing at the rate of $3,000,000 a year by the sales of the public land. Mr. Maxwell has tried hard to stop this increment by lobbying for repeal of existing land laws, under which alone does the irrigation fund get additions to its volume. Senator Hansbrough seems to favor not only the enlargement of the fund, but its conservation, by putting its expenditure under proper official and professional supervision. To do this he has proposed that a supervising engineer be appointed by the President, who, under direction of the Interior Department, shall have general supervision and direction of the engineering work required by the law.

At present this task is assigned to an employe of the Geological Survey, who has neither the time for the work nor the compensation to justify his giving the attention it needs. It is easy to foresee that under such circumstances the fund will begin to spring leaks. The Government has a military engineer in chief, who has supervision of the large expenditures made under the engineer corps of the army. This system deposits authority and responsibility in one place. The authority is ample as the responsibility requires, and the effect is to protect the public funds. It is doubtful if authority and responsibility can be found hand in hand anywhere in the administration of the Federal irrigation law. Each work now in progress seems quite independent of any relation to any other work, and if there be any connection between them it is through a subaltern of a subordinate of the Interior Department.

We submit that a work as great as this, presenting as many complexities, and implying such ultimate risks to the National Treasury, was never before left as slipshod in respect to oversight and exactness in administration. Government, of necessity, does such things wastefully and therefore there are safeguards, audits, countersigns and all sorts of rifles established by law to catch such things as they flow and reduce to the minimum the inevitable waste. To say that this stupendous experiment and enormous expenditure of money shall go on under the normal conditions of Government waste, without the safeguards proved necessary by experience, is to utter folly of the flathead brand.

It is not proposed to disturb in any way the present corps of construction engineers, nor to revise or cancel existing contracts, or in any way check the progress of work now under way. But it is proposed to put it all under the direction of a supervising engineer of the highest qualifications, equal to those of the chief engineer of the army, in whose office and under whose eye every plan made, contract let, dollar expended, shovel of dirt moved and drop of water impounded shall be focused.

Those who are to occupy the lands irrigated and pay back the expenditures of the Government have rights in the matter and the most at stake. It is already known that the cost of works under way will be $20 for every acre irrigated. That has to be paid back by the man who occupies the land. When it is known that the cost per acre of the irrigation plant in the Modesto and Turlock districts is $10 per acre, the interest of the land holder looms largely. The Modesto and Turlock plant was not a Government enterprise, and economy and efficiency went together in its construction. One may easily see that it would be a blessing to the future land holders in the Federal irrigation districts if the burden per acre could be as low. It may not make any difference to Mr. Maxwell, who is not going to farm any of that land, but will gratify his agricultural heart by farming the farmers, but it does make a great difference to a tiller of the soil whether the Government mortgage on his land is $10 an acre or $20. He has to take the risk of frost and wind and weather, equip his land with buildings, teams and implements, support his family and pay off a mortgage of $20 an acre in a limited time. Farmers read this who have undertaken such jobs and they wince at the recollection. Senator Hansbrough seems to be accused of entertaining the malign purpose of making the mortgage as light as possible. Whereupon the National Irrigation Association is incensed and calls names and is afraid!

That association in its corporeal form, which preceded its corporate form, as the abalone precedes its shell, undertook for a salary of $30,000 a year paid by the Western railroads to get appropriations for irrigating direct from the treasury. When Senator Hansbrough proposed to derive the fund from the sale of the public land the corporeal part of the association fought it. Finding it would pass, the abalone acquired its shell by incorporation, in which form it claimed a caveat on all plans for irrigation. There is a suspicion now that it desires to stop accretions to the irrigation fund and to use a bungstarter on what is already in the barrel, in order to make good its contract to get direct appropriations. We shall see.

THE DOUBLE POWER WIND MILL.

We are continually meeting with surprises. Now comes a Two-Wheeled Wind Mill with a Governor that governs and wheels that run in opposite directions.

The Double Power Mill Company, of Appleton, Wis., are the patentees and manufacturers and claim that their invention revolutionizes wind power. This Company furnishes an "Insurance Policy," agreeing to replace all worn-out parts and repair damage by reason of wind for a term of from five to twenty-five years at a cost of $1.00 per year.

If the manufacturers' statements in their pamphlets are true (see ad elsewhere) there is no doubt but what many of our readers will be interested.

Wind furnishes the cheapest power on earth and we hope the Two-Wheeled Mill will serve to solve the problem with those who are looking for the right thing to pump water or run their machinery.

Double power mill manufactured by the Double Power Mill Co., Appleton, Wis.

Residents of the Pecos Valley in New Mexico are excited by the discovery that underlying more than 600,000 acres of desert land is apparently an inexhaustible supply of water. The fame of the region has spread throughout the country and even to portions of Europe. The water gushes from the ground wherever borings are made and pours over a thirsty land, transforming it into a garden of almost remarkable fertility.

EXTENSIVE IRRIGATION PROJECTS.

The most extensive and important irrigation projects in the history of this country are in process of development. The public mind has gradually been educated on the subject of irrigation, as the enterprises now going forward prove. Fully ten million acres of land are under irrigation in the United States and not less than two hundred million dollars have been spent in this line of enterprise. A great deal of territory that otherwise would be worthless is being reclaimed and in the semi-arid belts crop raising is being rendered more certain and land values are being enhanced.

Heyward G. Leavitt of Omaha proposes to complete 150 miles of irigation canal in Western Nebraska to cost $1,548,000. He has filed an application for a permit to appropriate water with State Engineer Dobson. His application is in the nature of an amendment or an extension of the farmer's canal in which he has become interested. The Farmers' Canal Company has been in litigation for several years in the supreme court, but its affairs appear to be well settled at this time. It has completed many miles of its canal in Scotts Bluff County.

Through a typographical error in our December number in the advertisement of the Jeffrey Manufacturing Company, Columbus, Ohio, the advertisement was made to read "Single Chain Water Elevator" instead of "Double Chain Water Elevator."

CHEYENNE, WYO., Dec. 31.—Prof. Elwood Mead, head of the irrigation investigations of the department of agriculture, who is in the West as an expert in the Kansas-Colorado water right suit, and who is taking the Scottish Rite degree in Masonry here, will leave in a few day for Omaha, in company with State Engineer C. T. Johnston, where they will consult with leading officials of the Union Pacific relative to the location of a deep well experiment station here, or in the immediate vicinity of Cheyenne.

The railroads of the West, and especially the Union Pacific, have in recent years gone into experimental farm, soil culture and stock feeding experiments on a large scale and numerous experimental stations have been located along the lines of railway.

The Government Irrigation Department will co-operate with the State engineer and with the railroad company in conducting a deep well and farming experiment station here.

LARGE TRACT IN MILK RIVER IRRIGATION PROJECT.

BUTTE, MONT., Oct. 18.—A miner special from Great Falls says:

The local land office today received instruction to withdraw from all forms of entry 276,480 acres of land, in connection with the Milk River irrigation project. Part of the tract withdrawn lies northwest of Havre, extending irregularly from from the line of the Great Northern to the international boundary, comprising part of the chain of lakes, reservoir sites and lands lying along Milk River and Sage Creek.

Another portion of the tract lies west of the Montana Central, between the Big Sandy and Box Elder Creeks, and is presumably withdrawn in connection with the Marias Diversion Canal portion of the Milk River project.—*Portland Oregonian*, Oct. 21, 1904.

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EDITORIAL

The Colorado-Kansas Suit. The Colorado-Kansas water right suit which recently came before Commissioner Granville Richardson has not proved such a walk-away as those most heavily interested anticipated in favoring the Colorado Fuel & Iron Company. We have before us a report of this suit which contains the testimony of Prof. L. G. Carpenter, State Engineer of Colorado. Portions of this report will be published in a later issue of THE IRRIGATION AGE. The fault with the Kansas end of the fight seems to be lack of capital, while the Colorado people find no difficulty in holding up their end in that respect.

Good Prospects. THE IRRIGATION AGE is glad to inform its friends that the first month of 1905 shows a better increase in point of circulation and business than any other month in the history of the publication. Plans are now being laid for the development of circulation and it is hoped to build our circulation up to the 50,000 mark before the end of this year. When we have once secured 50,000 subscribers, this publication will take rank with the leading class journals of the world. The manufacturers of agricultural implements, pumping machinery and irrigation tools and those who supply goods to prosperous farmers throughout the country should bear in mind that THE IRRIGATION AGE is the pioneer of its class in the world, is the standard in its line and will ever maintain its position as the leading and strongest irrigation magazine in the world.

Resolutions Wil Stand. In another column in this issue appears an outline of the report of the Committee on Arid Lands and Irrigation of the National Association of Implement and Vehicle Manufacturers, in which some strong recommendations are offered. These recommendations were made after due deliberation by the committee and when same appeared in printed form and had reached the hands of Government officials whom the carrying out of these recommendations would affect, a great scurrying around took place and an effort is now being made to compel the committee to withdraw these recommendations, or so materially change them that they would have no weight. The gentlemen who are at work with members of the National Association of Manufacturers, with a view to this end, may rest assured that the more effort they make to secure a change in the resolutions, the more thorough an investigation will result, and all good friends of irrigation development throughout the west feel satisfied that the more thorough the investigation, the more surely will good come out of it, and the resolutions as printed in the report will stand. It is understood that George H. Maxwell is making every effort through certain members of the association to counteract the effect of this report and it may not be out of place here to state that the more strenuous his efforts in that direction, the more likely the association is to make a careful investigation, which is all the friends of the cause desire.

An Experimental Farm. THE IRRIGATION AGE is about to try an experiment along the line of supplemental irrigation and has secured a tract of land in central Michigan, on which the work of clearing has already begun. This land is located on a beautiful lake and the intention now is to clear about ten or fifteen acres early this spring and establish a supplemental irrigation plant, that is to say, put in pumping machinery in the shape of a large wind mill and gasoline engines and raise the water to a reservoir on a side hill, with which to supply crops during the "dry spell" which inevitably strikes all the central states some time during the growing season of the year. It is not our intention to go into this on a very large scale during the first year. We will probably try the experiment on five acres planted to garden truck and at the same time set out five or ten acres to young fruit trees and a careful study will be made of the effect of water furnished growing crops and trees under this system. It is our intention to follow the line of work carried out by Dr. Gapen at the Northern Hospital for the Insane at Kankakee, and with that end in view will get in touch with this gentleman and secure such assistance in the way of suggestions as he may be able to offer us.

It may perhaps be necessary to lay out two five-acre plots, the crops of which will receive identically the same treatment and cultivation, the only difference being that water will be supplied to one of the tracts during the "dry spell" while the other will be left to take care of itself so far as moisture is concerned. It is our impression that this experiment will be instructive and interesting to all our readers and we intend to not only tell what success may develop out of the proposition, but to state as well what mistakes are made and explain so far as we can the cause of failures as they may develop. It can be readily understood that an experiment of this kind would be of little value to the general public unless they are taught to avoid mistakes as well as to improve advantageous conditions.

Photographs of this tract in different stages of development will appear in the columns of THE IRRIGATION AGE. The land lies in what is known as the Cadillac tract, one and one-half miles southeast of Cadillac, Mich., is on a lake as above stated and the Ann Arbor railway cuts diagonally across the tract. This plan was suggested by a citizen of Michigan, who has been making experiments on a small garden patch during the past several years with good results. The idea of this experiment is to illustrate to our readers the practicability of establishing a water supply station on all the farms in the humid section, so as to be able to distribute water to plants during the growing season when lack of the natural supply would make the artificial application necessary to insure normal or good crops.

If any of our readers have experimented along this line and will furnish us with information which will be of value to us in our experiment, we will be very glad to receive same.

Curtis on Irrigation. We are presenting in this issue a comprehensive report on irrigation development under the Reclamation Act prepared by Mr. William E. Curtis, the well known correspondent of the *Record-Herald,* Chicago, which will prove interesting matter for all of our readers. Mr. Curtis secured his data from the fountain head at Washington and all of his information is presumably, therefore, authentic. There are many facts, to be sure, connected with the report prepared from data secured from the chief of the Reclamation Service or Geological Survey which are passed over lightly and details connected with the selection of sites for Government projects are necessarily eliminated. It is safe to say, however, that Mr. Curtis and other correspondents of national reputation will later on secure information which will permit them to give facts concerning matters of grave interest to all interested in the subject of national irrigation. It will be noted that Mr. Curtis speaks of the Tonto or Salt River Basin project in Arizona and states that it will be one of the greatest dams in the world. He says that the entire cost of this reservoir will be $3,200,000 and it will reclaim an area of 160,000 acres of desert land around the capital of Arizona. THE IRRIGATION AGE can not agree with Mr. Curtis in this connection, as it is a well known fact that the lands to be irrigated under the Tonto reservoir are lands held in private ownership and the majority of the land has at some time or other been under cultivation, if it is not in fact being profitably cultivated at the present time; and Mr. Curtis no doubt failed to learn that the Tonto proposition and the expenditure of this $3,200,000 are practically a loan to a lot of private land owners in this vicinity; he perhaps did not learn further that there was strong talk just before election last year of using such influence as could be brought to bear by one of the congressional delegates, who was defeated, to so arrange matters that none of this money would be paid back to the Government under the provisions of the law. Fortunately the gentleman who intimated that this end might be attained, was defeated. Otherwise there might have been a possibility of his mixing matters very badly and so shaping affairs that the Government would have expended over $3,000,000 purely and solely for the benefit of a group of land owners who had no claim whatever upon it.

In this connection Mr. Curtis also states that when this money is paid back to the Government at the rate of about $20 per acre, the fund is to be used for the new reservoir project which has been surveyed on the Verde River and also the Gila River at San Carlos, where the engineers say 200,000 acres may be reclaimed at the small cost of $2.00 per acre. Mr. Curtis evidently fails to note the incongruity of this proposition. Possibly his lack of knowledge of conditions in the Territory of Arizona has been the cause of his overlooking the fact that if 200,000 acres of desert land can be reclaimed on the Gila River at a cost of $2.00 per acre, or, say, $500,000 for the project, would it not be much better for the country at large to open up 200,000 acres of land for settlement and permit a few thousand settlers to secure cheap homes and land under this project than to invest $20 per acre out of the first money obtained under the Reclamation Act to irrigate 160,000 acres of land held in private ownership in the Salt River Valley?

The facts as THE IRRIGATION AGE has them are that 360,000 acres may be irrigated under the San Carlos project and if it would cost five times the $2.00 mentioned by Mr. Curtis, or $10,00 per acre, would it not have been better to have opened up this land and have permitted a lot of settlers to get in on the land and develop it than to invest $3,200,000 for the benefit of private land holders? These are points that will come out later on as Government work progresses and while it is impossible at this time for any one publication or group of individuals to control the action of the Reclamation Service, all mistakes of this kind will eventually be brought to light and it is our impression, place Mr. Newell and his assistants in a peculiar position. This is the sort of work for which THE IRRIGATION AGE censured Mr. Newell, Mr. Walcott and their press agent, Mr. Maxwell. Mr. Curtis goes on to speak of the Gunnison project in Colorado and a perusal of his article is well worth while.

Imperial Project. According to reports received by THE IRRIGATION AGE within the past month strange things are happening in the Imperial country in California and it is now stated that Mr. Lippincott, one of the Government engineers, has recommended the purchase of this project by the Government. It is a well known fact that one expert strenuously opposed taking over this Imperial enterprise by the Government, but he now recommends, so we are informed, that the Government purchase it at a fairly long price. Perhaps the result of the investigations by this expert has been such as to justify him in changing his opinion and if so and his opinion is now correct, he is to be congratulated on this decided change. If on the contrary any influence has been brought to bear on him to secure his recommendation of the purchase of this project, it would be well for the public and the Government officials generally to understand the situation.

THE IRRIGATION AGE was informed some time ago that a certain paper devoted partially to the subject of irrigation, published in Washington, had been paid $2,000 by the Imperial Company, ostensibly for advertising. We have, however, failed to note anything in the line of advertising which has appeared in the columns of this journal, except editorial comments, and if the $2,000 was paid for the space devoted to this subject by the paper, the Imperial people have made a very bad bargain. Our informant states that the object of paying this sum of money to the Washington publication was to place them in a better light with the Reclamation Service, with whom they were trying to negotiate the transfer of the property to the United States Government. This is rather a serious accusation, but it came direct to THE IRRIGATION AGE from a source that is unquestioned and as soon as further investigations have been made in the matter, we will give our readers additional information, some of which may be of a startling character.

Northwestern Wyoming is to witness a splendid bit of enterprise. Two and a quarter millions of dollars will be spent by the government in constructing a large dam and extensive irrigation works on the Shoshone River. The Shoshone project has great possibilities and when completely worked out will probably irrigate fully 500,000 acres of waste lands, parched, but holding in their dry embrace enduring fertility.

Mr. Joseph Tweedy is probably the most experienced irrigation farmer in West Texas and has just purchased a $1,700 irrigating plant, consisting of a twenty-five horse power portable Fairbanks-Morse gasoline engine and a No. 8 centrifugal pump, having a capacity of 2,000 gallons a minute.

KANSAS IRRIGATION ASSOCIATION.

The third annual convention of the Western Kansas Irrigation Association met in Garden City, Kansas, December 28-29. Almost all the western counties of the State were represented and much interest was taken in the various sessions. A large number of delegates from foreign points were in attendance and the convention was altogether considered a very profitable one. Addresses were delivered by Prof. O. V. P. Stout, of Lincoln, Neb., representing Prof. Elwood Mead, of the Department of Irrigation Investigations; Professor Wolf, of Manhattan; Professor Lloynd, of the American Beet Sugar Company, and Judge Mason. A very interesting paper by Prof. Charles S. Slichter was read, the subject being "Government Investigations of the Water Supply in Western Kansas." The officers for the ensuing year are the same as last year, viz.: I. L. Diesem, president; Alfred Pratt, vice-president; Charles Loucks, secretary, and C. A. Schneider, treasurer. The executive committee is composed of: E. P. Taylor, G. M. Kerr, R. A. Beckett, W. J. Carter, R. M. Lawrence and A. Barlow.

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, courtesy United States Department of Agriculture.

(Continu d.)

Similar tubes are used on many of the naval-orange orchards of Tulare County, Cal. Some few orchards were also noticed where short pipes supplied the place of the wooden boxes. These pipes are usually one and a half inches in diameter and about twenty-four inches long, and are inserted in the lower bank of a temporary ditch. The water is held at the desired elevation in these temporary ditches by earth dams, and water passes from one division to another through a short length of 6-inch pipe, which is built into the earth dam.

Fig. 1—Rotary Scraper.

These home-made devices for regulating the flow in furrows may be adapted to any size of furrow. The box first described has an opening of nearly 8.5 square inches and, if placed with its center four inches below the surface, would discharge 7.5 miner's inches under a 6-inch pressure. Such boxes are intended for large furrows. On the other hand, the small lath box just described is intended for small furrows. The discharge of a tube can be controlled by a gate in such a manner as to suit any furrow.

The appliances recommended are all cheap. Farmer's boys can make them during the winter months. There is usually enough lumber lying around the farm buildings to provide boxes for a 10-acre tract. This suggests that Western boys who live on irrigated farms should practice carpentry in learning to make some of these boxes, and next spring, when the vegetable garden needs water, try the new way. Fig. 13 shows the construction of such boxes. They are made of ½x2-inch lumber, dressed on both sides and edges. The top piece is cut back three-fourths of an inch and a metal slide operated in saw kerfs is shown. When this box is placed with its center five inches below the surface the discharge will be two miner's inches.

THE USE OF FLUMES AND PIPES IN FURROW IRRIGATION.

In irrigating the more valuable varieties of fruit trees, such as oranges, by the furrow method, it is customary to carry the water to the upper ends of the furrows in flumes or pipes. Flumes for this purpose were formerly made of wood, but the short life of lumber in contact with the soil has led many orchardists to substitute more durable material. The cement flume made without joints is now the most popular. When pipes are laid to convey water to the head of each furrow they may be made of iron, steel, cement, mortar, clay, canvas or paper. These half dozen kinds of pipes are in use at the present time in California.

Wooden Flumes.—A common form of wooden flume is made, in the manner shown in Fig. 14, of redwood boards, which are held in place by yokes about four feet apart. Water flows to the furrows through auger holes in the side midway between the yokes and is controlled by small zinc slides.

When V-shaped flumes are preferred they are usually built as shown in Fig. 15. The slides are fastened near the bottom of one slope.

Head Flume of Cement Mortar.—This flume is made in place in one continuous line across the head of the orchard by a specially designed machine. The ingredients of the cement mortar are one part by volume of imported Portland cement and five parts by volume of clean, coarse sand. The sand and cement are mixed into a mortar and fed into the machine, which forms the bottom and sides of the flume and compresses the mortar in one operation.

Flumes of this kind are made in five sizes, designated by the number of inches across the inside of the bottom. An 8-inch cement flume is shown in cross section in Fig. 16. The remaining sizes are similar in form but have varying dimensions.

The sizes, cross sections, volumes of mortar and prices are given in the following table:

PRICES OF CEMENT HEAD FLUMES.

Size *Inches.*	Cross Section *Sq. inches.*	Volume of mortar per linear foot *Cubic feet.*	Price
6..........	36	0.35	$0.16
8..........	56	.40	.18
10..........	80	.50	.20
12..........	96	.72	.22
14..........	126	.82	.25

After a flume is made, and before the mortar becomes hard, small tubes from three-fourths to one and a half inches in diameter, the size depending somewhat on the size of the flume, are inserted in the side next to the orchard. These tubes may be of tin or galvanized iron, and each has a small slide gate in the form shown in Fig. 16. There should be as many tubes between the rows of trees as there are furrows.

On medium or steep slopes the water in the flume flows at a high rate of speed, which lowers the head over each opening and lessens the discharge to the furrow. This difficulty is readily overcome by inserting one or more short pieces of laths in grooves made by a trowel when the mortar is soft. These low checks are put in on an angle, so as to crowd the water toward the opening in the tube.

Head Flumes of Cement Concrete.—These flumes are made of materials which closely resemble the ordinary concrete of engineering structures. One part of the best Portland cement to six parts of sand and gravel is the usual mixture. It is laid in place across the head of the tract to be watered in sections of about twelve feet. Special molds are designed to hold the concrete in place until it partially sets, when the molds are removed. A flume of this kind is shown in Fig. 17. By comparing the dimensions of this 10-inch flume with a similar size of the kind previously described it will be seen that the latter contains more material of decidedly greater strength. These advantages are offset by greater cost.

For distributing the water from the flume to a large number of furrows, devices somewhat similar to those already described under the head of cement mortar flumes are used.

Cement Pipes.—Both cement and salt-glazed vitrified pipes are occasionally used in place of earthen head ditches. These pipes are too common to need any detailed description. They are placed deep enough not to interfere with plowing, but seldom more than two feet beneath the surface, and various contrivances have been designed, some of which are controlled by patents, to distribute the water to a large number of furrows in nearly equal and constant streams.

A practice lately introduced in citrus orchards is to distribute the water from the cement pipes by means of short standpipes of the same material which terminate in semicircular basins of cement mortar. Each basin has about six holes in the curved portion, through which water is fed to the furrows. The water may be turned on or off by operating a small rubber-faced valve, which is fitted over the top of the standpipe and is flush with the bottom of the basin.

The present (March 1, 1904) prices of cement pipe of different sizes at Los Angeles, Cal., are as given in the following table:

Fig. 2—Distributing Water with Canvas Hose.

PRICES OF CEMENT PIPE AT LOS ANGELES, CAL.

Inside diameter of pipe *Inches.*	Price per foot	Thickness *Inches.*	Weight per foot *Pounds.*
4............	$0.05	1	13
5............	.065	1	16
6............	.08	1 1-16	20
7............	.10	1⅛	25
8............	.125	1¼	31
10............	.17	1⅜	44
12............	.21	1½	57
14............	.25	1⅝	68

The above prices are for cement pipe composed of one part Portland cement to three parts sand. Other makers use one to four and increase the thickness of the walls. Last January (1904) a Riverside firm was selling pipe of the latter composition at the following prices:

PRICES OF CEMENT PIPE AT RIVERSIDE, CAL.

Diameter of pipe *Inches.*	Price per joint	Price per foot
6..................	$0.12	$0.06
8..................	.16	.08
10..................	.26	.13
12..................	.31	.155
14..................	.40	.20

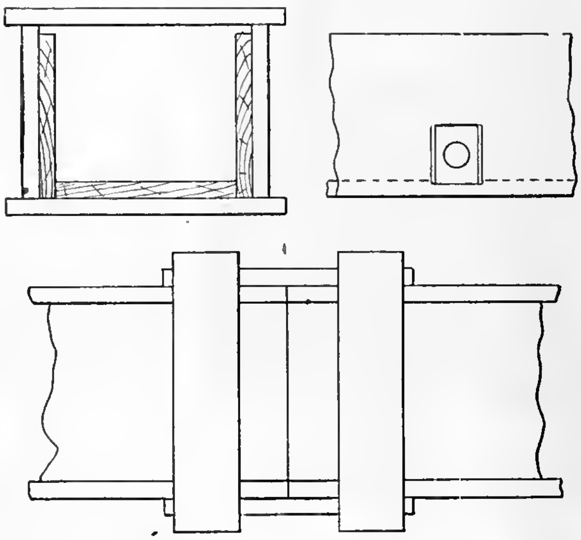
MAKING FURROWS.

The furrows for crops like potatoes, which are planted in straight rows, are made with an ordinary walking plow with a cultivator having a large shovel attached, or with a lister.

Sometimes it is very desirable to irrigate grain, clover or alfalfa from furrows, on account of the liability of the soil to bake when flooded. In making furrows for such crops home-made implements are most commonly employed. These usually make small furrows from two to four inches in depth and from 1.5 to four feet apart down the steepest slope from the head ditch. The home-made furrower shown in Fig. 18 is well suited for this purpose.

When the soil will not be injured by rolling, projections in the form of an inverted V are sometimes fastened around the circumference of the roller and each of these makes a well-defined and smooth furrow.

Some years ago small, shallow furrows made by cultivator teeth were about the only kind to be seen in orchards. Now a small number of large, deep furrows are frequently used instead. Plate III, Fig.



Board Flumes for Use in Furrow Irrigation.

2, shows an implement for making such furrows in use on J. H. Williams' large orange orchard near Porterville, Cal. He took a cultivator and removed all the shovels. Two double-mold shovels were attached to an arm, which is fastened by the clamps of the cultivator. The right-hand plow extends out to the side, so that the distance between the centers of the two plows is 4.5 feet. This enables the driver to make a furrow beneath the outer branches of one row of trees in going one way and of the adjacent row in returning. With trees twenty feet apart, four furrows are made, and these can be arranged in the best way by adjusting the arms of the plows. The lever arm of the cultivator controls the depth and size of the furrows.

Shallow Versus Deep Furrows.—Ten or fifteen years ago the prevailing custom among fruit-growers was to make a considerable number of shallow furrows between the rows of trees. While this practice is still followed by many, the general trend of the best practice is toward a smaller number of deeper furrows. A desire to economize water by lessening the amount evaporated was doubtless the principal reason for a change of usage. Besides, running water in deep furrows tends to break up hard subsoil and to promote deep rooting.

Owing to the scarcity and value of water in southern California, the orchardists have been forced to make a close study of the effects produced by different methods. This office began a series of experiments in June, 1903, at Pomona, Cal., to determine the actual difference in loss of water by evaporation between the shallow and deep furrows. The experiment has not

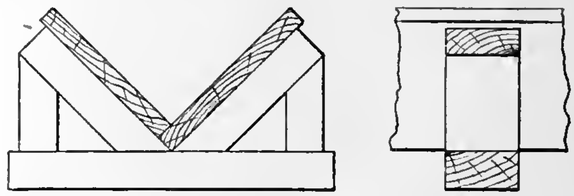


Fig. 15—V-shaped Flumes—Use in Furrow Irrigation.

been continued sufficiently long to warrant any conclusive statements. The results, however, show a marked gain in favor of deep furrows. From June 20 to October 24, 1903, the average amounts evaporated from equal areas of the same kind of irrigated soil for the different modes of applying water were as follows:

	Acre feet.
Irrigation by flooding	0.62
Irrigation by furrows 3 inches deep	.55
Irrigation by furrows 12 inches deep	.41

Length, Grade and Number of Furrows.—One of the common mistakes in furrow irrigation is to try to run water from end to end of a long field. A uniform distribution can not be made from long furrows. Their length should rarely exceed 660 feet (forty rods), which measures the side of a 10-acre tract. A tract from forty to eighty rods long in the direction of the furrows should have two head ditches and longer fields a larger number.

The fall or grade of furrows may vary between about 4.4 feet per mile and eighty-eight feet per mile,

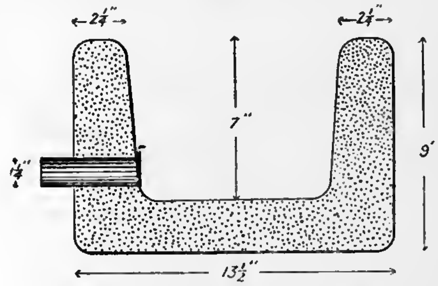


Fig. 16—Cross Section 8-inch Cement Flume.

or from one to twenty inches in 100 feet. On ordinary soils a fall of from three to four inches to 100 feet is to be preferred. When the slope of a field is too great that of the furrows may be reduced by changing their direction.

The number of furrows in orchards depends on the age of the tree, the space between the rows and the depth of the furrows. Nursery stock is irrigated by one or two furrows and young trees by from two to four. Only one very deep furrow made by a subsoiler may be run between the rows, while four is a common number for those of medium size. Shallow furrows in orchards are spaced from two to three feet apart. For grain and forage crops the spacing will depend chiefly on the ease and rapidity with which water spreads sideways in the soil.

Furrow irrigation has several advantages over other methods. It requires less water than any form of flooding, because the water surface exposed to evaporation is confined to a small fraction of the total land surface, seldom more than 5 per cent. Again, the water is applied from three to twelve inches below the surface

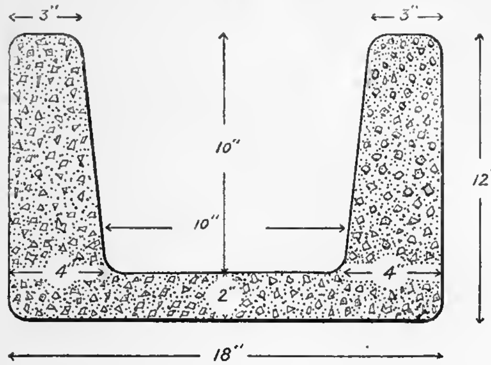


Fig. 17—Cross Section 10-inch Cement Flume.

and is distributed through the soil by capillarity rather than by gravity, and plants seem to thrive best when they receive moisture in this way. When water is applied in the bottom of V-shaped furrows the surface soil is not saturated and baking is prevented. By the furrow method the surface soil is kept tolerably dry, excessive evaporation is avoided, there is little displacement of surface soil, and a tendency toward deep rooting in the plant is promoted. Finally, it is cheap and convenient.

In seeking to improve on present methods of applying water by furrow irrigation one is tempted to recommend the best appliances, regardless of cost, but such recommendations would be followed only in rare cases. Local conditions have always to be considered.

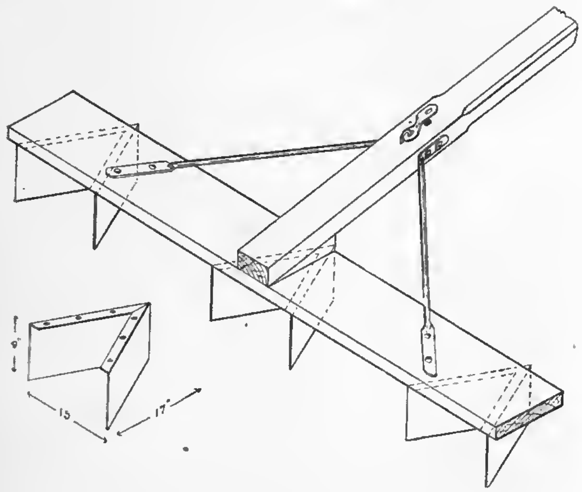


Fig. 18—Furrower.

If one assumes that pipes are the best means of distributing water, he is at once met with the objection that the large majority of irrigators could not afford to lay pipes for that object. It is questionable, also, if cement-concrete flumes could be used in the colder portions of the West on account of the severity of the frosts and the tendency of the ground to heave when frozen. There is also the same objection that applies to pipes, viz., the first cost. Even wooden flumes are considered by the majority of water-users to be too expensive for the mere purpose of dividing an irrigation stream equally among a number of furrows.

THE BASIN METHOD OF IRRIGATION AS PRACTICED IN THE SANTA CLARA VALLEY, CALIFORNIA.

Owing to the light rainfall since the dry year of 1898 most of the Santa Clara Valley orchards are now

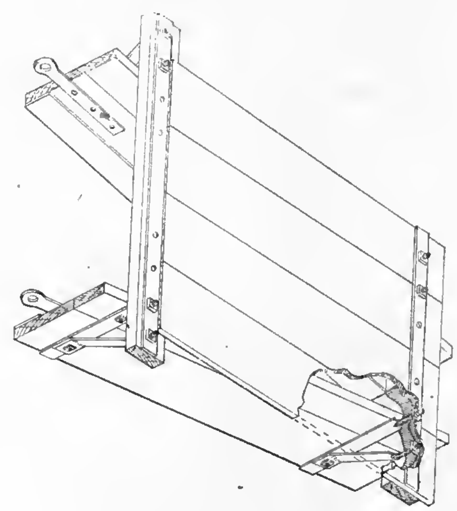


Fig. 19—Adjustable Ridger.

irrigated. The water supply comes chiefly from wells by the use of pumps, but the various creeks also furnish the gravity canals with considerable volumes during the rainy months from January to April. About four-fifths of all the irrigated orchards are watered by means of small basins. The basin method may, therefore, be regarded as not only the most prevalent, but as having attained in the Santa Clara Valley its greatest perfection. The same system is extensively practiced in the walnut orchards of Orange County, in California; but since the implements used and the manner of making basins and applying water are much the same in both sections, as well as elsewhere, the descriptions which follow under this heading will be confined to Santa Clara Valley. For much of the infor-

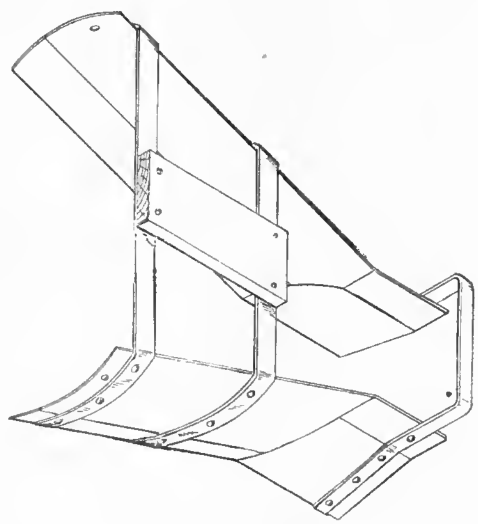


Fig. 20—Steel Ridger.

mation contained in these descriptions the writer is indebted to Mr. F. H. Tibbetts, a student in irrigation at the University of California.

The trees of orchards are about twenty feet apart, set in squares or in diamonds, 108 trees to the acre. In some of the younger orchards, particularly cherry orchards, the trees are spaced farther apart. The most common practice is to form a square basin around each tree by throwing up ridges midway between the rows of trees in both directions. These ridges are made with ordinary walking plows, to which extension moldboards are sometimes attached. Usually two furrows are thrown together, the second furrow reinforcing the first and making it higher.

On light, sandy loams and all ordinary soils that are not too wet or lumpy an implement known as the "ridger" is commonly used to form the ridges (Fig. 19). The narrow, deep runners are made of 2-inch planks and are from fourteen to eighteen inches high and from five to eight feet in length. They are from four to five feet apart at the front end and from fifteen to twenty-four inches apart at the rear end. The runners should be shod with steel on the bottom and on the inner side part way up to prevent wear and lessen the draft. The runners are held in position by cross-pieces on top and straps of steel. A steel ridger, which is claimed to be superior to the ordinary wooden ridger, is shown in Fig. 20.

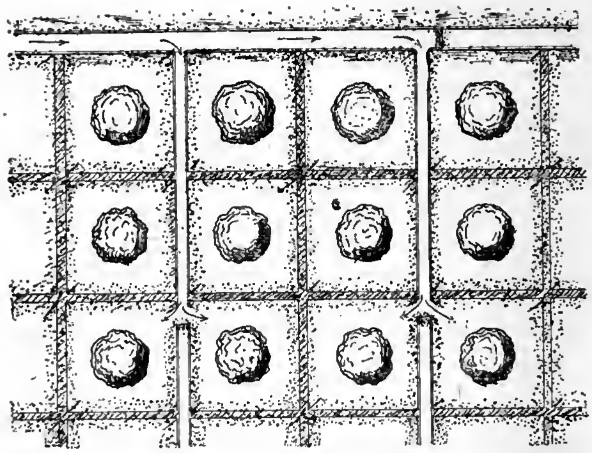


Fig. 21—Irrigating Orchard by Basin Method.

On light, sandy soils, which are free from weeds, good ridges can be formed with the ridger alone. One man with three horses can ridge twenty acres in ten hours. On compact soils and those covered more or less with weeds a strip must first be plowed and harrowed. Disk harrows and disk plows combine both operations and are much used for this purpose. The loose earth is afterward thrown up by a ridger.

The combination rotary disk, a recent design, is highly praised by those who have used it for making checks or ridges. It consists of four ordinary disks, arranged in the form of a V to throw the earth toward a common ridge in the center. It requires from four to six horses to operate it successfully, but time is saved over the common ridger in not having to pass along the same ridge more than once.

When an orchard is cross checked or ridged by first making ridges at right angles to the direction in which the water will flow, and afterward in the direction of flow, openings are left at all points where ridges cross. Each basin is thus open at each of its four corners. The most laborious way to fill these gaps is by the use of the shovel. The common scraper, drawn by one horse, is also used for this purpose. The horse walks along the side of the continuous ridge and as each cross ridge is reached sufficient earth to fill the gap is dumped.

A rotary scraper recently invented to fill basin gaps was extensively used in the Santa Clara Valley last summer. It differs from the ordinary scraper in that the scoop is free to revolve about two fixed points in the frame instead of being attached rigidly to the handles (Plate IV, Fig. 1). It is filled in the usual way, and when the gap is reached the operator releases the catch at the handle, which dumps the scraper, after which it is again snapped back into position to be filled.

There is no fixed rule as regards the height of ridges. The lowest are usually eight inches high, with sufficient base and top width to retain water in the basin to a height of four inches. Some orchardists apply as much as nine inches in depth over each basin at one time, and in such cases the ridges need to be at least twelve inches high. On nearly level ground, two, four, sixteen or even a much larger number of trees may be included in one basin. This practice requires higher and stronger ridges.

FLOODING BASINS.

As a rule, permanent supply ditches extend across the upper end of the tract to be irrigated. Flumes made of wood and cement concrete are also being introduced with beneficial results to take the place of earthen ditches. In some orchards these supply ditches are temporary, like the ridges, and are made by plowing out a dead furrow as deep as possible and then scraping it out with a V scraper. If a larger ditch is required, it is plowed and scraped out a second time.

Perhaps one of the best methods of conveying water from the supply ditch to the basins is to make double ridges in the alternate spaces between the rows of trees in the direction of the greatest slope, as indicated in Fig. 21. The water in the supply ditch is checked and diverted down one or more of these small ditches. When the flow reaches the lowest tier of basins, an opening is made in each ridge and the water floods the two adjacent basins. When these have received sufficient water, other openings are made opposite the next higher pair of basins and the flow is checked, so that it will be diverted into them. This operation is continued until all the basins on both sides of the ditch are flooded. The most convenient means of checking the flow in both kinds of ditches is by canvas dams.

WILL MAKE WASTE LANDS GARDENS.

Mr. William E. Curtis Writes About Irrigation Projects for the Record-Herald, Chicago.

No achievement of his administration gives President Roosevelt more thorough satisfaction than what is termed "the reclamation law" enacted by Congress on June 17, 1902, in response to the recommendations of his first annual message. He esteems it one of the wisest and most beneficial pieces of legislation of recent years and is confident that it will promote the public welfare quite as much as the Morrill act, which dedicated a great part of the public lands to the education of the people, or the homestead law, which did more than any other measure to build up the great West. The reclamation law is intended, without expense to the taxpayers, to make the arid regions of the West capable of cultivation. It applies the proceeds from the sale of public lands to the construction of irrigation systems and reservoirs to supply them, which are to be sold at cost price on ten years' time to the people who enjoy the benefits created by them. The money thus refunded is to be used again and again and still again in extending the irrigation system until every acre of the arid regions is watered and fit for human habitation.

The reclamation fund has grown very rapidly, much more rapidly than any advocate of the law expected. During the first year about $4,000,000 was turned into the treasury. On the 30th of June, 1904, it amounted to $11,276,289.87, and by the end of the current fiscal year it will reach, if it does not exceed, $15,000,000.

Surveys have been completed for thirteen great irrigation projects in as many different States, contemplating the reclamation of 1,131,000 acres of desert land at a cost of $31,395,000, or an average of $27.26 per acre. The land thus improved will be sold to the public at that price in ten annual installments and thus the entire amount of money expended will be refunded to the Government.

RECLAMATION PROJECTS APPROVED.

State.	Projects.	Acreage.	Cost.
Arizona	Salt River	160,000	$3,200,000
California	Yuma	85,000	2,975,000
Colorado	Uncompahgre	100,000	2,500,000
Idaho	Minidoka	70,000	1,820,000
Montana	Huntley	40,000	1,200,000
	Fort Buford	30,000	900,000
Nebraska	North Platte	100,000	3,500,000
Nevada	Truckee-Carson	100,000	2,600,000
New Mexico	Hondo	10,000	280,000
N. Dakota	Fort Buford	61,000	1,450,000
Oregon	Malheur	75,000	2,250,000
S. Dakota	Bellefourche	60,000	1,920,000
Washington	Palouse	80,000	2,800,000
Wyoming	Shoshone	160,000	4,000,000
		1,131,000	$31,395,000

The President is also greatly gratified at the rapid progress that is being made by the irrigation bureau. Six of the projects in the above list have been begun; contracts have been let, and thousands of laborers are already employed in Arizona, Colorado, Idaho, Nebraska, Nevada and New Mexico. The other propositions will be undertaken as rapidly as possible.

In Nevada work commenced as early as September, 1903, in building a dam in Truckee River to take the flood waters from the mountains and the overflow of Lake Tahoe and dump them into Carson River. Another dam will be built in Carson River to store these waters until they are needed in the dry season, when they will be distributed by means of canals and ditches over an area of about 100,000 acres, mostly desert land belonging to the Government. The cost of this improvement will be $2,600,000, or $26 an acre, and the land improved is now subject to homestead entry in tracts of forty, eighty, 120 or 160 acres, according to its situation. About 20,000 acres can be cultivated during the coming summer. It is expected that the waters will be turned on in April and settlers are going in very rapidly.

The law allows enough land to each settler to support a family. No cash payments are required; no commutations, but the settler must actually live on it and cultivate it for five years and pay $2.60 an acre each year for ten years, when he will receive a title to the land and own the water rights without additional payments. Private land which receives the benefit of the water must pay at the same rate—$2.60 per acre for ten years. After ten payments the owner of the land will have the water rights free of cost for all eternity. The land is good for alfalfa, sugar beets, potatoes and all the root crops and fruits of the temperate zone. It is only twelve hours from San Francisco by rail, fifty miles from the capital of Nevada, and is surrounded by mining settlements in every direction.

Part of the land reclaimed will be the old Forty-Mile Desert, or Carson's Sink, which was a horror of early emigrants—the worst spot on the overland trail; and was lined the entire distance with the bones of men and animals. Thousands of poor creatures died there from thirst and exhaustion. Farmers who plow there now turn up in almost every furrow gun barrels which were driven into the earth to mark graves and have since been buried deep in the drifting sands. As an illustration of the perversity of nature, the engineers who have been laying out the proposed irrigation system have found an abundance of cold, pure water a few feet below the surface wherever they have made borings. All of this desert will be redeemed and when the present proposition is finished the works will be extended to the Humboldt and Walker rivers, which will bring several hundred thousand acres more under irrigation and make a paradise of what is now the most desolate spot in Nevada. These rivers carry plenty of water from the mountains, but it disappears as soon as it reaches the sand. The engineers propose to catch it before it reaches the "sinks" and store it in reservoirs, to be tapped when needed.

Down near Phoenix, Arizona, the engineers under Dr. Newell are building one of the greatest dams in the world. It is to be 270 feet high, 210 feet wide, 165 feet thick at the base and 20 feet thick at the top. This enormous structure extends across a narrow gorge where the Salt River has burrowed its way through the mountains, and it will create an artificial lake thirty-two miles long, five miles wide and 200 feet deep. More than a million dollars has already been spent in preliminary surveys and construction; the foundations for the dam have been laid, and bids for the masonry work will be opened on the 8th of February next. The entire cost of this reservoir will be $3,200,000, and it will reclaim an area of 160,000 acres of desert around the capital of Arizona, which is now given over to cactus, sagebrush and tin cans. There is very little Government land; almost every acre has been already taken up, but the owners will pay for the work in ten annual installments of $2 an acre. At the end of that time they will own the reservoir and the whole irrigation system, while the money will be turned back into the fund to be used for the new storage project which has been surveyed on the Verde River, and still another on the Gila at San Carlos, where the engineers say 200,000 acres can be reclaimed at the small cost of $2 an acre.

There is a new feature in the Salt River reservoir, the possibilities of which have not yet been fully determined. The release of the water from the reservoir into the irrigating canals will generate at least 10,000 horse power of electricity, which Dr. Newell says may be used to pump water over 40,000 acres more of the desert, and cause it to blossom as the rose. This feature has not yet been developed, but it contains almost unlimited possibilities.

In Colorado the Gunnison River flows through a narrow canyon 2,000 feet deep. This canyon has always been regarded as impassible because of the swift current and the rocks, which have crushed every boat that has ever struck them. But A. L. Felloes, one of the engineers of the reclamation service, and an assistant made the passage by using their ordinary camp hair mattresses as rafts. They carried their food and extra clothing in rubber bags, and by floating, swimming and climbing succeeded in getting through the canyon and locating a point where a tunnel twelve feet in diameter will be bored through the granite cliffs for a distance of six miles into the Uncompahgre Valley, on the other side of the ridge. This will be the most remarkable engineering feat that has been undertaken in recent years.

The water of the Gunnison River, being conducted through this tunnel, will be spread over 100,000 acres of desert, which is now worthless, but which will have a value of $300 and $400 an acre as soon as it can be irrigated. The contracts were let October 5. Work was begun November last. The entire cost of the undertaking will be $2,500,000, which the owners of the land thus irrigated will pay in ten years at the rate of $25 an acre in annual installments.

This is the great horticultural district of Colorado. It is 4,000 feet above sea level and produces hardy fruits of all kinds and of most excellent quality.

Snake River, in Idaho, is to be harnessed at a cost of $1,820,000 about six miles from the tracks of the Oregon Short Line railroad, near a town called Minidoka. On November 15 work was begun on an enormous dam 2,000 feet long and fifty feet high, which will back up the water so that it can be brought out into the valley above and given sufficient fall to reclaim about 70,000 acres of public lands. That tract is now a desert without a living thing except sagebrush and cactus, but as soon as water can reach it it will produce anything in the way of plants, trees, fruits and vegetables—anything that will grow in New York State or Ohio. The entire area to be benefited is public land, and it is all open to homestead settlement in tracts of forty, eighty, 120 and 160 acres, without cash payment, but it must be paid for at the rate of $2.60 an acre for ten years. There are plans in the geological survey for the extension of this improvement until the Snake River has been made to redeem several hundred thousand acres of desert.

There is a big project down in the Pecos Valley of New Mexico, which is fairly well settled by farmers and ranchmen, who have not been successful in their private irrigation schemes, because the soil is underlaid by soluble gypsum, which absorbs the water and allows it to escape through underground passages. The owners of these enterprises have fought the plans of the irrigation bureau fiercely until a few weeks ago, when a flood washed away their dam and their ditches. Now they are begging the Government to hurry up and do something lest they lose their peach and apple orchards, which now can not be reached by water until the irrigation system is restored. If they do not get water on that land before midsummer, hundreds of thousands of dollars' worth of fruit trees will perish. Dr. Newell and his men are working as rapidly as they can, and will put in a system that will reach about 10,000 acres to start with, at a cost of $280,000, near the town of Roswell, on the Santa Fe railway. It will be the first step of a comprehensive system to include the entire valley of the Pecos, which resembles Salt Lake Valley in Utah. It has a deep, rich soil, capable of producing unlimited crops of melons, sugar beets, berries, fruits of all kinds, root crops and alfalfa, and the climate is one of the best in the United States. It is a natural health resort, particularly for consumptives. Nature, unaided, will cure tuberculosis while you wait. About half the land is vacant, and belongs to the Government. It is open to homestead entry, but settlers will have to pay $28 an acre, in ten annual installments, for the irrigation system.

For several years negotiations and surveys have been going on for an international dam in the Rio Grande River near the city of El Paso, which is needed to store the water to irrigate about 50,000 acres on both sides of the Mexican boundary. But it loons as if the benevolent scheme would have to be abandoned, as the engineers can not find a foundation for the dam. They have been boring everywhere that a dam could possibly be placed, and have gone down eighty-six feet into the sand without striking bottom. They say that, even could a dam be built, the storage lake would be so wide and so shallow that more water would be sucked up by the thirsty atmosphere than could be utilized for irrigation. They have recommended an entirely new plan, with a dam at Engel, about eighty miles north of El Paso, where all the water that falls within a wide drainage basin can be stored and three times the area of agricultural land can be reclaimed by it; that is, about 150,000 above and 50,000 acres below El Paso.

A big dam is being built in the North Platte River at what is known as "The Devil's Gate," about twenty miles above the town of Casper, Wyo., at a cost of $2,500,000, by which about 100,000 acres of desert land in Nebraska can be redeemed. It is mostly public land, open to homestead seekers, and settlers are already going in rapidly. The engineers expect to get water on most of the land within two years at a cost of $25 an acre, which must be paid by the settlers in ten annual installments. This project illustrates the advantage of having irrigation plants built by the Federal Government. It would be impossible to find water in Nebraska to reach the land in qnestion, while all that is needed can easily be caught and stored over the border in Wyoming.

These six projects have been commenced, and rapid progress is being made upon them.

THE PRIMER OF IRRIGATION.

Chapter XXII.

ORCHARDS, VINEYARDS AND SMALL FRUITS.

If there is no water in the subsoil of an orchard, no ground water, or water table, as it is called, it will be advisable to create an artificial one. One great drawback in orchard cultivation in the arid and semi-arid regions is, that the moisture does not penetrate to a sufficient depth to enable the deep roots to derive any benefit therefrom. The consequence is that where the moisture occupies a shallow belt the small feeding roots are forced to come to the surface, or near enough to the surface to receive all the desiccating effects of a hot sun, and a dry atmosphere. As trees require their natural food as well as plants of the most succulent nature, it will be readily perceived that these surface roots will soon exhaust the nourishment they require and then the whole tree will feel the effects.

The finer and more highly flavored the fruit the more care must be taken to see that it has the proper quality and amount of food elements. It requires the destruction of a vast quantity of roses to obtain one single ounce of attar of roses, and to perfect the flavor of a single peach the distillation in the laboratory of the soil must be enormous. When it comes to one or several acres of luscious fruit, the quantity of elements necessary to perfect the fruit is simply incalculable.

From this idea will naturally be derived two suggestions: Let nothing grow in an orchard but the trees bearing fruit; second, see to it that the soil has moisture down to a good depth, five or six feet, before venturing to set out the selected trees.

It is sometimes customary to plant small fruits between the rows of fruit trees; some plant vegetables, strawberries, and even forage plants to occupy the ground and keep it busy while the fruit trees are growing and coming into bearing. Better have only one tree in its twenty or thirty feet square of well tilled vacant soil, than ten trees surrounded by stranger plants to eat out their substance. There is a very good reason for not mixing up plants in this manner, which is, not all plants require the same amount of moisture, some requiring more, others less. Now if the orchard is made a hodge podge of plants with different appetites, and requiring a different diet, how will it be possible to administer to each one according to its necessities? Some will be overfed, other underfed, with the result that none of them will be perfect or produce what is expected or hoped from them. The only case where a little crowding will be justified is in the case of peach trees. These come into bearing very young, in some localities under the most favorable circumstances two or three years after setting out, at which time the tree will be about five years old. As peach trees bear heavily when fostered carefully, they are short lived, and therefore, many fruit farmers plant young peach trees in the rows about fifteen feet from the bearing trees when the latter are in their third or fourth year of bearing, and when the old trees shown signs of degeneracy they are cut down and the younger trees left to bear the burden of production alone. There is no harm in thus maintaining the full vigor of a peach orchard, for the trees belong to the same family and require the same food for their maintenance and practically the same quantity of irrigating water.

So far as filling the soil with water is concerned, where there is an absence of ground water it is better to irrigate for a full year or season before setting out the young orchard trees. If the soil is carefully tilled and pulverized, just as if the orchard were in good bearing, the next season will find an orchard ready for planting, and the process of growth will continue without any interruption and the applying of water be attended with less waste.

If there is ground water in plenty and within six or eight feet of the surface it is liable to come nearer by fresh applications of water and trench upon the root zone, thus destroying the trees. This will soon appear in evidence by the top limbs drying up or dying. It should be always borne in mind that generally there is as much of the plant under the ground as above it. Nothing but the tap root bores its way straight down; the rootlets and feeders spread out in every direction, something in the shape of a fan. Hence if some of these roots are injured the tops of the trees will also suffer. Metaphorically, the roots of every tree are its nerves, which can not be interfered with without injuring some member of the tree. Root-pruning is often practiced when taken in connection with limb-pruning, but where good, strong roots are desired top- or limb-pruning is beneficial. But the roots alone can not be tampered with except at the expense of the tree.

In the case, therefore, of too much ground water, or a liability to raising the water table, drainage tile should at once be put in at least five feet down, not in the middle of the rows, but comparatively near the trees, as far, perhaps, as they are buried underground. If arranged in this manner they will serve for drainage and also for sub-irrigation. The attention of the author has been called to cases where the subsoil was originally dry down for a hundred feet, and there was never a thought of the possibility of a water table ever forming. But it did, and by constant irrigations the water found an impervious strata and then began to collect and form a water table, which required drainage in the course of less than five years from the time of the establishment of the orchard.

Furrow irrigation is the most suitable, however, in most orchards, and it has always proved adequate to produce excellent crops. But the furrows must run deep and the after cultivation must be thorough or evaporation will injure the plants. Long furrows are to be avoided, and the water should never be "rushed" through them. Short furrows and a slow flow will tend to soak far enough down into the soil to reach the roots and far enough beyond that to enable the capillary motion to have a supply to carry up into the exhausted portions of the root zone. Three good irrigations during the season are ample and more than enough where there are ten inches of rainfall and a supply of underground water to draw upon. This can be acquired by fall and winter irrigation; that is, running the water into, not upon, the land after the leaves have fallen and following it up in the fall by deep plowing, cultivation and harrowing. Some dig a basin around their apple trees in the fall, and when freezing weather comes fill the basin with water and let it freeze. They say it prevents the tree from blossoming too early in the spring. Others mulch around their trees heavily with manure to keep out the frost. There is no way to reconcile these contradictory practices except by giving the soil moisture in the fall and winter and thorough cultivation. The earth will be a sufficient mulch and the moisture will freeze soon enough. But all the regulations in the world can not prevent the tree from following the course of nature. After the crop is gathered aud the leaves departed, the tree still goes on preparing for the coming spring. It is busily engaged in ripening its wood and storing up food for the new buds, and ice around its trunk will not stop it, nor will a heavy mulch of manure prevent it from freezing unless the entire tree is enveloped in the mulch.

Constant cultivation and the stirring or mixing together of the food essentials are what the tree needs and demands, and when this is done and the compote of organic and inorganic elements mixed with water all that man can do is done. Care should be exercised in irrigating when the trees are in bud, for if the water reaches them while in flower the blossoms will fall off, and the same is the case when water is turned on when the fruit is ripening. In the case of apples, however, the fruit may be made to attain large proportions by copious applications of water, although in general the application of water at the time of ripening tends to loosen the stems and cause the fruit to drop off before fully ripe.

THE VINEYARD.

The plan adopted by the vineyardists of France to destroy the pest of the phylloxera demonstrated that the vine is no tender plant which requires nursing. The vineyards were flooded and the vines kept under water for a longer or shorter period until tests showed that the larvæ of the pest was extinct. The conversion of the vine into an aquatic plant did not harm its vitality, although a crop was lost through overmuch water.

There is a hint in this result worth remembering. Too much water, no crop. It should be considered as an axiom for every irrigator to carefully observe.

The affliction of every vineyard is an excess of water. Grapes love a warm soil, but too much irrigation, particularly on the surface, renders the soil cold through evaporation. Wherever there is evaporation cold is produced and the more rapid the evaporation the greater the cold and the stoppage of growth.

During the first two years of the growth of a grapevine the greatest care must be bestowed upon it, particularly the second year, for it is during the second year that the cane which will bear the fruit is formed. Cultivation and irrigation are the main causes of a good crop; irrigate every two weeks if the soil shows signs of dryness. Like all fruit moisture in the soil is absolutely necessary, and if this is supplied by irrigation it must be followed immediately by thorough cultivation to reduce evaporation to a minimum and prevent the soil from becoming cold.

If there is ground water there should be drainage, the same as in the orchard, the tiles of which may be used for sub-irrigation, and they should always be used for that double purpose when needed. In the latter case if the moisture in the soil is sufficient no irrigation is necessary until the fruit is forming. As in the case of orchard fruits, never irrigate when the vine is in flower. The vine roots penetrate to a great depth in the soil, and therefore deep plowing and cultivation is advisable. If drainage tile are laid for drainage and sub-irrigation they should be laid near the main roots, so as to carry off the excess of water from irrigation on the surface. Where surface irrigation is practiced it should be the furrow system between the rows and deep. The water will sink deep and reach the roots, whereas by mere surface applications the thread roots are liable to rot and cause damage. The usual practice is to irrigate when the grapes are about to ripen, when they will fill out and ripen more evenly. In the finer varieties of grapes, like the high-flavored ones, the Concord, Muscat of Alexandria, etc., water should be applied more sparingly than when wine is to be manufactured. Fall and winter irrigation is the same as in the orchard, but care must be taken not to soak the soil by applying too much water unless it can be drained off.

SMALL FRUITS.

By small fruits are meant blackberries, raspberries, currants, gooseberries, etc., and the ground vines, such as strawberries.

The bush fruits require a rich and highly-manured soil to attain perfection, although they will grow in any soil capable of growing corn.

They require plenty of water, for the soil must be maintained in a uniformly moist condition. When blossoming, irrigation should be suspended, but renewed every week or ten days when the fruit has set. It is usual to irrigate immediately after one crop has been gathered, the water hurrying another picking to maturity.

The tendency to mildew makes small-fruit growing somewhat of a risk, but by careful pruning to let in the light and the air this tendency will be checked and the berries ripen bright and clean.

Constant cultivation, fall and winter irrigation, as in the case of other fruits, are essential, and when drainage is adopted the perils of small-fruit growing will be reduced to a minimum.

Strawberry culture may be carried on several months during the summer in the humid regions and all the year 'round in the arid or semi-tropical regions of the country.

It is a self-perpetuating plant, propagating itself by means of runners, which take root at the slightest provocation. To foster this habit and obtain fresh plants for a continuing crop, the soil must be kept in a fine, pulverized condition, with plenty of moisture near the surface. The plants may be puddled in a small ridge, hollowed to receive a rill of water, and when the runners creep over the ridge into the paths a little water run in will aid them to take root. The direction of their growth may be easily controlled, and when they have taken root they should be cut loose from the parent stem. The matted bed system is the best for irrigation, for the leaves cover and shade the ground and prevent evaporation. When the fruit is ripening care should be taken when irrigating or running water on the beds, not to wet the fruit, a contingency which tends to rot them before they can become ripe.

FORAGE AND FODDER CROPS.

These crops require abundance of water and quick growth. There are many varieties of forage plants, but alfalfa and corn will always be the standards—corn for the silo and alfalfa for hay. The latter will produce from three to five full crops a year if well irrigated, and that irrigation is by flooding in large fields as well as small ones. Some alfalfa growers do not hesitate to turn in horses, cows, sheep and hogs in their order to pasture the alfalfa patch when the crop is removed. Then water is run on the field and permitted to stand a week before being run off. After that nothing more is done until the crop is ready to again cut.

Others will not permit pasturage on the alfalfa field, but after harvesting it flood the soil with water and again several times before harvesting again. The rule is different in the arid and semi-arid regions, more water and less care being given it, but it grows right along without being disturbed by inattention.

All forage plants, whether corn or the grasses, require flooding at various periods of their growth. The first time after planting, when up three inches, when half grown and about the ripening period. Then after the harvest the ground should be well soaked if it is desirable to use the land for pasturage, the after-harvest irrigation producing a good growth of succulent grazing. Fall and winter irrigation are unnecessary unless for the purpose of keeping the soil in a moist condition, which is always advisable in the arid and semi-arid regions.

REPORT OF COMMITTEE ON ARID LANDS AND IRRIGATION OF THE NATIONAL ASSOCIATION OF AGRICULTURAL IMPLEMENT AND VEHICLE MANUFACTURERS.

The report of the Committee on Arid Lands and Irrigation of the National Association of Agricultural Implement and Vehicle Manufacturers has reached our hands and is altogether the best report ever submitted to that body. Mr. Charles Rowley, Chairman of the Committee, made a trip through the Western States in August and September with a view to becoming thoroughly posted on the subject of irrigation before preparing his report, which was presented to the National Association at its annual meeting held in Chattanooga, Tenn., November 16-18. This report occupies forty-eight pages and covers the subject in a comprehensive way.

We give below the remarks of Mr. Rowley, which preceded the presentation of the report in printed form.

It will be noted that this committee calls attention to two important subjects in connection with the irrigation movement, which we quote below:

First: "It seems to your committee, however, that the general sentiment in the West is against the repeal of the commutation clause of the Homestead Act, the Timber and Stone Act and the Desert Land Act."

Second: "Owing to the immense amount of money which necessarily must be expended by the United States Government under the Reclamation Act, we would suggest the recommendation be made, through the proper channel, that a committee composed of business men from the irrigation section be appointed by Congress to supervise the selection of reservoir sites and general work under the Irrigation Law of 1902, and to investigate the effects of the present law and whether it should be repealed or not, and why; and in view of the fact that eventually a larger sum of money will be expended under this law than will be used in the construction of the Panama Canal, it is the opinion of your Committee that the control of so large a sum of money should not be placed in the hands of one or two individuals."

It will readily be seen from the foregoing that when the subject is investigated, where the people are fully posted, the sentiment prevails that there should be no repeal of the land laws and, furthermore, the stand taken by THE IRRIGATION AGE concerning the appointment of a Commission to supervise the location or selection of sites for Government projects is upheld. The last clause is of great importance and the general opinion is that it will receive attention during the next session of Congress.

We give below an outline of the preliminary remarks of the Committee.

"To give even a brief synopsis of the history of the irrigation movement would require too much time and space, and there are other topics which in themselves would easily elucidate the subject for separate reports, such as General Laws on Irrigation, Rights to Use Water, Forests, Grazing Lands, The Desert Land Law, the Commutation Clause of the Homestead Act, Irrigation Investigations, Hydrographic Surveys, Reservoir Sites, Rights of Way, the Carey Act, and Other Details of the Reclamation Law. Much of this is given elaborate attention in the reports of the Reclamation Service and is available for the asking, and is not without deep interest to the investigator.

"It has been the aim of this Committee to conduct their investigations purely from an impartial standpoint, free from prejudices or bias; to glean the facts as they exist and, if possible, present them in our report in their true light. In the promotion, throughout the country, of the many-sided interests involved in this subject, whether personal or otherwise, diversity of opinion naturally results and we have found that entire harmony in the ranks of the advocates of irrigation does not exist. It is not our purpose to appear, directly or indirectly, as the advocates of ideas or projects put forth by any faction, or to be party to existing controversy, and while we have accorded a listening ear, the Committee stands first and last for the promotion through our organization of those interests best calculated to fairly and justly serve the masses.

"Congress has several times been asked to repeal the Timber and Stone Act, the Desert Land Act and the commutation clause of the Homestead Act, but thus far has done nothing. It is claimed that repeal or revision is a necessity; that abuses apparently exist under present laws, and the vital interest of the home-making inhabitants of the Great West, both now and for the future, are in a measure subverted by the operations of land speculators and others; that if the present laws enable the absorption of large tracts of land by speculative and selfish agencies to the detriment of the masses, then the people should demand suitable laws, freed from the possibility of perversion or doubtful interpretation. If repeal is necessary, then the laws must be repealed; if revision is deemed best, its early accomplishment is imperative.

"It seems to your Committee, however, that the general sentiment of the West is against the repeal of the commutation clause of the Homestead Act, the Timber and Stone Act and the Desert Land Act.

"To the average resident east of the one hundredth meridian the possibilities of the development of this boundless arid and semi-arid territiory of the West are inconceivable or incomprehensible. If manufacturers could but visit one or more of the well-known irrigated districts in Colorado, Wyoming, Utah, California, Idaho, Arizona, New Mexico, Nevada, Washington and Montana, and compare the green fields and bountiful crops with the sagebrush land in other sections of those States, they would readily grasp the possibility for development of business along the line of agricultural implements and vehicles in this Western country when once a general movement is on foot to reclaim it. A careful examination of conditions throughout this country demonstrates the fact that a magnificent development has been accomplished under private irrigation projects; and while the Government will do much toward assisting to irrigate large areas whose reclamation private corporations would hesitate to attempt, it is our impression that the bulk of irrigation development throughout the West will eventually be found to be under private projects. We do not mean to detract in any way from the possible strength of National aid, which is absolutely necessary in certain cases, but *all who are well posted on the general subject of irrigation admit that private projects have, up to this time, proved the salvation of the West and will continue to hold the lead in development regardless of the large expenditures of the Federal Government under the Law of* 1903.

A general examination of some of the large Government projects, notably that of the Carson Reservoir in Nevada, demonstrates that it will take some time to secure proper development, owing to the fact that large undertakings of this character require much time.

Again, while in the West, the Chairman of this Committee saw land which ten years ago could be purchased for $1.25 per acre, and that now, under cultivation by irrigation, commands readily from $100 to $400 per acre. Is it not reasonable to suppose that a farmer who may be able to make his land earn from $40 to $100 per acre annually is a possible good customer for your wares and ours? It is a well-known fact that there are hundreds of farmers throughout the West who are cultivating from fifty acres upward whose net income exceeds $100 per acre per year.

"Another good feature about irrigation farming which impressed your Committee is the fact that the market for products raised under irrigation is practically unlimited, owing to the vast areas settled by mining communities who have no means of securing the necessities of life in the farm products excepting from the irrigation farmer. This is especially true of Nevada and Montana, where innumerable mining camps are located. Nevada, however, bids fair to become divorced from a condition which heretofore has given the impression that its resources were practically worked to the full; for, by means of the great irrigation projects on foot by the Reclamation Service, which will sooner or later apply water to the millions of acres of what has been demonstrated to be extremely fertile soil, Nevada will become transformed from a State of arid desolation into one of the greatest agricultural States in the Union. Montana, too, is large enough to support an enormous population in the future when the lands become available for farms, and great projects are now on foot to bring about the storing of the waters of its rivers and streams so that they may be distributed through irrigation ditches over the naturally rich soil of millions of acres.

"We understand the Reclamation Service are now surveying the Missouri River for the purpose of making proper recommendations to Congress relative to irrigating the arid portions of North Dakota, which, when irrigated, would open up something like ten million acres of land for agricultural purposes.

"It was the good fortune of the Chairman of this Committee to reach Denver at the time of the meeting of the Live Stock Association of Colorado, some of the sessions of which he attended, and where a good idea of local Colorado conditions was obtained. The Chairman met at that time Mr. E. H. Grubb, of Carbondale, Colo., President of the Live Stock Association of that State; Prof. L. G. Carpenter, State Engineer of Colorado; Prof. O. V. Stout, at the head of irrigation investigations of the University of Nebraska; and Mr. Teel, Government Expert, Washington, D. C. There were also present at this meeting the Honorable Secretary of Agriculture, Mr. Wilson, together with Mr. F. H. Newell, of the United States Reclamation Service and Mr. Gifford Pinchot, chief of the Government Forestry Bureau. Among others met and from whom valuable information was obtained, may be mentioned Messrs. Fort and Darlow, of the passenger department of the Union Pacific Railroad, both of whom very kindly gave such information and assistance as was in their possession. Mr. Darlow gave some very valuable information along the line of investigations which have been made under his supervision in the way of irrigation by pumping. He is an enthusiast on this subject and has prepared a specially printed pamphlet in which he goes thoroughly into the matter. This pamphlet may be secured by those interested by addressing the General Passenger Agent of the Union Pacific Railroad at Omaha, Neb. Other valuable information was secured from Mr. D. E. Burley and Mr. Spencer, general and assistant passenger agents, respectively, of the Oregon Short Line, whom the Chairman met at Salt Lake City. These gentlemen are enthusiastic promotors of irrigation interests and are ready at all times to furniish to those who may apply to them by letter detailed information concerning the development of irrigation in the West.

"Our report would be incomplete without giving some attention to the splendid work which is being done under the supervision of the Department of Irrigation Investigations, which is subordinate to, and part of, the Department of Agriculture. This department is under the direct supervision of Prof. Elwood Mead, chief of investigations. This branch of the Department of Agriculture has supervision of experimental stations in all of the States. Work is being accomplished to give farmers a better conception of agriculture and irrigation in their proper sense.

"Our report contains, in a condensed form, remarkably valuable information for every manufacturer in the United States who contemplates developing trade in the Arid West and we strongly urge each and all to peruse the contents carefully, so that they may be in better touch with existing conditions and thereby be in position to take advantage of the largely developing trade which is sure to come in their respective lines of goods.

"Owing to the immense amount of money which necessarily must be expended by the United States Government under the Reclamation Act, we would

suggest the recommendation be made, through the proper channel, that a committee composed of business men from the irrigation sections be appointed by Congress to supervise the selection of reservoir sites and general work under the Irrigation Law of 1902, and to investigate the effects of the present law and whether it should be repealed or not and why; and *in view of the fact that eventually a larger sum of money will be expended under this law than will be used in the construction of the Panama Canal, it is the opinion of your Committee that the control of so large a sum of money should not be placed in the hands of one or two individuals.*

It is inconceivable to us how any intelligent manufacturer can afford to remain ignorant regarding arid land and irrigation when, as before stated, one of the greatest openings for manufactured products now is, and will be in the future, the reclaimed Arid and Semi-Arid West."

[Following this is a complete report which may be secured by addressing Mr. C. G. Rowley, Chairman, Jackson, Mich.—EDITOR.]

DRAINAGE

REPORT OF THE SECOND ANNUAL IOWA STATE DRAINAGE CONVENTION.

Held at Ames, Iowa, January 13, 1905.

The second annual Iowa State drainage convention was called to order Friday evening, January 13th, at the Iowa State College, by President D. A. Kent. Several hundred of Iowa's land owners, statesmen, civil engineers, supervisers and drainage experts were in attendance, and a goodly number were also present from neighboring States. Great interest was manifested in the program throughout the two sessions and many profitable discussions were taken up with great enthusiasm and with much profit to the delegates present.

The opening address was made by Prof. C. F. Curtiss, director of the Iowa Experiment Station. He spoke most interestingly of the progress of the drainage improvements in the State during the past year but stated that the keynote of this convention would undoubtedly be an effort to secure as speedily as possible a test case which would prove whether or not the present drainage law is constitutional. The uncertainty regarding the law is a great barrier to the progress of drainage at the present time.

Mr. C. G. Elliott, drainage expert for the United States Department of Agriculture, spoke upon "Drainage Claims and Equitable Assessments in Drainage District Work." This is a subject of Statewide interest in Iowa and Mr. Elliott presented facts which will prove of inestimable value to the scores of county officials and land owners who heard him.

"The New Iowa Drainage Law" was discussed at length by Hon. R. M. Wright, of Fort Dodge, Iowa. Representative Wright was one of the chief advisors in framing the law, as well as its steadfast sponsor before the legislature. In his address, Mr. Wright cited many cases which he believes prove that the present law is constitutional.

Saturday morning, the convention assembled for its last session. Many of the delegates spent the greater portion of the preceding night in discussing ways and means for getting a test case to the supreme court as soon as possible. This must be done before drainage improvements can be successfully carried out. This subject was fully discussed by the convention for over an hour. A resolution was unanimously adopted urging the various counties to financially support the test case of Bollah vs. Monona-Harrison Community Drainage District. The thought prevailed that if this case could speedily carried to the supreme court, a great forward step will have been taken in drainage work.

A committee of five was appointed to interest the land owners and county officials in this case.

Prof. A. Marston addressed the convention on "The Importance of Drainage in Good Roads Construction." Professor Marston has made a careful study of road conditions in Iowa and his statements were heard with the greatest enthusiasm. The people of Iowa are awaiting with interest the publication of the Professor's bulletins on the results of his investigations regarding the building and maintaining of Iowa roads.

"The Drainage of Meandered Lake Beds" was the subject of a comprehensive paper by Prof. L. E. Ashbaugh, of the Iowa State College. The paper reviewed the provisions of the new drainage law regarding the drainage and sale of meandered lakes, and many facts were presented regarding the work that had been done in compliance with the provisions of the law and the number of lakes which had been filled up in recent years and were now simply sloughs or bogs.

Mr. F. J. Ford, of Fort Dodge, sent a paper on "The Progress of Drainage Improvements During 1904." There is now contemplated not less than 1,600 miles of artificial waterways to furnish outlets for drainage of our low and swampy land and to furnish service to drainage districts comprising no less than 1,300,000 acres of land of which not less than 350,000 acres is practically worthless at the present time on account of lack of drainage. This acreage, if in one body, would be equal to an ordinary county.

Prof. C. J. Zintheo spoke at length upon the use of the traction ditcher on various types of soil. Trials showed that tile ditches could be cut more cheaply with the machine than by hand, but that on heavy, sticky land it was difficult to operate the ditcher.

The regular program was concluded by an address by Prof. W. H. Stevenson, secretary of the Iowa Drainage Association, on "The Relation of the Soil to Underdrainage." This address was of unusual interest to land owners and drainage engineers who have charge of the drainage of clay, gumbo, muck and peat soils.

The Iowa Drainage Association was organized January 16, 1904. The purpose of the organization is the advancement of drainage improvements in Iowa. A large number of new names were added to the membership list during the convention and no doubt the statewide interest in drainage work will not flag during the year.

Hon. F. C. Hartshorn was elected president for the ensuing year and Prof. W. H. Stevenson, of the Agricultural College, was re-elected secretary-treasurer, and was instructed to publish the full proceedings of the convention.

The IRRIGATION AGE has arranged to publish in full all of the addresses delivered in its issues of March, April and May.

TO RECLAIM A SWAMP.

Mud Lake, in Hamilton County, Iowa, one of the greatest prairie swamps in the west, will be converted into one of the largest farms in the State of Iowa by plans carried out by Engineer D. A. Kent, of Hamilton county.

The land belongs to the Rand estate, of Burlington, Iowa, and the engineer has started to work to build a ditch seventy-five miles long, which will easily drain 180 square miles of land. Cairo Lake, as it is sometimes called, contains 1,600 acres of land, and is the basin of about 43,000 acres of land. It lies near Jewell Junction.

The main ditch will have a bottom width varying from thirty-two to nine feet. The estimated cost of the ditch and the four lateral ditches is $57,000. If the plan works as contemplated this land will then be easily worth $100 per acre.

BENEFITS FROM TILE DRAINAGE.

There are a good many direct benefits which follow the drainage in localities where drainage is necessary or where it might be said to be desirable. Where it is absolutely essential to drain a piece of land in order to make it useful, no argument is needed to convince the farmer that it will pay to drain, but when draining is apparently not needed in all seasons, the full benefit from drainage is oftentimes not appreciated. Stating a few of the benefits incident to drainage will therefore be of interest to many.

The roots of our ordinary farm crops extend from two to four feet into the soil, and ideal mechanical conditions is in a soil when they can do this readily. One of the functions of the root is to supply the plant with food and moisture, the more the roots can spread and ramify the soil the more plant food and water they can come in contact with and hence the more rapid will be the growth. All roots, however, need air, because roots breathe; in a water logged sail the air has been crowded out by the water, and hence there is not enough oxygen left for the breathing process to take place as it should, and this is one reason why plants turn yellow when grown on land that is not well drained.

A well drained soil will also withstand drouths better for the reason that in such soils the roots penetrate deeper and hence during periods of scant rainfall are less affected by drouth.

Another important factor which comes from proper drainage is increased warmth of the soil. Wet soils are cold for the reason that large quantities of water evaporate from them. When water evaporates it is converted into vapor and during this change it stores up large quantities of heat which it takes from the surrounding particles of soil. It is a well known fact that to convert water into steam requires a large amount of heat; the same amount of heat is needed to convert water into vapor which occurs naturally when exposed to the air. This is the reason why wet soils are always late and cold soils. After drainage of such lands it becomes possible to seed crops earlier in the spring and thus prolong the season of growth. This difference in temperature of drained and undrained soils is often underestimated; Observations show that during early spring there is frequently a difference of 12° F. in the temperature of well drained and poorly drained soils.

We have referred to the fact that air is needed by the roots of growing plants for breathing purposes, and that a well drained soil has more room for air than has one whose pores are filled with water, but this is not the only use of the soil atmosphere by any means. There are myriads of bacteria and other small plants constantly at work in all soils changing insoluble soil particles into soluble substances. These vegetable organisms also require air or oxygen, one of the constituents of air, in order to live and multiply. If we wish to preserve fruit, ensilage, meat or any other organic substances, we keep the air from them for the reason that practically all changes in such organic substances are brought about by low organisms which can not live and develop in the absence of air. The minute air is allowed to come in contact with dead organic matter, provided the temperature is also favorable, chemical changes at once take place. The same thing happens to the organic matter in the soil. If air is excluded from a soil organic matter or crop residues remain unchanged, or at least are not sufficiently changed to become soluble plant food. This is well illustrated in peat bogs, which always form in low, wet places, and for no other reason than that the organic matter present is not changed into soluble humus compounds.

Aside from this indirect effect, the oxygen of the air also has a direct influence upon the soil constituents, changing the mineral particles from insoluble to soluble substances. This action may perhaps be illustrated by the well known change that takes place when iron rusts or when rocks decay and crumble from contact with air. Such changes are purely chemical in their nature, and do not depend upon the intervention of germs, but are a direct result of the action of oxygen upon the soil compounds. Such changes, of course, can not take place unless air can circulate freely in the soil.

Earth worms also work freely in soils that are well drained, and they are known to be soil builders of considerable importance; their burrows and passageways also act as channels for the free circulation of air.

Much has been said of nitrification and dentrification. The former is a process of oxidation brought about by certain species of bacteria changing the nitrogenous organic compounds in soils of soluble substances called nitrates. For example, clover or alfalfa roots contain a large amount of nitrogen, but it exists principally in the form of compounds called proteids and amides. These substances can not be used by plants, but they must first undergo certain changes which are brought about by certain organisms that need free oxygen in order to perform their work, which consists in changing these substances into nitrates that are soluble in water and can be directly appropriated by plant roots.

When air fails to circulate freely in a soil, these germs do not thrive, but certain other species, which can only live in the absence of air, begin to work on these valuable nitrogenous compounds and change their nitrogen into free nitrogen or into the same form in which this element exists in the atmosphere. Thus it will be seen that in poorly drained soils the proper changes in the organic substances do not only fail to take place, but that there is actually an absolute loss of one of the most important and expensive soil constituents. This fact naturally emphasizes the importance of proper soil ventilation which in wet soils can only be brought about by drainage.

BROUGHT BY THE POSTMAN.

Letters from Correspondents to The Irrigation Age.

LINCOLN, NEB., Jan. 25.—In his biennial report to the legislature, Secretary Adna Dobson, of the State Board of irrigation has suggested certain amendments to the irrigation law of the State. He wishes a provision to require the filing of a copy of the petition of organization of each irrigation district that the board may have a complete boundary record of all the districts in the State. He also desires the registration of all irrigation bonds and the filing of duplicate maps and plans.

Mr. Dobson says that stream measurements have been taken, covering nearly all the streams in the State used for irrigation. An arrangement has been made with the United States geological survey, which maintains gauging stations on the principal streams, to take its figures on the daily outpour of the rivers, with little expense to the State.

By the construction of proper headgates in the last two years, which has been in the control of the under secretaries, much friction between irrigators has been stopped, says Mr. Dobson. These devises secure to the patrons the knowledge of an equitable distribution of water and this reduces complaint. Mr. Dobson commends some of the decisions of the supreme court as affording guidance on previously disputed points, thus lessening litigation over water.

BOMBAY, INDIA, Dec. 12, 1904.

EDITOR THE IRRIGATION AGE, Chicago, Ill.

Dear Sir—I am in receipt of your letter dated December 10, 1904, and I have just sent twelve shillings, which I reckon as $3.00, as my subscription for THE IRRIGATION AGE from December, 1904, and for the Primer of Irrigation if it comes out in that time. Your irrigation primer will, I think, be of interest to irrigation people all over the world.

Yours sincerely,
T. R. J. WARD.

MOUNTAIN VIEW RANCH, ELIZABETHTOWN, N. M., Jan. 18, 1905.

EDITOR THE IRRIGATION AGE, Chicago, Ill.

Gentlemen—I am in receipt of the sample copy sent me by request and enclosed please find P. O. money order for $1.00 and send THE IRRIGATION AGE to me for 1905. I expect, during the year to install a plant to pump water for irrigation and to furnish power for general farm work. I want the best outfit on the market, but I find myself between the devil and the deep blue sea. All are best because each is simplest, most durable and gives the most power for fuel consumed.

Don't you think that some way can be devised to show your readers which way to turn. Testimonials are no good. manufacturers' claims are no good and notices like yours of ——— ——— are no good. How would it do to advocate comparative tests by the experiment stations to be published for the benefit of farmers? It seems to me that some such course would surely get at bottom facts and these would be of as much benefit to tillers of the soil as many of the feeding tests; at any rate would it not be just the thing to include such tests in the list of experiment station work?

Very truly,
J. W. TURNER.

BUFFALO, WYO., Jan. 20, 1905.

EDITOR THE IRRIGATION AGE, Chicago. Ill.

Gentlemen—I have just received my first copy of your paper, and am well pleased with its general appearance and subject matter. But I am anxious and in a hurry for information regarding best method of flume construction for large ditches or canals. Has iron taken the place of wood to any extent for ditches carrying 100 cubic feet per second and upward?

Being seventy-five miles from the railroad, iron would be hard to get and expensive and we incline to favor construction of wood, as lumber can be had on the ground for about $25.00 per thousand.

Our flumes must be eight to ten feet wide and three feet deep.

Would a floor built of 2x4 stuff on edge, with bearings every four feet give the best satisfaction, or can you name something which has been found more practical?

Our local engineer has not had extensive experience in ditches of this size and is not qualified to advise us.

If you have any back numbers of your magazine or books on the subject which would aid us, please forward copy or copies and I will promptly remit.

Yours truly,
E. D. METCALF.

CHICAGO, ILL., Jan. 28, 1905.

MR. E. D. METCALF, Buffalo, Wyo.

My Dear Sir—In reply to yours of the 20th inst., would say that it is difficult to state what kind of a flume or other conduit you should install when first cost and the cost of maintenance are both taken into consideration. If you have grade to spare, a pipe line would undoubtedly be the best as a comparatively small pipe will carry a large volume of water under such conditions.

I doubt the advisability of your attempting steel construction under the circumstances. The same might be said of a concrete-steel pipe line, since the cost of transportation of cement and steel would be high. All these matters are worth looking into, however, and an engineer who can go on the ground, determine the grades and prepare you accurate estimates could save you much more money than his salary and give you a structure that will be serviceable.

A wooden flume is a temporary device and where lumber is cheap may be the cheapest in first cost and maintenance. The native pine should be seasoned thoroughly before it is used. Flumes are liable to warp badly if the lumber is not well seasoned. It is important to prevent leakage from a flume where the ground is soft and to prevent this the entire structure is often lined with tar paper, over which a layer of inch planking is carefully laid.

We feel that a competent engineer could study the situation and save you much expense and future trouble.

Yours respectfully,
D. H. ANDERSON.

PAYETTE, IDAHO, Jan. 20, 1905.

EDITOR IRRIGATION AGE, Chicago, Ill.

Thousands of people will take advantage of the cheap rates this year on account of the Exposition at Portland.

Most of these people will be anxious to see something more of the little State that has been awarded first prize for the agricultural exhibit at the St. Louis Exposition than can be observed in the fleeting glimpses of sequestered valleys while crossing the streams which traverse the sage brush plains in their descent from the snow-capped mountains in the distance to the great Snake River which spans the State from east to west.

Until a few years ago Idaho was considered only a mountainous grazing country, but when the mountains were found to be rich in gold and silver and other precious metals and the sage brush desert was transformed by irrigation into orchards which rivaled those of the older States, home-seekers become home-builders and their efforts have certainly been richly rewarded. Three times in succession Idaho received first prize for her apples at the World's Fairs and for display of the greatest variety and most perfect fruit she won the first prize at the Irrigation Congress in 1903, the most complete exhibit coming from the celebrated Payette Valley. This valley contains less than 100,000 acres of land which can be irrigated from present canals and while there are some larger irrigated districts in the State, none are more fertile or attractive to the educated and thrifty farmer or fruit grower who is seeking a mild climate where crops are prolific and sure, water abundant and the modern conveniences of the telephone and rural free delivery easily accessible. People who are fleeing from the cramped conditions that exist in the Eastern States desire first of all to cast their lot among a good class of people.

The Payette Valley is settled with an educated, thrifty class, mostly from the middle Western States and the results of their labors during the past three years in developing this land from its natural state into homes most beautiful is certainly marvelous.

Numberless thousands of streams of clear pure water wending their way perpetually through orchards laden with fruits and fields of golden grain and blooming alfalfa presents a most enchanting scene and takes from life the monotony usually attending the efforts of the farmers in the East.

This valley offers superior school, church and social advantages to many of the older States, also health, home and happiness with all the necessary comforts of life.

PAYETTE.

KANSAS CITY, Dec. 28.—The States of Kansas and Colorado are the contestants in a suit of law in the United States Supreme Court. The bone of contention is the Arkansas River.

This river flows through an arid region in southwestern Colorado and western Kansas, that was known as the Great American Desert fifty years ago. The development of irrigation has turned a large part of this, nearly 350,000 acres, into the most fruitful fields of the entire Rocky Mountain States. The celebrated Rockyford melons are grown here, likewise heavy yields of sugar beets, alfalfa, fruit and garden truck.

Land that could not have been given away a few decades ago is now selling at from $50 to $200 per acre, and farmers are making it pay at these prices. All this prosperity has come through irrigation and the source of the water supply is the Arkansas River.

Now Kansas goes to the United States Supreme Court with the complaint that the appropriation of the river waters by the Colorado farmers has had the effect of almost entirely drying up the stream in Kansas.

The water used by the irrigators is not lost, but percolates through the surface soil and then unites to form an underground stream, flowing in approximately the same direction as the course of the river in its normal flow before any of its waters were diverted for the purpose of watering the thirsty fields of the Great American Desert.

The question involves a large amount of capital. The value of the irrigated lands of this section of Colorado is $269,000,000 and the irrigating works have cost $25,000,000. There are a number of large reservoirs, and some of the canals are over 100 miles long.

The defense made by the people of Colorado is that unless so used the water would go to waste, and that the benefit derived by using it in irrigation is sufficient to warrant its used for that purpose.

It is further argued that it has been used for irrigation since 1859 and was, in that year, recognized by the legislature of Kansas Territory, then including the Arkansas Valley of Colorado, by granting charters to several companies, for the purpose of establishing irrigating works. Also that Kansas upholds the irrigation system today by allowing the use of the Arkansas waters for irrigation of lands in western Kansas to the extent of 150,000 acres.

The case will probably not be heard for at least two years. In the meantime the Colorado people will endeavor to have the supreme justices visit the territory in question in order that they may appreciate the gravity of the question. Should Kansas win the whole system of irrigation would be endangered by like claims.

GROWTH OF UTAH'S SMELTERS.

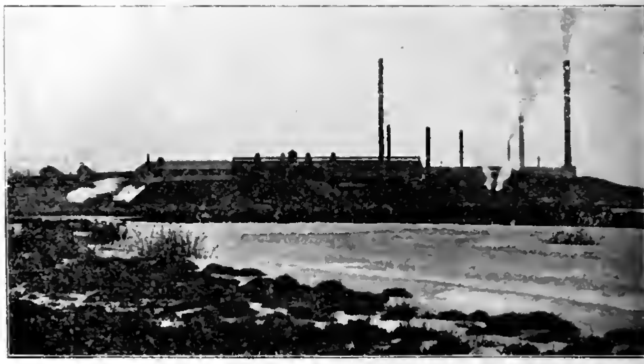
While the mines of Utah are yearly producing more than $30,000,000 in ores, an army of workmen employed at the nearby smelters contribute in no small degree to Salt Lake's trade and wealth.

Nearly 3,000 men are constantly on the payroll of the various plants in the valley that are occupied with the reduction of ores.

The largest of these great plants is that of the American Smelting and Refining Company, which alone engages 1,000 men and daily transforms 1,000 tons of ore into bullion. This smelter is located at Murray, seven miles south of Salt Lake City. In the past four years Murray has advanced from a straggling village into an active and growing little city with all modern improvements and hundreds of new buildings.

Three miles further to the southwest is the plant of the Highland Boy Mining Company, which in the last year has been doubled in capacity and now employs 400 men. Then in the same vicinity are the smelters of the United States and the Bingham Consolidated Companies, both of which are now largely increasing their daily capacity to keep pace with their mine development and also for the purpose of entering the open market for ores.

The total capacity of these plants contiguous to Salt Lake City is now 3,500 tons of ore per day and as another year or two will advance Utah from fourth to



Bingham Copper & Gold Mining Co.'s Smelter, Bingham Junction, Utah, near Salt Lake.

second place among the States that produce precious metals, the smelting interests will certainly grow in like manner.

RECLAMATION OF ARID WEST.

Government Engineer C. J. Blanchard, of the United States Reclamation Service, Writes of Work.

The Engineers of Uncle Sam's reclamation service now engaged in solving the difficult problems incident upon the irrigation of millions of acres of arid public lands in the inter-mountain country, are often at work in regions which possess remarkable historical and archæological interest.

ANCIENT CANALS UNEARTHED.

In the valley of the Salt River the lines of modern canals follow closely the ditches of the ancient races which once densely populated it. The excavations of the scientific ditching machine uncovered the irrigating canals of lost races, the records of which are shrouded in the gloom of past centuries. Many of these ancient canals show a knowledge of engineering, and all bear evidence of the patience and industry of their builders. Although construction took place doubtless before the age of metals, these canals in many places were cut through solid rock at a cost of time and labor which it is impossible for us now to more than faintly conjecture.

Down in the lower valley of the Rio Grande in this country, Government engineers for many years have studied the problems of flood storage, and have made exhaustive researches for feasible and adequate reservoir sites. Since the passage of the irrigation law the engineers of the service have pursued these investigations industriously, and an especially fine reservoir site has been located which promises to transform a wonderful desert valley into one of our most productive and populous sections.

A peculiar interest attaches to the selection of this reservoir site from the fact that the region which is to be benefited by the waters conserved in it is today being irrigated by the oldest irrigation system in use in this country. This portion of the Rio Grande basin is known as the Mesilla Valley, and lies on both sides of the river, between two spurs of the Rocky Mountains. Beginning at the north at Fort Seldon it extends almost to the corporate limits of El Paso on the south, a distance of fifty-five miles. In width it varies from five to seven miles. On the east and west its boundaries are the lofty ranges of mountains, the highest of which —the Organ Mountains—rise to a height of 8,000 feet above the sea. The general elevation of the valley is almost 4,000 feet.

Irrigation canals and ditches constructed so long ago that the date is forgotten are being used today in much the same primitive manner in which the ancestors of the present race used them, nor have the methods of agriculture changed to any appreciable extent among these descendants of Old Mexico's pioneers to the United States. They are indeed strikingly like those practiced by the farmers of Spain ever since the fifteenth century.

PRIMITIVE METHODS.

The method of raising wheat among the Mexican irrigators of the valley is not unlike that which prevailed a thousand years before the Christian era. The tillers of the soil in the days of the Pharaohs, if they could be called back, would require no training to take a position on one of these Mexican farms. Early in the springtime the Mexican and his family journey forth into the fields and collect and burn the forest of weeds which have accumulated since the preceding summer. Then goeth forth the sower, equipped with a pailful of wheat, which he scatters broadcast over the land. The plowman follows, driving generally a small pony. Only the surface of the ground is stirred, and this seldom to a depth more than three inches. Then the field is divided into square beds by furrows turned up by the plow, the edges being raised by high borders to hold the water. The squares are filled with water from the ditches, the water is being applied again and again, until the soil is thoroughly saturated. The Mexican haciendado now becomes a gentleman of leisure, with "time to burn." He squats in the sun or in the shade of his adobe hut, and, cigarette in hand, watches Dame Nature hustle for him.

Early in June, with his family, which includes sons, cousins and nephews, he proceeds to the field, armed with his sickle, manufactured at a very remote date, and cuts the crop. The straw is left standing, as it has no value to the Mexican. The grain is brought to the threshing floor, which is made of beaten mud. A herd of goats or sheep, and often ponies, is brought up and driven round and round until the grain is threshed out. This will call to mind the Biblical description of "treading of the corn." The short straws are now raked away, leaving the wheat and chaff. Now follows the winnowing, which is performed as it was in the days of Abraham. The grain is tossed high in the air and the wind carries away the chaff.

CARELESS FARMING.

Corn is second in importance as a crop in Mesilla Valley. The seed is sown at intervals in a small furrow by hand. As soon as the plant shows up well the rows are hilled, and throughout the season the fields are usually planted in rotation. Alfalfa is a very important crop in the valley, and its value for forage is fully recognized. Being a perennial plant requiring but one planting, it is very popular with the Mexican agriculturist. The present systems are wasteful of water, and owing to the careless farming, the crop yields are very light. Lately all the irrigators have been complaining of shortage of water. The construction of immense canals in Colorado on the headwaters of the Rio Grande has greatly lessened the flow of the stream, and there is crying need of storage to hold back the great spring floods now wholly unutilized and run to waste.

THE PROPOSED RESERVOIR.

The reservoir site is at Elephant Butte, and is described as one of the most favorable locations for storage found in the West. The reservoir will be forty miles in length, and its capacity will be 2,000,000 acre feet, or ample for the 180,000 acres of land to be supplied by it.

The cost of the project, including reservoir and all diversion works and canals above El Paso, is estimated at $7,200,000, or $40 per acre on 180,000 acres. This is below the value of irrigated land in the valley, and those best informed pronounce the project desirable at the price. The main item of cost is the dam, which will require 300,000 barrels of cement, a large amount of machinery, gates, etc., entailing a very heavy outlay for freight. It is estimated that the dam will cost approximately $5,300,000. As projected the dam will be arched up stream and on a six degree curve, the upstream edge or crest having a radius of 955.4 feet. The dimensions are as follows: Height of dam from bedrock formation to top of parapet walls or crest, 255 feet; thickness at bottom, 180 feet; on top, 20 feet; length of crest, 1,150 feet. The roadway is five feet below the crest, between parapet walls on each side, at a natural gap on the west side of the valley, is several miles above the dam, and about 175 feet above the level of the present river bed. It will have a total length of 800 feet.

At a public meeting recently held in the valley a resolution was unanimously adopted declaring in favor of the project and urging Congress to pass legislation to enable lands in Texas to be benefited by this reservoir and contribute to its cost.

C. J. BLANCHARD.
United States Reclamation Service.
Washington, November 22.

GREAT IRRIGATION ENTERPRISES IN CALIFORNIA.

In the Sacramento Valley, California, great irrigation systems are being built which will add, within the next few months, 500,000 acres to the irrigated area of this country. During the past two or three years this great valley has been the scene of elaborate irrigation surveys by the United States Agricultural and Interior Departments, and the abundance of water supply and comparative cheapness of application have been commented on at length in exhaustive official reports, which have spoken in high terms of praise of the productive capabilities of Sacramento Valley soil and climate and the immense wealth certain to be created by the development of irrigation systems. It is said that the National Government has now in contemplation an immense irrigation project for the Sacramento Valley, but the people of California are not waiting on national enterprise.

At the present time three great systems are under construction in this valley. One of these, the Central Irrigation Canal, was started as a district enterprise several years ago, but, like many other district irrigation projects started under California's irrigation laws, it has been the subject of continuous litigation and work was discontinued for years. At the present time work is being prosecuted and it is expected that water will soon be running. This canal is sixty feet wide and will irrigate 200,000 acres of land, while it may be extended to water millions of acres. Its source of supply is the Sacramento River.

Another great system just nearing completion is the Yolo County Consolidated Canal, which diverts the waters of Cache Creek and will irrigate 100,000 acres of land lying in Yolo and Solano Counties. This canal is constructed by a private corporation. It is forty feet wide and carries water to a depth of six feet. A notable feature of this system is the fact that the source of Cache Creek is Clear Lake, a mountain reservoir covering eighty square miles and having vast storage possibilities. This project was seriously considered by Government experts as the initial undertaking of the Government under the national irrigation law. Water was turned into this canal October 8th and the event was marked by a great celebration at the town of Winters, near the course of the artificial stream.

Another irrigation celebration of equal importance was held a week earlier at Gridley, in Butte County, and marked the breaking of ground for the Butte County Canal, which will divert the waters of Feather River and cover at present an area of 215,000 acres. This system is capable of vast development, as the Feather drains an area of approximately 4,000 square miles, with an annual rainfall ranging from thirty to sixty inches. This canal may be made to irrigate all the lands lying between the Feather and the Sacramento from the point of diversion southward, an area of 700 square miles. It, too, is built by private capital.

The development of these great irrigation systems is worthy of note, both on account of the magnitude of the enterprises themselves and because of the conditions in the territory covered. The Sacramento Valley has an annual rainfall of from fifteen to thirty inches, and is far from being an arid or even semi-arid region notwithstanding the dry summers which prevail in California. The lands that will be watered by these canals have for half a century produced crops. Wheat, barley, vegetables and fruits are grown. Some of the largest orchards in California are here, as well as some of the largest grain ranches in the world.

One of the first effects of the introduction of irrigation on a large scale will be to induce the subdivision of these great grain ranches into small farms and the transformation of a grain country but sparsely inhabited into a land of diversified crops and many homes.

(Reference: "Report of Irrigation Investigations in California," by Elwood Mead, Bulletin No. 100, United States Department of Agriculture.)

NORTH DAKOTA'S IRRIGATION CONGRESS.

The North Dakota irrigation congress was held at Bismarck, N. D., January 24-25-26. The attendance at this meeting was large, as it was estimated there were fully 500 delegates in attendance, made up of farmers and business men of the State who are interested in the subject of irrigation. A number of prominent officials connected with the Government were also in attendance, as well as a large number of men connected with the State agricultural institutions of Montana and others western States. The delegates were entertained by Governer and Mrs. Sarles at the executive mansion. The program of exercises was as follows:

Congress called to order by President E. A. Williams.

Address of welcome—Hon. E. Y. Sarles, governor.

Appointment of committees on resolutions.

Objects of the Congress—Senator L. B. Hanna, chairman of the senate committee, and Hon. F. B. Chapman of the house committee.

Irrigation in North Dakota—Prof. E. F. Chandler, state engineer.

General Farming—Prof. Thomas Shaw, Agricultural College at St. Paul.

Policy of Reclamation Service Regarding New Projects—H. N. Savage, supervising engineer.

Pumping Projects in North Dakota—H. A. Storrs, engineer in charge.

Possibilities of Gravity Irrigation in North Dakota—S. B. Robbins and J. A. French of the reclamation service.

General discussion.

Agricultural Possibilities Through Irrigation as Shown by the Camera—Prof. Morton J. Elrod, State University, Missoula, Mont.

Extensive Farming by Aid of Irrigation—Prof. F. B. Lindfield, director Montana Experiment Station, Bozeman, Mont.

Effects of Fruit Growing on Contentment of People—W. B. Harlan, president Montana Horticultural Society, Como, Mont.

Artesian Wells in North Dakota—Prof. D. E. Williard, Agricultural College, Fargo, N. D.

Coöperative Irrigation Canal Construction—W. M. Wooldredge, president Montana Agricultural Association, Hinsdale, Mont.

Irrigation in Italy and America (illustrated by the stereoptican)—Elwood Mead, Irrigation Experiment Station, Department of Agriculture, Washington, D. C.

THE CONGRESSIONAL PUN.

"What has the Capitol got that you will never have?" asked Congressman Fletcher, of Minnesota, of Congressman Tawney.

"Give it up," said Tawney.

"Two white wings," said Fletcher.

"Pretty fair, pretty fair," admitted Tawney. "But what has the Capitol got that you give to applicants for office?"

"It's too many for me," replied the other Minnesota man.

"A marble stair."

At this point quits were called.—*Baltimore Herald.*

LARGE TRACT IN MILK RIVER IRRIGATION PROJECT.

BUTTE, MONT., Jan. 18.—A miner special from Great Falls says:

The local land office today received instruction to withdraw from all forms of entry 276,480 acres of land, in connection with the Milk River irrigation project. Part of the tract withdrawn lies northwest of Havre, extending irregularly from from the line of the Great Northern to the international boundary, comprising part of the chain of lakes, reservoir sites and lands lying along Milk River and Sage Creek.

Another portion of the tract lies west of the Montana Central, between the Big Sandy and Box Elder Creeks, and is presumably withdrawn in connection with the Marias Diversion Canal portion of the Milk River project.

Farming in Colorado, Utah and New Mexico.

¶ The farmer who contemplates changing his location should look well into the subject of irrigation. Before making a trip of investigation there is no better way to secure advance information than by writing to those most interested in the settlement of unoccupied lands. Several publications, giving valuable information in regard to the agricultural, horticultural and live stock interests of this great western section, have been prepared by the Denver & Rio Grande System, which should be in the hands of all who desire to become acquainted with the merits of the various localities.

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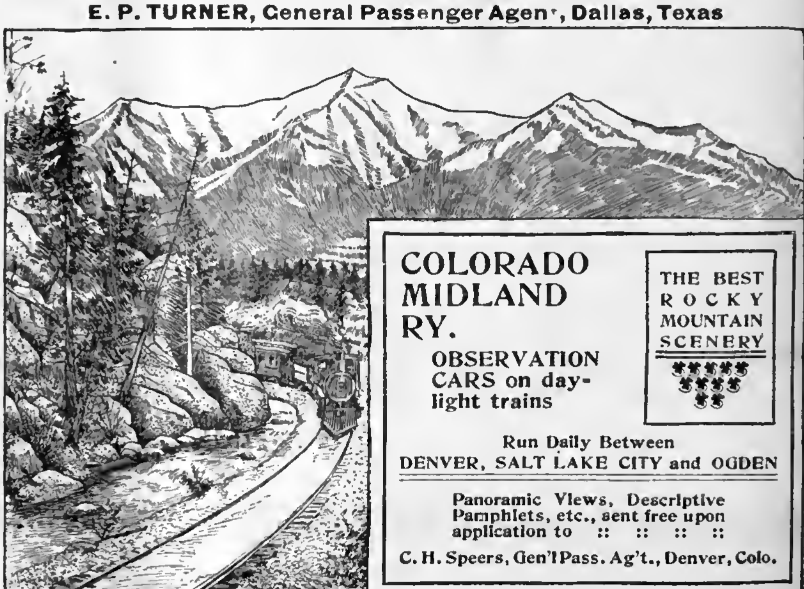

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SPECIAL FEATURES

Nebraska Irrigation Decision

Railways Withdraw Appropriation

Kansas vs. Colorado

Administration of Streams in Irrigation

U. S. Reclamation Service

Primer of Irrigation

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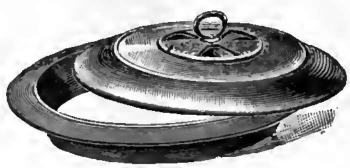

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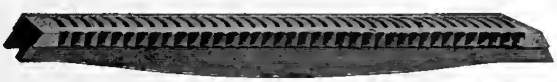

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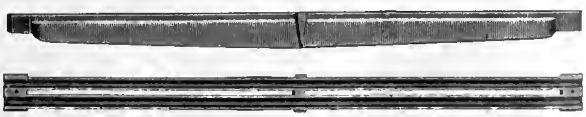

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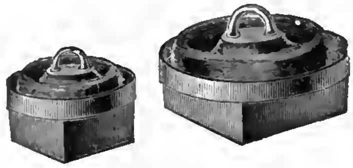

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THE IRRIGATION AGE

VOL. XX CHICAGO, MARCH, 1905. NO. 5

THE IRRIGATION AGE

With which is Merged

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

Nebraska Irrigation Decision. The decision of the Nebraska State Board of Irrigation in the contest between the Government and a company who contemplated developing a project with private capital near Scott's Bluffs, in that State, is in line with other conditions and decisions where the Government steps in to hamper projectors of private enterprises. To the casual onlooker this decision is in keeping with the well-established opinion that an enlightened handling of such cases binds the land and water together and makes the sale of water impossible.

It will be noted that Elwood Mead, who is unquestionably the best authority on this subject in the United States, says: "The idea of private ownership in water, apart from the land, can not prevail without creating institutions essentially feudal in character." Professor Mead also says that the water lord is even more undesirable than the landlord as the dominating element in society. It should be noted that the Nebraska State Board is quoting Professor Mead and others of prominence in support of their decision, but they either willfully ignore the salient features in the case or are ignorant of true conditions. The case against Mr. Leavitt and his associates is undoubtedly the most important matter which has developed since the passage of the reclamation act of June, 1902, involving, as it does, the usurpation of rights of private corporations by the agents of the Reclamation Service, this act placing the United States Government in the position of an ordinary competitor—in a purely commercial sense, a competitor of the individual or corporation, a condition, clearly, not contemplated by the framers of the law.

It is the opinion of THE IRRIGATION AGE that the State Board of Nebraska would not have been so quick to reach a decision in favor of the Government had its members been fully cognizant of the attitude of officers of the Reclamation Service to a majority of the private projects in the West.

The trouble is that there is a general belief that the Reclamation Service is going to make every man in the arid West rich and the public does not know that the officers of this bureau are conducting affairs with a high hand, are deliberately opposing a large number of private irrigation enterprises, many of which were in operation years before the passage of the reclamation act of 1902; nor is it known that this combination has in operation an active press bureau, which misleads the local papers in sections where Government work is contemplated or going on. This press bureau keeps before the people in different localities extravagant representations of what the Government is intending to do and conveys the impression that much more would be done by it were the private projects killed or materially hampered in their work of development. THE IRRIGATION AGE can cite cases in Idaho, Washington and elsewhere of unwarranted interference, bordering, in certain cases, on malice or a narrowness hardly to be expected from officers of a Government founded on our broad lines. This position is all the more exasperating to people managing private enterprises, who know that all irrigation development accomplished so far throughout the West has been by private capital. It is a well-known fact that over $200,000,000 have been expended under private control and not one acre so far has been brought under cultivation by the efforts of the Reclamation Bureau. All work of this character under Government supervision has been in charge of the Department of Agriculture, office of experiment stations. It is doubtful if the Nebraska State Board would have reached so hasty a decision in favor of the Government if the facts indicated above had been as thoroughly exploited throughout the Nebraska State press as were those circulated by the press bureau of the Reclamation Service. The people of Nebraska may some day awake to a realization of the fact that its State Board would have done better to have given a longer time to the study of this matter before making a decision.

Kansas vs. Colorado. In a recent communication from Prof. L. G. Carpenter, State Engineer of Colorado, he calls attention to the short editorial which appeared in our February issue concerning the Kansas-Colorado suit. He states:

"As this editorial possibly implies a misunderstanding and as the case is so important in its relation to irrigation of any kind, your journal, published for the interest of irrigation, can not afford to misunderstand. An inference that you may not understand may be unjustified, but as the matter is of such importance to the whole west, I will write you a note, even if unnecessary.

"Were the case only one concerning the use of water in Kansas and the use in Colorado, other States would not be interested, except as the case might form a precedent. Such an issue is not brought forward by Kansas, and so far as it does come in, it is as a subordinate and relatively unimportant issue. The real issue, which is the most important, and which affects every State in the west, and one which any person who has spent any time at all in the irrigated regions can scarcely conceive as possible, *is whether any one shall irrigate at all.* This case is the first where the doctrine of appropriation, as recognized wherever the physical conditions require irrigation, and the doctrine of riparian rights have come in direct conflict. The State of Kansas in its bill of complaint claims "the right to the uninterrupted and unimpeded flow of all the waters of said river into and across the State of Kansas." (Page 26 of the amended bill of complaint.) While the attorneys of that State probably do not want to push that doctrine to its logical conclusion, it is a part of their complaint; they have raised the issue and claim before the court of last resort, and the decision, if such doctrine is recognized, would affect the value, if not destroy, every ditch in the whole arid west, for it denies the right to withdraw water from the river unless it is returned in undiminished quantity. The necessity of appropriation is so apparent to one in the west, that most of our own people have not realized the character of the contention, or the seriousness of the doctrine; it is not surprising that those of other States should assume that the dispute is a local one.

"The State of Kansas has also brought into the case the claim that there has been some navigation at the southern State line of Kansas, and that this has been interfered with because of the alleged diminution of the river due to irrigation. This brings in the navigation issue, which, in the Elephant Butte case was interpreted that any ditch or any tributary of a stream which might interfere with the flow of water so as to affect navigation, even though insignificant in amount, and hundreds of miles away, could be enjoined.

"These issues are the important issues and in defending such suit Colorado is not simply defending her own interests, but she is fighting for the very right to exist of the whole arid region.

"Hence the issues are so momentous in possibilities that no one in Colorado who understands the matters at stake feels that the State can afford to omit any step on the score of economy. The character of the issues are such that Kansas does not need to expend much to make a serious case, for the cases concerning the use of water have come from the east, and therefore the riparian doctrine is recognized by scores of decisions, and the arid doctrine of appropriation is novel to precedent of our supreme court. When the appropriation doctrine, therefore, comes in conflict with the old riparian doctrine, the west are of necessity forced to show reason why the court should recognize a doctrine hitherto new to them.

"The Colorado Fuel & Iron Company, which is named as one of the defendants, and is mentioned in your note, is very little involved directly in the case. Its use of water is almost entirely for manufacturing, is of the character of uses recognized as riparian, and to a great extent it might have claimed exemption from such suit. Such company would be seriously affected as would any one with large interests in the State or whose trade would be affected by the prosperity of the west."

Petty Competitor. Is the Government to stoop to the position of a petty competitor of private irrigation projects?

Wake Up. The people of the States of North and South Dakota, Minnesota and Nebraska will wake up some day to learn that a lot of good money received from the sale of public lands within their borders has been used for building large irrigation dams in remote States, and it is barely possible that they will also learn that some of the money has been used to furnish water for large tracts of land held in private ownership—whereby the owners and not the public will reap large returns.

Primer of Irrigation. We are pleased to inform our many readers that after long delay the Primer of Irrigation, which has been running in serial form in the columns of THE IRRIGATION AGE, is soon to be ready for publication in book form. The delay in issuing it in book form was unexpected, but nevertheless unavoidable, and the proofs are now in the hands of an expert, who will make such suggestions or corrections as will strengthen the work, after which the plates will be placed in the hands of our printers and we hope to be able to have the book ready for mailing by the first of April. From all sources good words have come to us concerning this work. We have received orders from all parts of the world and have on file bulk orders for the work to be used in school work at some of the State universities throughout the United States. The reception of the work in its serial form has been very gratifying indeed, and we trust that the matter in book form will meet with a large sale. It has been decided to make the price of the work, bound in cloth, $2.00. Where the Primer and THE IRRIGATION AGE are ordered jointly, $2.50 will be quoted. The book complete will fill about 300 pages and will be finely illustrated. We trust that those who have ordered the Primer may be patient for a little longer time.

Railways Withdraw Appropriations. It will be gratifying to the readers of THE IRRIGATION AGE to learn that the different railway companies throughout the West have decided to withdraw their support from the organization known as the National Irrigation Association. This association, as has been stated many times in these columns, is purely a one-man affair, and the individual in control has used his position as executive chairman—a purely self-appointed position, by the way—to influence the railways to contribute large sums of money, the idea conveyed to them being that by supporting this association large benefits could be obtained by them in the way of irrigation development under Government aid along their various lines. Events subsequent to the passage of the reclamation law have proved that while in some instances some of the railways have been benefited, a large number of them are being overlooked, and this is probably the reason why their support is being withdrawn. Other very good reasons could be given for this action on the part of the railways, among them the fact that the executive chairman of the National Irrigation Association attempted to control matters with a high hand and assumed, in a sense, the position of dictator, not only to irrigation sections of the West, but the railways themselves.

In view of the fact that the railways have been contributing something like $40,000 per year to this association for five or six years past, they had a good right to expect favors from the association, provided the organization was in a position to "deliver the goods." Many of our readers will, no doubt, remember a series of articles published in the columns of THE IRRIGATION AGE, entitled "Influences in the National Irrigation Program." In those articles an attempt was made to give information concerning the following subjects: "Character of Water Rights and State Supervision," "Early Agitation to Enlist National Aid," "The Irrigation Congress," "Objects of the National Irrigation Association as Set Forth in the Constitution," "Publications and Work of the Association," "Coöperation with Government Officials," "Campaign Against Reform in State Irrigation Laws."

Among the different subjects discussed, that of coöperation with Government officials was, perhaps, as important as any, and we quote herewith several paragraphs which will give a better insight into the condition of affairs as they existed at the time of the publication of the articles:

"Before the plan submitted to the railroads by Mr. Maxwell was accepted he had the campaign fairly well outlined in his mind. He saw that it would be necessary for him to become intimate with Government officials who could bring him into contact with congressmen, members of the cabinet and even the President. He had already become acquainted with those who had ambitions to direct the irrigation policy of the country, and through them he met heads of bureaus in Washington who hoped, through his coöperation, to broaden the sphere of their influence and work. We do not wish to bring these men into disrepute and do not say that their ambitions are either to be commended or condemned. We do say that their methods are open to criticism. That they have been working with Mr. Maxwell for the past two or three years is an established fact. The readers of *Forestry and Irrigation* can easily inform themselves as to the bureaus which are working with Mr. Maxwell to maintain that publication. Those who were at the Irrigation Congress held in Chicago in 1900 have no doubt as to who the gentlemen are, and they fully appreciate the support which the National Irrigation Association has since received. The arrangement made with Mr. Maxwell by these officers is not known, but since 1900 the National Irrigation Association has advertised these men and their work in return for substantial support of another kind. Mr. Maxwell has, through one of these men, been able to confer with the President upon more than one occasion. Through the favors extended by another he has met congressmen who have been particularly active in the movement for national aid, and has thus been brought into contact with the Secretary of the Interior. He has had their support in meetings of the Irrigation Congress or wherever their services have been needed. He has been introduced into clubs at Washington and has appeared before engineering and scientific societies. Only a short time since, both Mr. Maxwell and one of his Government assistants appeared before an economic society in Washington to promote their mutual policies. Through the publications controlled by Mr. Maxwell he has been able to repay his debt to these gentlemen. Besides, he has flooded the country with material, sent to the daily newspapers, advertising those who have been of service to him. He has realized that should the Government embark on a plan whereby the West is to be reclaimed it would be to his advantage to have his friends maintained in places where they would be valuable in carrying out the policies of the National Irrigation Association. We have a bale of newspaper clippings sent out by this bureau relating to the thorough training and wide experience of the men with whom Mr. Maxwell has found it advisable to work.

Mr. Maxwell has always been active in working for specific appropriations for the construction of projects which he has already selected. These projects need not be mentioned here, as they are enumerated in the report of the Secretary of the Interior for the year 1901, published eight months prior to the passage of the irrigation bill. No reliable preliminary surveys had been made to determine the feasibility of these projects up to that time, and this work has not yet been completed. Why should the Secretary of the Interior place himself on record as favoring one or all of these projects unless his subordinates had so recommended? Through whose influence were the subordinates induced to advocate Government construction of these projects? It is not our place to guess or surmise as to how the Secretary of the Interior was thus led to commit himself. We feel, however, that an explanation should be made as to why, if the Secretary of the Interior should advise the construction of these projects two years ago, the Reclamation Service has found it necessary to spend much time since then making surveys as to their feasibility.

Mr. Maxwell has led the way in planning the work of the Government during the past year. He goes here and there, promising what the Reclamation Service will do for this or that community and formulating regulations under which the act of June 17th can be carried out without delay. He has been especially active along Salt River Valley in Arizona, where conditions are rather unusual. Mr. Maxwell was hailed first as a prophet, but his domineering tactics have robbed him of much of his power and influence. Men with whom he first coöperated have turned against him, and it is extremely doubtful if any of the measures he has advocated will be indorsed by a majority of the people of the valley. In a number of States those chosen by him to act as vice-presidents of his associations are now using their influence to make known the character of the organization and the man who dominates its policies.

The question as to who has given Mr. Maxwell permission to represent the Government in irrigation matters is often asked. If you should ask him he would probably answer that he is acting as the chairman of the Executive Committee of the National Irrigation Association. Those who have read what has gone before know what this means. He does not get his position from the Association, however, but from Government officials who are willing that he should represent them. That this places the national irrigation program in the hands of those who furnish the financial support to the propaganda is plain.

To show how Mr. Maxwell attempts to control the Reclamation Service through his Association, a copy of a letter sent out recently to the members of the organization is given. Attention is called to his demand for the construction of "specific projects" and his reference to his "own work":

"CHICAGO, ILL., February 14, 1903.

"Dear Sir: The National Irrigation Association is working for *results*. We want to see the irrigation works *built*, and the increased population and trade actually *created*.

"When completed, the Tonto, or Salt River, reservoir in Arizona, costing $2,700,000, with a capacity of 1,500,000 acre-feet, will rival the Nile dam as a great engineering work. It will more than double the *productiveness*, population and trade of the Salt River Valley.

"To make the influence of the National Irrigation Association effective, it must be *concentrated* on specific projects which will demonstrate the benefits of national irrigation to the entire country, and this Salt River reservoir is such a project.

"*The Homemaker* for January contains, in both the illustrated section and the editorial section, articles giving in detail an account of this great project and my own work in connection with it. *Read it carefully.*

"The enemies of the national irrigation movement, our erstwhile opponents, who wanted the States to control the great work of reclamation, though scotched, are still active and *venomous*. They are leaving no stone unturned to undo the great work we have accomplished.

"'*By their fruits ye shall know them*' is the rule by which the friends of the national irrigation movement, who comprise the National Irrigation Association, must be measured. So far it is a record of *things done*. Yours faithfully,

"GEORGE H. MAXWELL.

It will readily be seen by those who have followed the matter closely that what Mr. Maxwell claimed in his letter dated February 14, 1903, as to the National Irrigation Association working for results, has had some effect. This is particularly true in the Tonto Basin Reservoir case in Arizona, where, as we have repeatedly stated, 160,000 to 200,000 acres of land held in private ownership are to be irrigated by funds obtained under the reclamation act. Does it seem fair that speculators and private landowners in Arizona should be permitted to reap the benefit obtained from money expended under this act through the sale of lands in the Dakotas and other States where irrigation is nearly, if not quite, as important as in Arizona? It is strange to those who are acquainted with the whole situation that the railway companies traversing the

Dakotas or other States similarly situated should permit a large percentage of the money derived from the sale of lands in these States to be used for the purpose of irrigating territory remote from that section—territory that can never in any sense benefit, in a commercial way, the States from which this money is taken.

It is presumed that the railway companies have learned that the National Irrigation Association and Mr. Maxwell, or perhaps it would be better to put it Mr. Maxwell and the National Irrigation Association (as he seems to be about all there is to that organization), has attempted to run things with a too high hand, causing too much ill feeling against the Reclamation Service and the Interior Department, under which this work is being carried out. Those who have followed the columns of THE IRRIGATION AGE in the past will readily understand the feeling which exists throughout the West, where the Government, through its Reclamation Service officers, is attempting to curtail the development of legitimate private projects in many sections. This is particularly true in Idaho and some adjoining States. Some time ago a report was sent to the Secretary of the Interior, Washington, D. C., at his request, covering a lot of facts concerning the action of the officers of the Reclamation Service. This report gave information about how these officers used unfair means to hamper and retard development work under legitimate and worthy projects controlled by private capital. THE AGE has been gathering information along these lines, which will be submitted to the proper authorities when the time comes, and there is every reason to believe that steps will be taken to relieve the service of individuals who have been prime movers along the lines indicated.

To illustrate how some of the better-posted hydraulic engineers of the West feel toward the Interior Department and the Reclamation Service, we are publishing herewith a letter from Mr. Walter H. Graves, of the firm of Graves & King, Boise, Idaho, which is self-explanatory. We received a number of inquiries as to who was the author of letters recently published in these columns signed "Ontario." These letters were written by Mr. Graves; it was thought better at that time, however, to omit his name, for fear the officers of the Reclamation Service would attempt to injure him in a business way in Idaho. A request, however, came from Washington asking for the name of the author of these letters, and the following reply from Mr. Graves was forwarded, which we feel at liberty to publish at this time:

February 11, 1905.

D. H. Anderson, Esq., Chicago, Ill.:

Dear Sir: In reply to your favor of the 1st inst., which has been delayed on account of the press of other matters, I beg to say that I see no reason for withholding my name in connection with the communications published in your journal over the signature of "Ontario." When I wrote you I did not do so with the idea that the communication would appear in print, but to let you know how I felt in regard to the course of the reclamation officials in this section of the country, and especially in regard to Mr. Newell's gratuitous and uncalled-for attack on those engaged in developing sections of the West along lines of "private enterprise." I have spent a good many years of my life in the irrigation business, that is, in constructing irrigation works and ditches. As engineer I have laid out and had charge of the construction of nearly 5,000 miles of irrigation canals and ditches, and in doing this have had the supervision of the expenditure of something over $8,000,000. There are today over 30,000 people living under and by reason of these ditches. My experience in this direction has probably been duplicated by other engineers and men in the West. We were engaged in this business before Mr. Newell knew what the word irrigation meant, and when he attacked the men that had for years been engaged in this business and had the magnificent record behind them as public benefactors it naturally made me indignant, and if I had had the time I certainly should have gone into the matter more thoroughly and would have sought the use of the columns of some public journal, like your own, to have given more vehement expression to my indignation, but I was limited in time and opportunity and one evening sat down in my office and delivered myself of the hastily prepared communication addressed to you in the first instance. When your request came for permission to publish it I was in the field and my partner opened the letter and communicated its contents in substance to me, and at the same time suggested the advisability of declining your request on the ground that we had already suffered considerable at the hands of the reclamation officials, and the communication would only serve to arouse their animosity more. However, I advised you of the situation and suggested publishing it over the signature "Ontario," and in doing this I was prompted solely by a desire to conform to the wishes of my associate. There was nothing in the communication to cause me to wish to hide my identity, and since it has seemed to cause some one to think there might have been some ulterior motive in the matter I do not see why I should wish to conceal it longer. I can hardly believe ——— ——— ——— has any real desire to know the name of the writer. I can see no reason for his wishing it. Should he wish to verify any of my statements he can do so without leaving his office, and I do not believe it will have the slightest weight with him in any course that he is at all likely to pursue with reference to the plans or methods of the Reclamation Service. I have no doubt his request is prompted solely by Mr. Newell. However, as it does not signify in either case I have no hesitation in allowing you to inform ——— ——— as to my connection with the letters referred to in his request.

I have been in the service of the Government long enough to know the futility of attempting to reach an erring official by placing a charge or complaint before the departments at Washington. Such matters are usually referred back and forth and ultimately land in the hands of the wrongdoer, only to be used as a "big stick" against the accuser, and who usually becomes the culprit in the case. Nor do I know of any department of Government service that is used more freely or more effectively to gratify personal malevolence or to advance personal interest or ambition than this same Reclamation Service. It might seem strange to you, upon casual consideration, that any one engaged in legitimate business entirely outside of the sphere of governmental affairs need apprehend injury or persecution at the hands of the officers of the Government—in the United States. Yet this is precisely the case in a number of instances hereabouts. I have no disposition to air my own grievances except to say that I have been pretty severely "crimped" by these same people and expect to be whenever the opportunity is presented to them, and, in a measure to protect myself against such injury in the future, I have recently sold my farm and am disposing of my other property preparatory to becoming a "soldier of fortune" if it becomes necessary.

The case of the Ontario High Line Canal, referred to in my first communication to you, is a peculiarly aggravating one and amounts to a practical confiscation of property and investment amounting to thousands of dollars.

The history of the Canyon Canal Company is one of continual persecution on the part of the reclamation officials. These cases and others serve to create a feeling of bitter resentment against the Government, which is not growing less as the plans and methods of the Reclamation Service become better known. The circle of hostility is widening and becoming more pronounced. The Quixotic plans of the Reclamation Service, inspired by the overweening vanity and unbridled ambition of its chief and exploited by its overzealous subordinate chiefs, promise to invade every field of industry and overshadow all institutions of private enterprise in this section of the country. As an example, note a bill recently introduced in Congress to provide for the Reclamation Bureau to engage in the business of creating townsites, selling town lots, building electric lighting plants, electric railways, power plants, etc., etc. However, if Congress and the officials at Washington can be induced to engage in these socialistic experiments I do not see why I should be concerned with the outcome.

I had intended to go into details relative to the several cases of unjustified interference with private enterprise with which I am connected, but I will forego that in view of the necessity of introducing facts and information that it would be better to keep back at this time and until such can be put to more effective use.

I was pleased to learn that you intended to make a visit to Idaho soon. You might learn much that would interest you as a publisher. People will talk when they will not write sometimes. Wishing you success in your efforts, I am,

Sincerely yours,

WALTER H. GRAVES.

AUSTRALIA'S PROGRESS—RESCUE OF THE WATERLESS PLAINS.

Australia is the latest country to catch the transcontinental railroad fever and, with an energy characteristic of pioneer lands, has taken the most direct way of getting what it wants. The parliament of South Australia has formally invited capitalists of Europe and America to bid for the contract of connecting the city of Adelaide on the south coast with Palmerston on the north coast. Ninety million acres of land along the right-of-way, with all the minerals and other sources of wealth they may contain, are offered as a bonus to the company that has the courage to undertake a project that will cost from $30,000,000 to $40,000,000, and to operate a railroad through twelve hundred miles of semi-desert land that has only one white inhabitant to every three square miles.

But 90,000,000 acres of land, even in the most unpromising region on the earth's surface, may well be a temptation when it is offered at forty cents an acre; and capitalists are not so much afraid of big railway ventures now as they were before the Union Pacific was finished, nearly thirty-five years ago. When our first great transcontinental road was proposed in 1852, financiers looked upon it as a wild scheme to run two thousand miles of tracks across the "Great American Desert," where nothing grew but sage brush, and nothing lived but a few scattered tribes of Indians and dwindling herds of buffalo. The people, however, clamored for the road. We had acquired California the Golden, and Commodore Perry had opened the ports of Japan, and no pessimistic prophesying could make the mines and the oriental trade less alluring.

You know the results. The "Great American Desert" has disappeared from the maps and from reality, and this generation of young thinkers may well wonder that there was ever any question as to the wisdom of building the Union Pacific. Today four transcontinental roads connect the Atlantic and the Pacific. Canada has a fifth line and is planning to build another. And there is plenty of work and profit for them all.

One can go now from New York to points in Central America, and some day we shall, no doubt, be able to go on to Valparaiso and Buenos Ayres. Russia has completed a transcontinental line from Moscow across Asia to Vladivostock, a distance of nearly six thousand miles. England is constructing the "Cape to Cairo" to connect Egypt with Cape Town, and Belgium, England and Germany will cross this line in the Congo country with a road running from the Atlantic to the Indian Ocean. This very month it will be possible for passengers to step on board a train in any European capital and steam away across Central Asia for Canton, China, over the Chinese Eastern Railway.

"And then," say the South Australian enthusiasts, "passengers, freight and mail can make the journey from London, England, to Palmerston, on the north coast of South Australia, in fourteen days, for well-established steamer lines already ply between Canton, Hong Kong and Palmerston. Now, if we had that transcontinental north and south railroad the city of Adelaide would have a boom and our 'Great Australian Desert' would blossom with the rose."

Uncle Sam down in Washington is always looking out over the world to see where he can find work and markets for his 80,000,000 people. He is especially interested in big railway projects for a railroad cannot be built anywhere without giving work to American factories, American bridge builders, locomotive makers, rolling mills, car-wheel works, air-brake makers, car buiders, civil engineers, may all expect to be called upon for work or construction materials. Our wheat shippers, flour mills, beef canneries and textile mills also are interested, for the army of workmen to be employed in a wild country must be supplied with every necessary of life from without.

In many ways this proposed Australian railway line, when it comes to be built, will encounter the same difficulties that were met in the building of the Union and Central Pacific roads. There is no mountain system to be crossed and no great rivers to be bridged, but there are broad reaches of desert as hot as those of Arizona and so little known that the maps show blank spaces for hundreds of miles in extent. All Australia taken together is within 50,000 square miles as large as the United States. In the interior deserts ten states as big as Pennsylvania could be dropped down and lost.

As our transcontinental railway builders had to fight Indians, so the builders of the Australian road may have to fight black Bushmen as they push the steel rails across the burning sand, where for hundreds of miles there may not be a blue gum tree or a spring of water. Water, as well as food and clothing and construction material, must be transported from the coast. Although the distance to be covered is only 1,200 miles, or as far as from New York to the Mississippi River, the cost will be something enormous, and the returns must, for years, be a matter for conjecture rather than a matter that can be figured out.

South Australia realizes all this, and knows that her only hope of developing the great interior is to have a railroad. Now, members of the South Australian Parliament who live on the north coast ("South Australia," you can see by the map, runs clear through the continent and is really "Central Australia"), can get to Adelaide, the capital, only by taking a steamer and making a long voyage around the east or west coast. There is known to be silver and copper in the interior mountain ranges, and spots, here and there, where sheep can be grazed and crops grown. The people on the coasts hope that there is vast wealth hidden in that forbidding interior as was found to be the case in the Great American Desert. She, therefore, offers 90,000,000 acres of land, along the right-of-way, to any company that will build and operate the road. This is about fifteen per cent of the entire area of South Australia. The United States gave only 25,000,000 acres to the Union and Central Pacific for building a road twice as long.

South Australia is businesslike. The bill just passed by the state parliament at Adelaide says, in plain language: "We are offering a good thing, and we intend to have our money's worth. Whoever builds that road must build it and operate it according to certain specifications and, after a certain number of years, the government must have the privilege of buying it at a price to be fixed by arbitration. It is confidently believed in Adelaide that Canton, China, is to be the great port of debarkation for European traffic to the east and that Palmerston, South Australia, only ninety-six hours from Canton by fast steamer, is to become the great Australian seaport to connect with Europe. This projected line, when built, will thus be of international importance, expediting travel, mails and commerce.

An Australian Dam—For Irrigating Purposes.

Scientists are perhaps only a little less interested in the proposed line than South Australians. Australia is the land of connecting links and freaks in animal life. Trees and fish and birds and animals have been found there that occur nowhere else. There is a tree without foliage, a fish that has lungs as well as gills. In Australia is the duck-bill, that has the fishing bill and webbed feet of a water bird and the fur covered body of a land animal, and lays eggs. It is thought that there may be found a living specimen of a bird-lizard, whose tracks have been seen on the snow of the eastern mountains. From these tracks scientists think that there still exists in the interior of Australia a creature found elsewhere only in prehistoric fossils. It should have a winged and feathered body, the head of a bird and jaw of a crocodile, a long, scaly or smooth reptile tail, and short, strong legs.

You may be sure, therefore, that along with civil engineers and construction bosses and coolies, will go scientists to capture specimens of Australian fauna before the creatures are scared from their haunts by the shriek of the locomotive.

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, courtesy United States Department of Agriculture.

(*Continued.*)

Another way of applying water to basins is indicated in Fig. 22. The water from the supply ditch passes through the basins from top to bottom in a zig-zag course, due to the position of the gaps in the ridges. Only half of the gaps need to be filled before water is admitted, but those remaining are usually filled immediately after each basin is flooded. This method is objected to for the reason that the basins nearest the supply ditch receive the most water.

Still another method used under gravity canals where water is more abundant is to make the basin complete, then turn the water into the upper basin and allow it to flow over the dividing ridge into the next basin, and so on until the row is under water. The

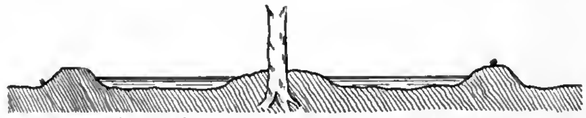


Fig. 23—Method of grading interior of basins to prevent water coming in direct contact with trunk of trees.

irrigator then begins at the lower end and repairs the breaks, leaving each basin full of water. In a few hours the soil absorbs the whole amount.

All of the basins, ridges, checks, etc., just described are temporary. After heavy rains and after each irrigation the orchards are thoroughly cultivated and harrowed and the ridges are worked down to the general level to be rebuilt for the next irrigation.

Some of the orcharists consider it detrimental to have the water come in contact with the stems of the trees. To prevent this those who are of this opinion form two ridges between the rows of trees. This forms small basins, in the centers of which the trees stand, the water being applied to the outer basins. This prevents water from coming in direct contact with the tree and leaves the soil around it in good tilth. Nearly the same benefits may be obtained by the common basin if care is used in grading the soil within each basin so that the circular portion around each tree will not be submerged. The sketch shown in Fig. 23 may convey a better idea of this custom.

According to the report submitted by Mr. Tibbetts, the cost of preparing the surface is small in comparison with the cost of the water and the expense involved in applying it. The water, which is conveyed and delivered by canals, is never measured to the consumer. The canal companies charge each taker from $15 to $20 per day for a "head" of water, which varies according to the conditions from two to three and one-third cubic feet per second, or from 80 to 133 miner's inches under a 6-inch pressure.

The average annual cost of water on 130 orchards was $2.50 per acre.

The cost of preparing the surface in one of the ways previously described was found to be, on an average, 68 cents per acre.

Two men are generally required to attend to the water. They work twelve hours each day and receive in wages from $2.00 to $3.00. About 20 per cent higher wages are paid for night shifts. The average cost of applying water on 130 orchards was $1.88 per acre.

The items in the following brief summary give the cost per acre for orchard irrigation under the gravity canals of the Santa Clara Valley:

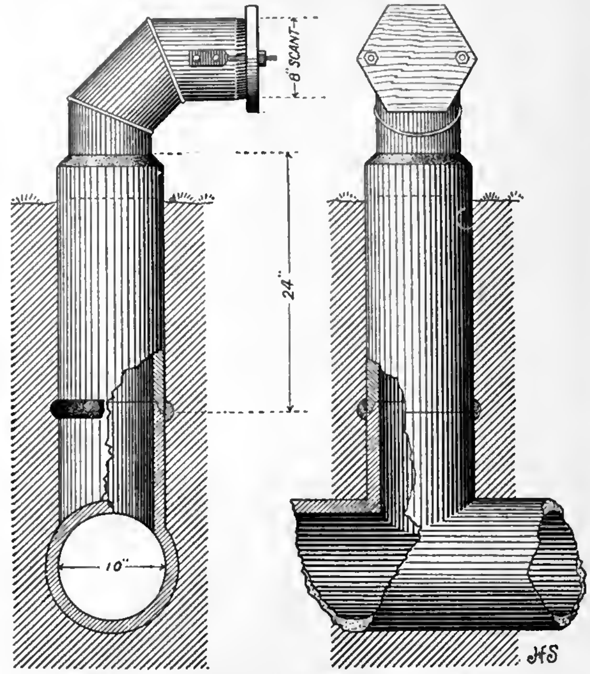


Fig. 24—Details of construction of 8-inch cement stand. Method of closing discharge is described elsewhere.

	Per Acre.
Average cost of water	$2.50
Average cost of preparing the surface	.68
Average cost of irrigating	1.88
Total average cost	$5.06

USE OF METAL PIPE AND CANVAS HOSE IN IRRIGATION OF FIELD CROPS IN CALIFORNIA.

There is no section in the arid West where so much skill is shown in irrigating field and orchard crops as in southern California. In this section water is made to do the highest duty possible and all irrigation practice tends toward the greatest economy in its conveyance and use.

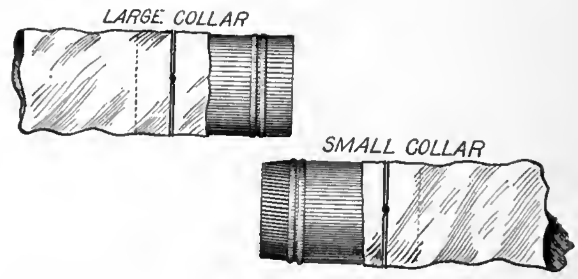


Fig. 26—Methods of arranging collar connection at ends of canvas hose.

The water supply of the San Bernardino and adjacent valleys is derived, to a large extent, from natural streams which, during the rainy months, are subject to heavy flow, but which during the dry season discharge in many cases no water whatever and leave the irrigated lands dependent upon such water as may be stored or upon the supply derived from artesian sources. In the great majority of cases it has been found profitable to construct impervious channels, either by lining the canals with cement or by the use of underground pipes, and so reduce all losses to a minimum. The water is drawn from the underground distributary pipe through cement standpipes or "stands," and as a rule is conveyed to the fields in rough furrows and the crop irrigated by the flooding, furrow, basin or check method. The water is turned into the basin, furrow or lateral, from which it seeps rapidly away. In the case of the orchard this is just what is wanted, provided the water reaches the root zone of the tree. In the irrigation of field crops, however, it is very different. Field laterals, both permanent and temporary, from the nature of their construction and use are poor water-carriers and great amounts seep out, from which but a small area is benefited. This area, as a rule, lies along the ditch bank and is allowed to go to weeds.

a T joint (Fig. 24). They are placed at intervals along the highest side of a field and serve as outlets from which the piped water is taken into the metal and canvas pipes.

Various combinations of galvanized iron pipe and canvas hose are used. Some irrigators prefer to use all canvas hose with only a short length of metal pipe (Plate IV, Fig. 2). Others use nearly all metal pipe and only a short piece of canvas hose to join the metal pipe to the stands. Often even this small amount of canvas hose is dispensed with. Still others have adopted the metal pipe to convey the water from the stand to the section of the field to be irrigated and use the hose simply to distribute it. The best results

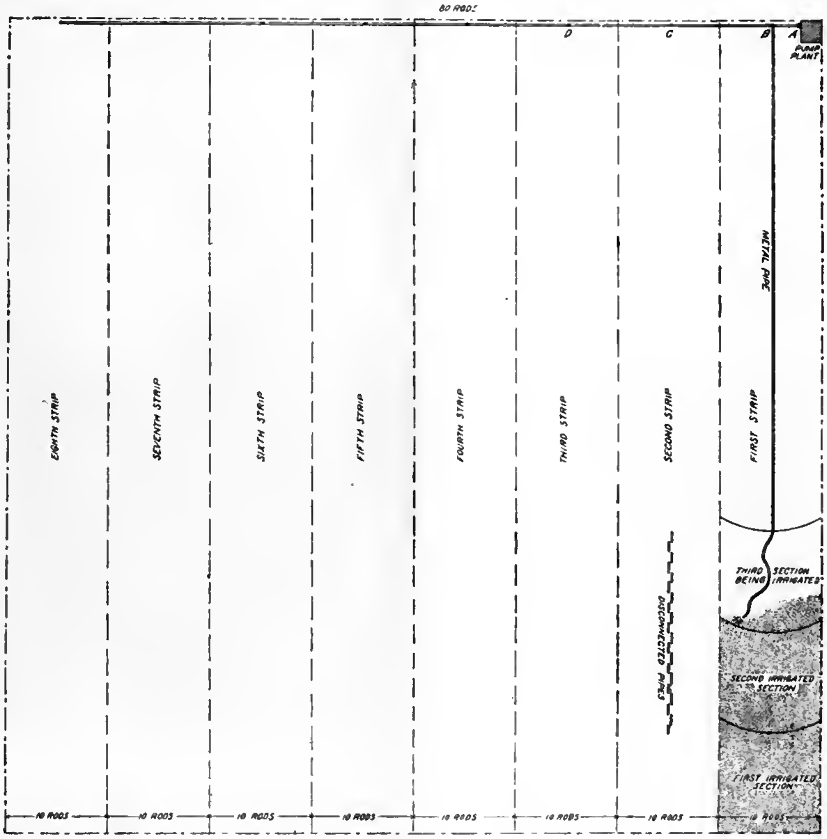


FIG. 25. Irrigating Field Strips.

In addition to losing water the channels of such laterals, together with their banks and dumps of excavated material, decrease by no small amount the crop-producing area, to say nothing of obstructing the free use of farming machinery. The losses by seepage and leakage can be prevented only by the use of lined channels, and these channels, to permit the fullest use and free cultivation of the land, must be removable. To meet these conditions and to bring about a more economical use of both land and water, the use of metal pipe and canvas hose in the irrigation of field crops has been quite widely adopted in the region referred to.

Fields of alfalfa irrigated with pipe and hose are usually laid out in such manner that from five to ten acres may be served from each stand, depending, of course, upon the size and shape of the tract. These cement stands consist of two or three sections of 8- or 10-inch cement pipe placed in a vertical position and connected with the underground distributary pipe by

seem to be obtained through the use of this last-mentioned combination. Fig. 25 shows part of a field of alfalfa irrigated in this manner, which will illustrate the common method of handling the conduits when in use. The sketch is taken from a 40-acre field in the vicinity of Chino. The water from a pumping plant located on the northeast corner of the tract is delivered into a large cement standpipe three feet in diameter and about seven feet in height above the ground level. This standpipe regulates the flow of water to the distributary and provides sufficient head to force the water through the entire system of pipes. The main underground distributary is a cement pipe ten inches in internal diameter and is laid across the upper side of the field, as shown. The cement stands are placed ten rods apart, each thus serving a strip of land containing about five acres.

The metal pipes are first strung down the first strip, end to end. Beginning, then, at the stand, the first length of pipe is either joined directly to the stand by a right-angled elbow, as shown in Plate V, Fig. 1, or the connection may be made by a short piece of canvas hose from six to ten feet in length. Many prefer this latter method, as it gives greater freedom of movement to the first two or three sections of pipe and also protects the cement stand from disturbance by careless handling. When the sections of pipe are jointed and extend nearly to the lower end of the field, the water is turned in and the irrigation of the first strip begun. Many irrigators distribute the stream from the metal pipe directly. Others distribute by means of one or two lengths of metal pipe, which are attached to the main pipe either by a short piece of hose or by a metal elbow (Plate V, Fig. 2), while still others use one, two or three 50-foot lengths of canvas hose at the end of the metal pipe, with which the stream can be conveyed to every part of the strip within the radius of the hose. It is common practice, after having sufficiently irrigated the lower five or six rods of the strip, to disconnect several lengths of the metal pipe, reattach the distributing hose and proceed with the irrigation of a second and higher portion of the strip. While the water is running there the disconnected pipes are placed in the adjoining strip in much the same manner as that in which they were originally strung out in the first strip, beginning, however, at the lower end of the strip and proceeding upward in reverse order. When the second portion of the first strip is watered, more metal pipe is disconnected and placed in the adjoining strip, the hose is moved up to the third portion of the strip and the stream handled in the same manner as in the two lower portions just irrigated. This method of procedure is continued until all of the first strip has been watered. Then the metal pipe is jointed up and the connection made with the second stand and the irrigation of the second strip accomplished by repeating the operation as in the first strip.

Distributing Water From Sections of Metal Pipe Attached to Main Pipe by Canvas Elbows.

This method is used to the best advantage on land having a fairly even slope. Where the land is uneven and broken the metal pipes give better results if laid along the ridges and the water distributed on either side by canvas sections. This system might be employed on very rough ground with but little preparation of the surface and with but little modification of the method just described. The only requisite is that a head be maintained on the pipes sufficient to carry the stream to the top of the highest knolls without much diminution of its flow. The use of pipes is not confined to tracts where flooding is the method of irrigation employed, but they are also used to some extent with basin and contour check irrigation. The pipes convey the water to the various checks without the losses which would occur if the common method of filling one check through a serious of others were employed.

CONSTRUCTION OF PIPE, HOSE AND STANDS.

The thin iron pipe commonly used varies from seven to nine inches in diameter and is made in sections of varying lengths. The most common length is twelve feet, formed of four 36-inch sections. All joints and seams are riveted and soldered, and the end of each section is crimped to give it rigidity. Some 16-foot sections are used, but these are rather long, and, although there are fewer joints where leakage may occur, their length makes them bulky and awkward to handle. The roughness of the land on which the pipes are used governs to some extent the best length of section. On some rough land 10-foot sections are used with the best success, while on smooth land some prefer 15-foot sections.

Various weights of galvanized iron may be used, ranging from No. 20 to No. 26 B. W. G. No. 26 iron is too light for most work; it makes a fragile pipe which is easily damaged, especially at the ends. The most serviceable pipe, where price and durability are considered, seems to be that made from No. 22 or No. 24 iron. No. 20 is heavy for all ordinary purposes, but makes a very strong and lasting pipe. No. 22 iron is the grade most commonly used. It makes a good, serviceable pipe that is light but at the same time quite strong. The effect of water pressure on these metal pipes, as governing the weights of iron to be used, need not, in the majority of cases, be considered, for usually the head is low. Pipe should be just heavy enough to stand ordinary usage without being damaged.

The canvas hose should always be a little greater in diameter than the metal pipe with which it is used, in order that it can carry with ease the same volume of water. It should never be used under any considerable head, as it can stand but little pressure without leaking. The hose is made in 25- to 100-foot lengths and is formed of one strip of canvas, the width of which is approximately three times the diameter of the hose when sewed, allowance, of course, being made for the seam, which is double lap and, as a rule, machine sewed. Various weights of canvas are used, good results being attained with either 10- or 12-ounce duck. Many use a patented hose which has been treated with a preparation to make the duck impervious. Others use the plain duck without treatment. The plain duck, if carefully handled when in use and if not left lying on the ground, where it will rapidly mildew, when not in use, will last, as a rule, a season and a half and probably two. The prepared hose, will, with the same treatment and care, last two and two and one-half seasons, according to the amount of service and the way in which it is taken care of. It is quite possible to prolong the life of hose by giving it an occasional coating inside and out of boiled linseed oil. Sometimes it is boiled in paraffin. This not only preserves the fiber of the duck, but also adds to its imperviousness. Another treatment, which has been used with success on smaller canvas hose in some sections of the East, consists in saturating the canvas with hot coal-tar and linseed oil in the proportion of three or four parts to one. The hose, after being saturated, is passed through an ordinary clothes wringer and the excess of tar and oil squeezed out. It is then allowed to dry for several days before being used.

The canvas hose is attached to the metal pipe or other sections of hose by means of metal collars, which are short sections of pipe (Fig. 26), around which the canvas is bound with wire. At one end of the section is a large collar, at the other a smaller one. The short hose used to connect metal pipe with the stand, and also the shorter sections used as elbows, are similar in construction to the longer sections, each having a small and a large collar.

The details of construction of one style of cement stand are shown in Fig. 24, and in Plate V, Fig. 2, the method of connecting the metal pipe with this form of stand is illustrated. The right-angled elbow is made in three sections and is cemented firmly into the top of the stand. On either side of the horizonal section of the elbow a 3/8-inch threaded lug is riveted, as shown. These two lugs extend about three inches beyond the end of the elbow and are used to hold in place a hexagonal-shaped board somewhat larger in diameter than the end of the elbow, which, when the stand is not in use, is placed over the opening and there drawn snug by nuts, thus preventing overflow from the stand.

Where pipes are rightly constructed and properly connected there is little leakage at joints. Where it is necessary to carry water up grade less leakage will occur if canvas hose is used, as there are fewer joints and the hose adaptes itself to changes in direction better than does the metal pipe.

Common Method of Connecting Metal Pipe with Cement Stand.

MEETING OF IRRIGATION COMMISSION.

The irrigation commission of New Mexico was in session at Santa Fe, N. M., recently. There were present. G. A. Richardson, of Roswell, Arthur Seligman, of Santa Fe, secretary and treasurer; Charles E. Miller, of Anthony, and Carl A. Dalies, of Belen, members. A bill prepared by Mr. Richardson providing for the creation of the office of irrigation engineer and of an irrigation commission to have charge of irrigation matters in the Territory, was laid before the members, carefully examined and approved. It will be submitted to the assembly for enactment.

ADMINISTRATION OF STREAMS IN IRRIGATION.

BY ELWOOD MEAD, WASHINGTON, D. C.

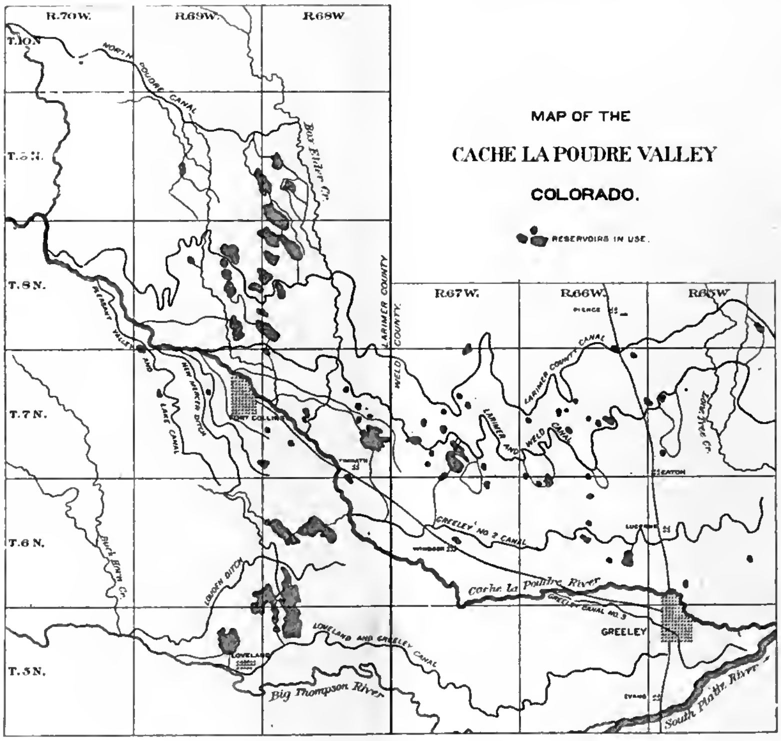
Read before the Western Society of Engineers.

In the arid West there is no escape from the overshadowing importance of streams. Not only the prosperity but the very existence of civilized life depends in large measure on ability to use rivers in irrigation. Whoever controls the water supply practically owns the land it makes productive, and just and stable titles to water are of far more importance than deeds to the land on which it is used.

We have reached a period when the significance of these facts can not longer be ignored. The water problems of the West are assuming national importance. In the suit of Kansas against Colorado in the United States Supreme Court, and the international questions created by the use of the Rio Grande, are examples of present conflicts created by turning streams from their courses. In its larger aspects the use of the rains and snows of the Rocky Mountains and Sierras to water the arid plains affects the flow of the Mississippi, the Columbia and the Sacramento, and will in time raise the question as to whether the farm at the head waters or the steamboat below is to have the use of the water supply. Meanwhile, with an optimism characteristic of the West, development goes bravely on.

The use of Western streams in irrigation has created a commerce in water of great and constantly growing importance. More than $100,000,000—and some estimates make it twice this sum—have been expended in the construction of irrigation works. They begin with the rivulets far up on the mountain slopes and extend to the great rivers which wind their lonesome courses across the dusty plains. The area which these ditches and canals can be made to water is as large as the State of Indiana, and an area half the size of that State is now being irrigated. The main canals and laterals are so arranged that every square foot of this area is watered from one to five times a year.

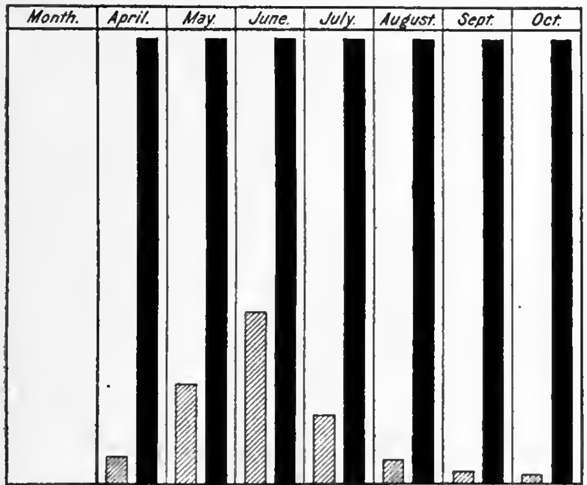
These cultivated lands are not continuous, but are oases scattered over a region larger than any European country save Russia and which embraces about one-third of the United States. The water supply is taken from thousands of rivers, creeks and rivulets, is drawn from reservoirs and pumped from wells. Its management and distribution require an army of men to patrol the canals, to regulate the gates by which the water is taken in and adjust those by which it is measured out to users. Claims to water are filed and recorded like claims to coal, oil or placer mines, and a settlement of the water titles involves a determination of the rights which shall be recognized in the rains and snows which fall on mountain summits, and the harmonizing of conflicting interests of individual irrigators, of communities and even different States.



In considering the administration of creeks and rivers we shall not be able to deal with the manner in which canals are operated, the contracts under which water is sold to farmers, nor the methods employed in its measurement and delivery. Either would be a large topic alone. I shall not attempt to define all the legal issues growing out of water ownership, because that would be impossible, nor to say much about engineering methods, because, in so brief a discussion, this would not be interesting. I hope, however, to make clear that the farmer under irrigation has to deal with knotty problems, of which the farmer who depends on the clouds knows nothing, and to place before you the relation of streams to the agricultural development of the West, to give you some insight into the meaning of a water right, the most vital and perplexing question which now confronts the farmer, the lawmaker and the jurist of the Western half of this country.

The most effective way of doing this seems to be to trace the growth of administrative methods on a single stream, to show how its waters have passed from public to private ownership and how they are being leased, sold, divided and used, letting this serve as an example of what is taking place in thousands of other valleys between the Missouri River and the Pacific Ocean. To attempt to deal generally with this subject would only result in dazing you with conflicting laws and diverse conditions of the seventeen arid States and Territories. There are complications enough in one valley to occupy one evening.

I first saw the stream we are to use as an illustration twenty years ago. I had traveled for 300 miles up the incline of the plains which lie against the eastern base of the Rocky Mountains. It was a country almost without inhabitants, and where it seemed that a light-footed and laborious grasshopper would



Month.	April.	May.	June.	July.	August.	Sept.	Oct.
Mean monthly Discharge, 1890 to 1894.	279	1012	1714	675	239	115	96
Volume of Excess Appropriation.	4354	3621	2919	3958	4394	4518	4537
Number of Appropriators without right to water.	91	63	50	70	93	98	5.[illegible]

Total volume appropriated 4632.53 sec.-ft
Total number of Appropriators 104.
Mean monthly discharge.

* —Relation between the mean monthly discharge of the Poudre River and the appropriations therefrom.

have hard work to live. The last part of my journey was up the valley of the Poudre River, near the mouth of which is the town of Greeley and the site of the historic Greeley colony*, and at the upper end of the town of Fort Collins and the State Agricultural College. This stream, which is too large to be called a creek and too small to be properly dignified as a river, has its source in the perpetual snows of the mountains. It tumbles down through rocky gorges for a hundred miles and then flows for fifty miles across the plain which falls away from the mountains to the east about twenty feet to the mile. Where the river leaves the mountains it is nearly 6,000 feet above the sea; where it joins the South Platte it is 4,800 feet above the sea. Bordering the stream is a strip of irrigated land varying in width from half a mile to fifteen miles. Fifty ditches and canals divert its water. The one farthest upstream starts in the canon, the one farthest down, forty-five miles below. The largest canal is sixty feet wide, five feet deep, seventy-five miles long, and supplies water to 400 farms. The smallest ditch can be stepped across and waters less than 100 acres.

The first ditches were built more than forty years ago in the vicinity of the stage stations along the line of the overland trail, one branch of which ran up this valley. At that time everything consumed had to be hauled in wagons over 700 miles. The freight rate was 25 cents per pound, with no insurance from loss from floods or Indian raids. Even unskillful irrigation was a success. Hay sold for $100 a ton; cabbages brought $1.00 a head and potatoes 50 cents a pound.

The founding of the Greeley colony in 1870 was the beginning of a new order of things in Colorado. Before that irrigated farms had been too small and too widely separated for their owners or their owners' families to enjoy either churches, schools or the advantages of social life. But the colony canal was large enough to create a community which could give its members all the comforts and institutions of civilization. Its success was quickly followed by other large projects which had their headgates farther upstream. Capitalists saw a new source of wealth in the melting snows. Irrigation development became corporate and, in a sense, speculative. In less than nine years over $1,000,000 was invested in canals and ditches which reached from the river for scores of miles out on the unsettled barren plains and covered many sections which were not watered nor farmed for twenty years.

The promoters of these enterprises came from all parts of the country and the money which built them from more remote sections. The largest one was built by a Scotch company with money brought from Edinburgh. Colonists from New York enlisted their friends in two or three others. The promoters of these enterprises were spurred by rivalry to secure these hitherto unused resources of nature, and in the race for acquire-

A Potato Crop Near Greeley, Colo. Irrigated Culture.

ment gave little heed to future consequences. No one knew how much water would be needed to irrigate an acre of ground, nor whether the river would fill all the canals after they were completed. The result was that ditch building far exceeded the capacity of the stream to supply water. The largest of these canals carries more water than the average flow of the river during the irrigation season, and all the water it carries can be turned into any one of a half dozen in August and September. When the snows are melting, or following cloudbursts, there are brief periods when the river will more than fill all these works, but it requires a continuous supply to serve farmers, and the chronic

*Greeley, Colo. The reader is referred to an interesting and valuable account of the origin, settlement and evolutions of Greeley in *Harper's Magazine*, February, 1903, under the title of "A Decreed Town."—Editor condition of the river is a need of more water than it will furnish.

Without some outside control, the position of headgates would count for everything. The canals farthest upstream would take what they pleased, those below would take what was left, and those farthest down would, most of the time, go without.

The lack of such division brought a crisis in 1878. The upper canals took all the water, leaving nothing for the Greeley colony canal, the first large irrigation works to be built. The farmers under this canal faced a situation which, unless soon relieved, meant their ruin. Unless they could get a share of the river all their crops would scorch under the summer's sun, and even the trees they had planted would die. Yet there was no law by which the upper canals could be compelled to close their headgates, and no officer to enforce such a law had it been in existence. It was another instance of necessity knowing no law. The Greeley farmers shouldered their shotguns and shovels and started upstream. Failing to secure the closing of headgates through appeals or argument, they tore out the dams so that the water flowed down to their farms unobstructed. Agriculture under such conditions ceased to be a peaceful industry. On several occasions bloodshed was narrowly averted, and the feeling between the owners of the upper and lower ditches became so strained that it was plain that there must be some law to govern titles to water if endless litigation or an endless warfare by force was to be averted. It is to the credit of the farmers along this stream that they addressed themselves to the framing of such a law and gave to Colorado the credit of being the pioneer in placing streams under public control.

In order to do this they had to face a new problem in American civilization, which was to determine the kind of ownership that should be recognized in running water. Up to this time they had given but little thought to these matters. To the majority of farmers and investors in canals this situation came as a surprise. They had been absorbed in overcoming physical obstacles, in building homes and learning how to supply water to their fields. Doing this was no light undertaking, and it had absorbed all their time and energy. Laterals had to be plowed, gopher holes had to be closed, methods of applying water to crops had to be learned, and every day the hot winds blew fields had to be watered or the desert would resume is sway.

Settlers had to first assure themselves that the experiment they were making was to be a success before it is worth while to provide institutions for its future regulations. Many were doubtful regarding this. Many soon became dissatisfied and surrendered. A letter from one of these homesick, discouraged pioneers illustrates why water laws were not considered until they had to be. Part of it was as follows:

"There is one thing we can and must say to our uneasy, restless readers—don't go to Greeley, Colorado Territory. That is the last place on the face of this terrestrial ball that any human being should contemplate removing to. Greeley, Colorado Territory, is a delusion, a snare, a cheat, a swindle. Greeley, Colorado Territory, is a graveyard, in which are buried heaps of bright hopes and joyous anticipations. Two or three hundred (floating population) that have not 'dudads' enough to get down to Evans, four miles below; several stern-wheel shanties and a few one-horse tents compose the population of the great Union colony.

(To be concluded in April number.)

UNITED STATES RECLAMATION SERVICE.

Reprinted from Biennial Report of the State Engineer of Idaho.

Of the work being done by the Reclamation Service of the United States Geological Survey this office has, of course, no report to make directly. But in certain features of this work, where it directly affects irrigation development work which has heretofore been fostered and encouraged by the various State departments there are effects apparent which I deem it my duty to call to your attention.

The national irrigation law was a most popular measure. Through it all those interested in the development of the resources of the arid West hoped to see the waste places made productive by the conservation and application of waters at present going to waste. It was popularly supposed that the larger enterprises would be undertaken that were beyond the reach of private capital. In the words of the President's message to Congress recommending this legislation:

"Great storage works are necessary to equalize the flow of the streams and to save the flood waters. Their construction has been conclusively shown to be an undertaking too vast for private effort, nor can it be best accomplished by the individual States acting alone. Far-reaching interstate problems are involved, and the resources of single States would often be inadequate. It is properly a national function, at least in some of its features. It is as right for the National Government to make the streams and rivers of the arid region useful by engineering works for water storage as to make useful the rivers and harbors of the humid region by engineering works of another kind. The storing of the floods in reservoirs at the headwaters of our rivers is but an enlargement of our present policy of river control, under which levees are built on the lower reaches of the same streams.

"The Government should construct and maintain these reservoirs as it does other public works. Where their purpose is to regulate the flow of streams the water should be turned freely into the channels in the dry season to take the same course under the same laws as the natural flow.

"The reclamation of the unsettled arid public lands presents a different problem. Here it is not enough to regulate the flow of streams. The object of the Government is to dispose of the land to settlers who will build homes upon it. To accomplish this object water must be brought within their reach.

"The pioneer settlers on the arid public domain chose their homes along streams from which they could themselves divert the water to reclaim their holdings. Such opportunities are practically gone. There remain, however, vast areas of public land which can be made available for homestead settlement, but only by reservoirs and main line canals impracticable for private enterprise. These irrigation works should be built by the National Government. The lands reclaimed by them should be reserved by the Government for actual settlers, and the cost of construction should, so far as possible, be repaid by the lands reclaimed. *The distribution of the water, the division of the streams among irrigators, should be left to the settlers themselves, in conformity with the State laws and without interference with those laws or with vested rights.* The policy of the National Government should be to aid irrigation in the several States and Territories in such manner as will enable the people in the local communities to help themselves and as will stimulate needed reforms in the State laws and regulations governing irrigation."

This, to the practical irrigator, seemed simple and feasible; the expenses could be allotted to water-users who were benefited by the conserved waters. The ordinary machinery of the various State governments could have been adjusted to meet the improved conditions and the development of irrigation on the torrential streams carried to a maximum. It was not the intention of the framers of the law to usurp the field that could be filled by the individual or by private capital. The Carey act had already enabled the States to encourage and coöperate with corporate capital, and in Idaho had resulted in the inauguration of enterprises which will ultimately reclaim over 400,000 acres of arid lands. It was, therefore, with considerable surprise that, as soon as the engineers of the Reclamation Service began active operations in this State, conflict of interests became apparent, and an antagonism developed against the Carey act enterprises and development by private capital. The good faith of the promoters of the Carey act enterprises was not questioned when we had to depend upon them for the development of the larger plans. If fault were to be found with them, the law was provided with sufficient safeguards to prevent the formation of "fake" schemes. They were obliged to file an application, with plans and specification; the State laws provided for inspection and thorough investigation of all the features of the plan, and, finally, the whole matter was investigated by the Department of the Interior before approval, and before a contract could be entered into by the State and the promoting company for the construction of the necessary works for irrigation and fixing of prices and terms at which the water rights should be sold to the settler. When the laws and the various regulations had been complied with and the work begun, the State became a partner in the enterprise, interested in the settlement and cultivation of the land, and had, to a certain extent, proclaimed the feasibility and merit of the scheme.

The antagonism of the engineers of the Reclamation Service to these enterprises has resulted in the abandonment of one by a company which was proceeding to perfect its surveys and preliminary investigations, and had already expended several thousand dollars on the work. This was on the so-called Minidoka tract. When application was made by the State for the segregation of these lands, in compliance with the provisions of the Carey act, the information was received that these lands had been withdrawn from the public domain at the request of the Reclamation Service. There was no method of recovering the money expended; no previous notice given of the withdrawal of the lands, although the lands were open and subject to the operation of the Carey act at the time the enterprise was inaugurated.

The Canyon Canal Company was organized to irrigate about 22,000 acres of land on the west side of the Payette River, near the town of Emmett. The company is under contract with the State to construct irrigation works and furnish water at a fixed price to settlers upon Government and State lands, and all proceedings of the company have been approved by both the State and National Governments; but they have suffered much in their financial negotiations, due to the direct opposition and interference of the employes of the Reclamation Service of the United States Geological Survey.

Add to this the fact that nearly all the available irrigable land of the State (amounting to over three million acres) has been withdrawn from the public domain, subject only to the uses of the Reclamation Service, under such regulations as its officers may from time to time establish, and we have a state of affairs that offers no inducements to private or corporate capital or enterprise, and has entirely checked irrigation development in the State along these lines, except in the case of enterprises too far advanced to recede. It is not now probable that any new Carey act work will be undertaken while present conditions obtain.

As a substitute for this great activity, from which so much was expected and so much already accomplished, we now have a cessation of development of larger enterprises and an atmosphere of expectancy among all classes of citizens that the "Government" will somehow improve the conditions of irrigation in all sections of the State. The farmer stands ready to sign any contract that is presented to him on behalf of the Government, and has abandoned individual effort.

It is well to bear in mind during all this hue and cry in favor of "Government aid" that so far every particle of work done in digging ditches and irrigating land in the State has been by private capital or individual effort, and to remember that not an acre of ground has as yet been irrigated by Government aid. It is well to remember that all our splendid development under the provisions of the Carey act was begun before the Reclamation act was passed, and to remember further that there would have been still more work under way had this act never been passed. It would be well for sober minded citizens to pause in their hurrahs long enough to inquire in what particular they will be benefited by a substitution of the apparent policies of those having charge of the work of the Reclamation Service. Will they get something for nothing? The law provides that every dollar shall be paid back to the National treasury. Will they get works constructed more cheaply? Compare the methods of organizing an irrigation district under our State laws and of organizing an association to seek Government aid. Will they get irrigation works constructed quicker? Compare the time of starting work under the irrigation district system with the progress made under Government aid.

I do not see the advantage to the State of the Reclamation Service becoming a competitor on a stream where the water supply is already insufficient for its needs; nor do we wish to encourage the settlement and development of the arid portions of the State until our citizens who have taken up land in good faith are supplied with water and taken care of to the best of our ability. It is my opinion that the first act of the Federal authorities should be to assist the settlers who have by their purchase of Government lands at $1.25 per acre furnished this reclamation fund. It seems to me that the settlers in our valleys who have been allowed to purchase Government land at $1.25 per acre and to settle on streams under the supposition, in the absence of definite information, that the water supply would be sufficient for their needs, and who now find that they have but a quarter of the necessary water to reclaim all their land, should first be considered in these expenditures for development of the water supply, especially if, at the same time, other land in the immediate neighborhood could be reclaimed by the same system of works which would assist these early settlers.

There is no method of ascertaining through investigation whether or not the works to be constructed by the Government will be adequate for the purposes intended, or whether they will include all the available land that is irrigable from a specific source. There is nothing under the present method of secrecy in vogue with the officers of the Reclamation Service by which their plans can be reviewed by the State authorities. Repeated requests for information have been met with the statement that it was not to the interest of the objects of the Reclamation Service to publish their plans or information beforehand.

It seems to be the policy that, when private capital proceeds to investigate an enterprise with a view of constructing works, a crying need immediately occurs for the withdrawal of the land under investigation or the withdrawal of a reservoir site it is sought to improve. Notably is this the case with a recent decision of the General Land Office in the case of a reservoir site on the Owyhee River which it was proposed to improve for the irrigation of lands lying partly in Idaho and partly in Oregon.

The irrigators of the Boise and Payette valleys, acting under the guidance of the Reclamation Service, are organizing themselves into a "Water Users' Association," in order to eventually enter into a contract with the National Government by which they will become equal sharers in whatever water the engineers may be able and willing to conserve and supply. The organization is an excellent one, and, when once formed, will be one great irrigation district. The members will then be in position to construct their own irrigation works under our irrigation district law. The benefit to them of having signed a contract to mortgage their lands to the National Government, to agree to make no changes in their by-laws except with the approval of the Hon. Secretary of the Interior, and to accept and pay for whatever irrigation works may be designed and constructed without their knowledge or approval, is not apparent. The irrigator must eventually pay the bills, and the only advantage he can have in accepting and paying for the Government works is in the apparent saving of interest charges. It is doubtful if this will offset the disadvantages incident to Governmental supervision and control of his every act and the increased cost to him of the works which becomes daily more inevitable.

There is to my mind no good reason for turning over the control of our irrigation matters to the Reclamation bureau, but the effort is seemingly being made to accomplish this end. Already we have the spectacle of the State of Nevada having surrendered her birthright, and, for the money consideration of having her irrigation matters advanced by National loan, passing a law compelling her Governor to appoint to the office of State Engineer only such a man as meets with the approval of the Chief of the Reclamation Service. We see, also, the State of Washington appointing a commission to devise a suitable irrigation law, and this commission so influenced by the numerous employes of the Reclamation Service (whose salaries and expenses the irrigator must eventually pay), that they have evolved and published a proposed irrigation law which suspends the right of the State to inspect the construction of any work which is in charge of officers of the United States; and further providing that an officer of the United States may notify the State authorities "that the United States wishes to use certain specified waters * * * and the waters so specified shall not be subject to further appropriation under the laws of the State."

The officers of the United States might construct a dam that would be a menace to life and property, and this proposed law would leave the officers and citizens of the State no protection. They might stop irrigation development on every stream in the State by notifying the State authorities that "the United States wishes to use certain waters." This proposed legislation bears the signature of the United States attorney for the Reclamation Service. Are the States ready to yield to this aggressive usurpation?

Such legislation is far reaching, and, while not particularly alarming at first glance, would nullify any beneficial features it might contain, as becomes more apparent upon careful study. Why this Government control should be necessary is not easily understood. The National and State Governments should work in complete harmony if the best results are to be obtained and the idea of the President and congress of providing homes for the people carried out. This can be done without surrendering our rights as a State or as individuals. It is a great work, if carried out along the lines intended by the framers of the reclamation law, and worthy of the careful and earnest efforts of all our citizens. The steps now taken in irrigation development and establishment of stable rights, both in law making and construction, should be in advance, and, with care, there is no reason why the present stage of development, so laboriously attained, should ever be receded from.

Appreciating the enthusiasm with which the public has welcomed the inauguration of certain enterprises by the engineers of that department, it is with the greatest reluctance that I have called attention to what, in my judgment, is the perversion of the original purpose of the Reclamation act; but I am compelled to this course by the obligations of my position as State Engineer, charged with the oversight of irrigation matters within our boundaries. I am hopeful, in view of the sentiments expressed by President Roosevelt, that the methods of the bureau will soon be brought into harmony with the original intent of the act that created it, and that this department of the Government, instead of entering the field as a competitor with private enterprise in the construction of irrigation canals from streams already largely, if not over, appropriated, will turn its attention to increasing the water supply available for irrigation by the construction of reservoirs for conserving the flood waters of our streams. There will then be no occasion for their efforts to change the State laws in such a way as to place the control of our irrigation affairs in the hands of a department with headquarters in Washington. To my mind, local control is the prime requisite for the best development of our irrigation resources, and, as far as practicable, the affairs of each drainage basin should be left to the management of its own settlers and irrigators. General rules and regulations adopted or approved at Washington for the government of our irrigation conditions, however wise, could be framed for only general application, leaving unsolved, or perhaps interfering with the solution of, questions peculiar to the different localities.

The irrigation district organization under the laws own State have distinctly demonstrated that the closer the irrigator can be brought to the solution of his own problems, the more satisfactory is the result. The work of the board has therefore been more in the nature of an advisory than a controlling factor, and has accomplished its best work by consultation and assistance rather than in promulgating rules and regulations.

The irrigation district organiation under the laws of our State is the logical and inevitable sclution of all our irrigation problems, whether they be inaugurated through Government aid, Carey act cnterprises or individual effort. The water users who take water from a common source of supply must inevitably establish their own home rule which is best suited to their conditions. They can do that as well in the beginning as in the end, and if the funds of the Reclamation Service could be invested in irrigation district bonds, with or without interest, it is my opinion that irrigation development would acquire such an impetus that it would not be checked until every acre of irrigable land was cultivated and growing the crops best suited to its climate and condition, and the largest number of homes built for the largest number of citizens conducive to our best development along all lines. The arbitrary ruling limiting the size of the tract a family may cultivate to minute dimensions, which is possible under the present regulations of the Reclamation Service, is not conducive to the highest development of the individual, and is a feature of the community of interest which our citizens will be slow to indorse.

Rumors are rife that it is the purpose of those having charge of the Reclamation bureau to introduce bills before our next legislature having for their object the turning over of State control of irrigation affairs in Idaho to this bureau. I hope this is not true, but recent legislation in other States makes it incumbent upon me to fully warn the members of our legislature to be on guard against any radical changes in our present laws. It would be far better for the present to take no action upon the slight changes I have recommended than take the risk by change of giving away the rights that properly belong to the State. If this is to be the price for Government aid under the Reclamation act, it would have been far better for the West in every way had this legislation never been enacted. In all matters pertaining to development under its provisions, it would be the safer plan for this State to withhold action until the policies of those in charge of the bureau are radically changed. Should this not occur, it would, as I view it, be the part of wisdom for the State and its people to decline the offers of aid from the Reclamation bureau. We have attained a very creditable development without this aid, and can work out our further salvation without it. To myself and many others interested in the highest development of our irrigation possibilities, a most pleasant vista of rapid and effective development was presented through co-operation with the National Government under the terms and seeming policies of the Reclamation act, and no one could be more disappointed in the results to this time; but most assuredly do we believe, however, that no price would recompense the State for the surrender of its rights and the local communities of their home rule in irrigation matters.

THE PRIMER OF IRRIGATION.

APPENDIX.

This appendix contains land, water, and power measurements, and other information for reference by the reader.

LAND OR SQUARE MEASURE.

144 spuare inches equal....	1 square foot.
9 square feet equal.......	1 square yard.
30¼ square yards equal...	1 square rod.
40 square rods equal......	1 rood.
4 roods equal............	1 acre.

SURVEYORS' MEASURE.

7.92 inches equal.........	1 link.
25 links equal............	1 rod.
4 rods equal.............	1 chain.
10 square chains equal....	1 acre.
640 acres equal..........	1 square mile.

CUBIC MEASURE.

1,728 cubic inches equal..	1 cubic foot.
27 cubic feet equal.......	1 cubic yard.
128 cubic feet equal.......	1 cord of wood.
40 cubic feet equal.......	1 ton (shipping).
2,150.42 cubic inches equal.	1 standard bushel.
268.8 cubic inches equal...	1 standard gallon.

LIQUID OR WINE MEASURE.

4 gills equal.............	1 pint.
2 pints equal.............	1 quart.
4 quarts equal............	1 gallon.
31½ gallons equal.......	1 barrel.
2 barrels equal...........	1 hogshead.

DRY MEASURE.

2 pints equal.............	1 quart.
8 quarts equal............	1 peck.
4 pecks equal............	1 bushel.
36 bushels equal..........	1 chaldron.

AVOIRDUPOIS WEIGHT.

6 drams equal............	1 ounce.
16 ounces equal..........	1 pound.
25 pounds equal..........	1 quarter.
4 quarters equal..........	1 hundred weight.
20 hundredweights equal...	1 ton.

TROY WEIGHT.

(For Precious Metals and Jewels.)

1 pennyweight.	24 grains equal..........
1 ounce.	20 pennyweights equal....
1 pound.	12 ounces equal..........

APOTHECARIES' WEIGHT.

20 grains equal..........	1 scruple.
3 scruples equal.........	1 dram.
8 drams equal...........	1 ounce.
12 ounces equal..........	1 pound.

METRIC SYSTEM OF WEIGHTS AND MEASURES.

The nickel five-cent piece is the key to the metric system of linear measures and weights. The diameter of the nickel is two centimeters exactly, and its weight five grammes. Five of them placed in a row give the length of the decimeter, and two of them will weigh a dekagram. As the kiloliter is a cubic meter, the key to the measure of length is also the key to the measure of capacity.

The Metric System was legalized in the United States on July 28, 1866, when Congress enacted as follows:

"The tables in the schedule hereto annexed shall be recognized in the construction of contracts, and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the metric system, and the tables may lawfully be used for computing, determining, and expressing in customary weights and measures the weights and measures of the metric system."

The following are the tables annexed to the above:

MEASURES OF LENGTH.

Metric Denominations and Values.		Equivalents in Denominations in Use.	
Myriametre	10,000 metres.	6.2137	miles.
Kilometre	1,000 metres.	0.62137	mile, or 3,280 feet 10 inches.
Hectometre	100 metres.	328	feet 1 inch.
Dekametre	10 metres	393.7	inches.
Metre	1 metre.	39.37	inches.
Decimetre	1-10 of a metre.	3.937	inches.
Centimetre	1-100 of a metre.	0.3937	inch.
Millimetre	1-1000 of a metre.	0.0394	inch.

MEASURES OF SURFACE.

Metric Denominations and Values.		Equivalents in Denominations in Use.	
Hectare	10,000 square metres.	2.471	acres.
Are	100 square metres.	119.6	square yards.
Centare	1 square metre.	1,550	square inches

MEASURES OF CAPACITY.

METRIC DENOMINATIONS AND VALUES.			EQUIVALENTS IN DENOMINATIONS IN USE.	
Names.	Number of Litres.	Cubic Measure.	Dry Measure.	Liquid or Wine Measure.
Kilolitre or stere.	1-000	1 cubic metre	1.308 cubic yards	264.17 gallons.
Hectolitre	100	1-10 of a cubic metre.	2 bush. and 3.35 pecks	26.417 gallons.
Dekalitre	10	10 cubic decimetres	0.08 quarts	2.6417 gallons.
Litre	1	1 cubic decimetre	0.908 quart	1.0567 quarts.
Decilitre	1-10	1-10 of a cubic decimetre.	6.1022 cubic inches	0.845 gill.
Centilitre	1-100	10 cubic centimetres	0.6102 cubic inch	0.338 fluid ounce.
Millilitre	1-1000	1 cubic centimetre	0.061 cubic inch	0.27 fluid dram.

WEIGHTS.

METRIC DENOMINATIONS AND VALUES.			EQUIVALENTS IN DENOMINATIONS IN USE.
Names.	Number of Grams.	Weight of what Quantity of Water at Maximum Density.	Avoirdupois Weight.
Miller or tonneau	1,000,000	1 cubic metre	2204.6 pounds.
Quintal	100,000	1 hectolitre	220.46 pounds.
Myriagram	10,000	10 litres	22.046 pounds.
Kilogram or kilo	1,000	1 litre	2.2046 pounds.
Hectogram	100	1 decilitre	3.5274 ounces.
Dekagram	10	10 cubic centimetres	0.3527 ounce.
Gram	1	1 cubic centimetre	15.432 grains.
Decigram	1-10	1-10 of a cubic centimetre	1.5432 grains.
Centigram	1-100	10 cubic millimetres	0.1543 grain.
Milligram	1-1000	1 cubic millimetre	0.0154 grain.

PRACTICAL MEASUREMENTS.

TO ASCERTAIN THE WEIGHT OF CATTLE—Measure the girt close behind the shoulder, and the length from the fore part of the shoulder-blade along the back to the bone at the tail, which is in a vertical line with the buttock, both in feet. Multiply the square of the girt, expressed in feet, by ten times the length, and divide the product by three; the quotient is the weight, nearly, of the fore quarters, in pounds avoirdupois. It is to be observed, however, that in very fat cattle the fore quarters will be about one-twentieth more, while in those in a very lean state they will be one-twentieth less than the weight obtained by the rule.

RULES FOR MEASURING CORN IN CRIB, VEGETABLES, ETC., AND HAY IN MOW—This rule will apply to a crib of any size or kind. Two cubic feet of good, sound, dry corn in the ear will make a bushel of shelled corn. To get, then, the quantity of shelled corn in a crib of corn in the ear, measure the length, breadth and height of the crib, inside the rail; multiply the length by the breadth and the product by the height, then divide the product by two, and you have the number of bushels of shelled corn in the crib.

To find the number of bushels of apples, potatoes, etc., in a bin, multiply the length, breadth and thickness together, and this product by eight, and point off one figure in the product for decimals.

To find the amount of hay in a mow, allow 512 cubic feet for a ton, and it will come out very generally correct.

TO MEASURE BULK WOOD—To measure a pile of wood multiply the length by the width, and that product by the height, which will give the number of cubic feet. Divide that product by 128, and the quotient will be the number of cords. A standard cord of wood, it must be remembered, is four feet thick; that is, the wood must be four feet long. Farmers usually go by surface measure, calling a pile of stove wood eight feet long and four feet high a cord. Under such circumstances thirty-two feet would be the divisor.

HOW TO MEASURE A TREE—Very many persons, when looking for a stick of timber, are at a loss to estimate either the height of the tree or the length of timber it will cut. The following rule will enable any one to approximate nearly to the length from the ground to any position desired on the tree: Take a stake, say six feet in length, and place it against the tree you wish to measure. Then step back some rods, twenty or more if you can, from which to do the measuring. At this point a light pole and a measuring rule are required. The pole is raised between the eyes and the tree, and the rule is brought into position against the pole. Then by sighting and observing what length of the rule is required to cover the stake at the tree, and what the entire tree, dividing the latter length by the former and multiplying by the number of feet the stake is long, you reach the approximate height of the tree. For example, if the stake at the tree be six feet above ground and one inch on your rule corresponds exactly with this, and if then the entire height of the tree corresponds exactly with say nine inches on the rule, this would show the tree to possess a full height of fifty-four feet. In practice it will thus be found an easy matter to learn the approximate height of any tree building, or other such object.

TO MEASURE CASKS OR BARRELS—Find mean diameter by adding to head diameter two-thirds (if staves are but slightly curved, three-fifths) of difference between head and bung diameters, and dividing by two. Multiply square of mean diameter in inches by .7854, and the product by the height of the cask in inches. The result will be the number of cubic inches. Divide by 231 for standard or wine gallons, and by 282 for beer gallons.

GRAIN MEASURE—To find the capacity of a bin or wagon-bed, multiply the cubic feet by .8 (tenths). For great accuracy, add ⅕ of a bushel for every 100 cubic feet. To find the cubic feet, multiply the length, width and depth together.

TO MEASURE CORN OR SIMILAR COMMODITY ON A FLOOR—Pile up the commodity in the form of a cone; find the diameter in feet; multiply the square of the diameter by .7854, and the product by one-third the height of the cone in feet; from this last product deduct one-fifth of itself, or multiply it by .803564, and the result will be the number of bushels.

CAPACITY OF CYLINDRICAL CISTERNS OR TANKS FOR EACH FOOT OF DEPTH (UNITED STATES GALLONS) FROM TWO TO FORTY FEET IN DIAMETER.

CAPACITY OF DRAIN-PIPE.

SIZE OF PIPE.	GALLONS PER MINUTE.							
	½ in. Fall per 100 feet.	3-in. Fall per 100 feet.	6-in. Fall per 100 feet.	9-in. Fall per 100 feet.	12-in. Fall per 100 feet.	18-in. Fall per 100 feet.	24-in. Fall per 100 feet.	36-in. Fall per 100 feet.
3-inch.	21	30	42	52	60	74	85	104
4 "	36	52	76	92	108	132	148	184
6 "	84	120	169	206	240	294	338	414
9 "	232	330	470	570	660	810	930	1140
12 "	470	680	960	1160	1360	1670	1920	2350
15 "	830	1180	1680	2040	2370	2920	3340	4100
18 "	1300	1850	2630	3200	3740	4600	5270	6470
20 "	1760	2450	3450	4180	4860	5980	6850	8410

For square or rectangular tanks, multiply the length and breadth and depth together to get cubic feet, then multiply by 1,728 to get cubic inches, and

Diameter in feet	Gallons	Pounds	Diameter in feet	Gallons	Pounds
2.0	23.5	196	9.0	475.9	3,968
2.5	36.7	306	9.5	530.2	4,421
3.0	52.9	441	10.0	587.5	4.899
3.5	72.0	600	11.0	710.9	5.928
4.0	94.0	784	12.0	846.0	7.054
4.5	119.0	992	13.0	992.9	8.280
5.0	146.9	1,225	14.0	1,151.5	9,602
5.5	177.7	1.482	15.0	1,321.9	11,023
6.0	211.5	1.764	20.0	2,350.1	19.596
6.5	248.2	2,070	25.0	3,672.0	30,620
7.0	287.9	2,401	30.0	5,287.7	44,093
7.5	330.5	2,756	35.0	7,197.1	60,016
8.0	376.0	3,135	40.0	9,400.3	78,388
8.5	424.5	3,540	.....	....	.....

this product, divided by 231, the number of cubic inches in a gallon, will give the number of gallons.

QUANTITY OF WATER DISCHARGED PER STROKE BY A SINGLE ACTING PUMP.

The first column of figures indicates the diameter of the pump cylinder in inches. The second column gives the area of the cylinder.

Diam. of Cyl. Ins.	Area Square Inches	LENGTH OF STROKE IN INCHES											
		2	3	4	5	6	7	8	9	10	12	14	15
		Capacity per Stroke in Gallons											
½	196	.0017	0026	.0034	004	.005	006	.007	.008	.009	.010	.012	.013
1	.785	.0070	.0100	.0140	017	.020	.024	.027	.031	.034	.041	.048	.051
1¼	1.227	.0100	.0160	.0210	.027	.032	.037	.042	.048	.053	.064	.074	.080
1⅜	1 485	.0130	.0190	.0250	032	.038	.044	.051	058	.064	.077	.089	.096
1½	1 767	.0150	0230	.0310	038	.048	.053	.061	.069	.077	.092	.107	.115
1¾	2 405	.0210	.0310	.0410	.052	.063	.073	.083	.094	.104	.125	.148	.156
2	3.142	0270	.0410	.0540	.068	.082	.095	.109	.122	.136	.163	.190	.204
2¼	3.976	.0340	.0510	.0690	.086	.103	.120	.138	.155	.172	.206	.241	.258
2½	4 909	.0420	.0640	.0850	.106	.128	.149	.170	.191	.213	.255	.297	.319
2¾	5.940	.0610	.0770	.1030	.128	.154	.180	.206	.231	.257	.308	.360	.385
3	7.069	.0610	.0920	.1220	.153	.184	.214	.245	.275	.306	.367	.428	.459
3¼	8.296	.0720	.1080	.1430	.180	.215	.251	.287	.323	.359	.431	.503	.538
3¾	11 045	.0950	.1430	.1910	.239	.287	.334	.382	.430	.478	.573	.669	.717
4	12 566	.1090	.1630	.2170	.272	.326	.381	.435	.490	.544	.653	.761	.816
4¼	14 186	.1230	.1840	.2450	.307	.368	.430	.491	.552	.614	.737	.860	.921
4¾	17 721	.1530	.2300	.3070	.383	.460	.537	.614	.690	.767	.920	1.073	1.150
5	19 635	.1700	.2550	.3400	.425	.510	.595	.680	.765	.850	1.020	1.190	1.275
5¼	21.648	.1870	.2810	.3750	.468	.562	.656	.750	843	.937	1 124	1.311	1.405
5¾	25 967	.2250	.3370	.4500	.562	.674	.787	.899	1.011	1 124	1.348	1.573	1.686
6	28 274	.2450	.3670	.4900	.612	.734	.857	.979	1.101	1 224	1.469	1.713	1.836
6¼	30.680	.2660	.3980	.5310	.664	.797	.930	1.062	1.195	1.328	1 593	1.859	1.992
6¾	35 785	.3100	.4650	.6200	.774	.929	1 084	1.239	1 394	1.549	1.858	2 168	2.323
7	38 485	3330	.5000	.6660	.833	1.000	1.166	1.333	1.499	1 666	1 999	2.332	2 499
7½	44.179	.3830	.5740	.7650	.956	1.148	1.339	1.530	1.721	1.913	2 295	2.678	2.869
7¾	47.173	.4080	.6120	.8170	1.021	1.225	1 429	1.633	1 837	2.042	2 450	2 858	3 063
8	50 266	.4350	.6530	.8700	1.088	1 306	1.523	1.741	1.958	2 178	2 611	3.046	3 264
8½	56.745	.4900	.7350	.9800	1.225	1.470	1.715	1 960	2.205	2.450	2 940	3 430	3.675
9	63 617	.5510	.8260	1.1010	1 377	1.652	1 928	2.203	2.478	2 754	3.305	3.855	4.131
9½	70.882	6120	.9180	1 2240	1.530	1 830	2 142	2 448	2 754	3.060	3 672	4 284	4 590
10	78.540	.6800	1 0200	1 3600	1.700	2 040	2.380	2 720	3 060	3 400	4.080	4.760	5.100
11	95.033	.8230	1 2340	1 6450	2.057	2.484	2.879	3.291	3.726	4.114	4 937	5.760	6 171
12	113.098	.9790	1.4680	1.9580	2 418	2.938	3.422	3 917	4.408	4.896	5.875	6 854	7.344

For strokes, two, three or any number of times the lengths given above, the capacities may be found by simply multiplying the number of times, into the quantities per stroke given above. Doubling the diameter of pipe or cylinder increases its capacity four times.

QUANTITY OF WATER DICHARGED AND POWER REQUIRED

At different elevations based on a Pump efficiency of 50 per cent.

Lift in feet	½ H. P.	1 H. P.	3 H. P.	5 H. P.	7 H. P.	10 H. P.	15 H. P.	20 H. P.	30 H. P.	40 H. P.	50 H. P.
	GALLONS PER MINUTE										
10	100	200	600	1000	1400	2000	3000	4000	6000	8000	10000
20	50	100	300	500	700	1000	1500	2000	3000	4000	5000
30	33	66	200	333	466	666	1000	1333	2000	2666	3333
40	25	50	150	250	350	500	750	1000	1500	2000	2500
50	20	40	120	200	280	400	600	800	1200	1600	2000
60	16	33	100	166	233	333	500	666	1000	1332	1666
70	14	28	85	140	200	286	420	572	850	1144	1428
80	12	25	75	125	175	250	375	500	750	1000	1250
90	....	22	66	111	155	222	333	444	666	888	1111
100	....	20	60	100	140	200	300	400	600	800	1000
125	....	....	48	80	112	160	240	320	480	640	800
150	....	....	40	66	93	133	200	266	400	532	666
175	....	....	34	57	80	114	171	228	343	456	572
200	....	....	30	50	70	100	150	200	300	400	500
250	....	....	....	40	56	80	120	160	240	320	400
300	....	....	....	33	46	66	100	133	200	266	333
350	....	....	....	28	40	57	85	114	171	228	285

Doubling the lift or quantity of water handled also doubles power required; *i. e,* power required varies directly as either lift or quantity.

HEAD OF WATER IN FEET AND THE EQUIVALENT PRESSURE IN POUNDS — PRESSURE OF WATER IN POUNDS AND THE EQUIVALENT HEAD IN FEET

Feet Head	Lbs. Press.	Feet Head	Lbs. Press.	Feet Head	Lbs. Press.	Lbs. Press.	Feet Head	Lbs. Press.	Feet Head	Lbs. Press.	Feet Head
5	2.17	70	30.3	200	86.6	5	11.5	70	161.6	180	415.6
10	4.33	80	34.6	250	108.2	10	23.0	80	184.7	190	438.9
15	6.50	90	39.0	300	129.9	15	34.6	90	207.8	200	461.7
20	8.66	100	43.3	350	151.5	20	46.2	100	230.9	225	519.5
25	10.83	110	47.6	400	173.2	25	57.7	110	253.9	250	577.2
30	12.99	120	52.0	500	216.6	30	69.3	120	277.0	275	643.0
35	15.16	130	56.3	600	259.8	35	80.8	130	300.1	300	692.7
40	17.32	140	60.6	700	303.1	40	92.3	140	323.2	325	750.4
45	19.49	150	65.0	800	346.4	45	103.9	150	346.3	350	808.1
50	21.65	160	69.2	900	389.7	50	115.4	160	369.1	400	922.6
60	26.09	180	78.0	1000	433.0	60	138.5	170	392.5	500	1154.5

TABLE FOR OPEN WEIR MEASUREMENT

Giving Cubic Feet of water per minute, that will flow over an open Weir one inch wide and from ⅛ to 20⅞ inches deep.

INCHES.		⅛	¼	⅜	½	⅝	¾	⅞
0	.00	.01	.05	.09	.14	.19	.26	.32
1	.40	.47	.55	.64	.73	.82	.92	1.02
2	1.13	1.23	1.35	1.46	1.58	1.70	1.82	1.95
3	2.07	2.21	2.34	2.48	2.61	2.76	2.90	3.05
4	3.20	3.35	3.50	3.66	3.81	3.97	4.14	4.30
5	4.47	4.64	4.81	4.98	5.15	5.33	5.51	5.69
6	5.87	6.06	6.25	6.44	6.62	6.82	7.01	7.21
7	7.40	7.60	7.80	8.01	8.21	8.42	8.63	8.83
8	9.05	9.26	9.47	9.69	9.91	10.13	10.35	10.57
9	10.80	11.02	11.25	11.48	11.71	11.94	12.17	12.41
10	12.64	12.88	13.12	13.36	13.60	13.85	14.09	14.34
11	14.59	14.84	15.09	15.34	15.59	15.85	16.11	16.36
12	16.62	16.88	17.15	17.41	17.67	17.94	18.21	18.47
13	18.74	19.01	19.29	19.56	19.84	20.11	20.39	20.67
14	20.95	21.23	21.51	21.80	22.08	22.37	22.65	22.94
15	23.23	23.52	23.82	24.11	24.40	24.70	25.00	25.30
16	25.60	25.90	26.20	26.50	26.80	27.11	27.42	27.72
17	28.03	28.34	28.65	28.97	29.28	29.59	29.91	30.22
18	30.54	30.86	31.18	31.50	31.82	32.15	32.47	32.80
19	33.12	33.45	33.78	34.11	34.44	34.77	35.10	35.44
20	35.77	36.11	36.45	36.78	37.12	37.46	37.80	38.15

In making Weir measurements, place a board or plank in the stream at the point so that a pond will form above it. A rectangular notch is cut in it large enough so that all the water will flow over the notch. The length of the notch should be from two to four times its depth. The edges should be beveled to slope outward in the direction of the flow of the water. In the pond about six feet above the Weir a stake is driven so that its top is precisely level with the bottom of the notch, and at some convenient point for measuring. The depth of the water flowing over the Weir may then be ascertained by an ordinary rule, placed on top of the stake, measuring to the surface of the water, and the quantity figured from the table above.

IRRIGATION QUANTITY TABLES

Amount of water required to cover one acre to given depths.			Second Feet reduced to Gallons and Acre Feet.				Gallons required to cover a given number of acres to a depth of one foot. (Acre foot.)	
Depth in inches and feet. (Acre inches and acre feet.)	Cubic feet (or second feet) contained in one acre to depths given in first column.	Gallons.	Second feet.	Gallons per minute.	Gallons per pumping day of 12 hours.	Acre feet per pumping day of 12 hours.	Acres (or number of acre feet.)	Gallons.
1 in.	3630	27154	¼	112.2	80790	2479	1	325851
2 in.	7260	54309	½	224.4	161579	4959	2	651703
3 in.	10890	81463	¾	336.6	242369	7438	3	977554
4 in.	14520	108617	1	448.8	323158	9917	4	1303406
5 in.	18150	135771	1¼	561.0	403948	1.2397	5	1629257
6 in.	21780	162926	1½	673.2	484738	1.4876	6	1955109
7 in.	25110	190080	1¾	785.5	565527	1.7355	7	2280960
8 in.	29040	217234	2	897.7	646317	1.9835	8	2606812
9 in.	32670	244389	2½	1122.1	807896	2.4793	9	2932663
10 in.	36300	271542	3	1346.5	969475	2.9752	10	3258515
11 in.	39930	298697	4	1795.3	1292634	3.9669	15	4887772
1 ft., 00 in.	43560	325851	5	2244.2	1615792	4.9586	20	6512029
1 ft., 2 in.	50820	380160	6	2693.0	1938951	5.9503	25	8146286
1 ft., 4 in.	58080	434469	7	3141.8	2262109	6.9421	30	9775544
1 ft., 6 in.	65340	488777	8	3590.6	2585268	7.9338	40	13034058
1 ft., 8 in.	72600	543086	9	4039.5	2908426	8.9255	60	19551087
1 ft., 10 in.	79860	597394	10	4488.3	3231585	9.9173	80	26068116
2 ft., 00 in.	87120	651703	20	8976.6	6463170	19.8345	160	52136232

One cubic foot of water per second (exact 7.48052 gallons), constant flow is known as the "Second Foot." The "Acre Foot" is the quantity of water required to cover one acre to a depth of one foot.

MISCELLANEOUS HYDRAULIC INFORMATION, ETC.

A common water pail holds nineteen pounds of water, or 2.272 United States gallons.

One horse-power will raise 16½ tons per minute a height of 12 inches, working 8 hours a day. This is about 9.900 foot-tons daily, or 12 times a man's work.

In Designing Hydraulic and Pumping Machinery, water is considered as incompressible.

"Head"—By "Head" is meant the actual elevation from the surface of suction water to highest point of discharge, plus the friction head, caused by flow of water through suction and discharge piping—often referred to simply as "lift" or "suction lift" and "discharge lift."

"Pressure"—To find the pressure due to the head, when water is at rest simply multiply the vertical height in feet, of the column of water, by .434. A quicker way to approximate is to divide the vertical height in feet by 2. The result is the pressure in pounds per square inch on retaining walls at bottom of water column, or plunger load.

A Double-Acting Pump discharges water on both forward and backward motions of piston, and has double the capacity of a Single-acting Pump.

A Triplex Pump is a three-cylinder Pump. The Cylinders are either Single or Double-acting. The discharge of a Triplex Pump is practically uniform and without pulsation.

To Find the Circumference of a Circle: Multiply the diameter by 3.1416.

Finding Capacities:—Of a Single-acting Pump: Multiply the square of the Cylinder diameter in inches by .7854, and by the length of stroke in inches. This product divided by 231 gives the capacity in gallons per stroke. Doubling the diameter of a Cylinder increases its capacity four times.

To find the number of gallons in a tank, multiply the inside bottom diameter in inches by the inside top diameter in inches, then this product by 34, point off four figures, and the result will be the average number of gallons to one inch in depth of tank.

For the circumference of a circle, multiply the diameter by 3.1416.

For the diameter of a circle, multiply the circumference by .31381.

For the area of a circle, multiply the square of the diameter by .7854.

For the size of an equal square, multiply the diameter by .8862.

For the surface of a ball, multiply the square of the diameter by 3.1416.

For the cubic inches in a ball, multiply the cube of the diameter by .5236.

SHORT FORMULAS FOR PUMP CAPACITY AND POWER

D—Diameter of Pump Cylinder in inches. S—Length of stroke in inches.
N—Number of strokes per minute. Q—Quantity of water in gallons, raised per minute.
H—Total height, in feet, water is elevated, figuring from surface of suction water to highest point of discharge.

THEN WE HAVE

$D^2 \times .7854$ —The Area of a Circle (or Cylinder) of given diameter.

$D^2 \times S \times .7854$ —Capacity of Pump in cubic inches, per stroke.

$\frac{D^2 \times S}{294}$ —Capacity of Pump per stroke in gallons.

$\frac{D^2 \times S}{2200.152}$ —Capacity of Pump per stroke in cubic feet.

$\frac{D^2 \times S}{35.266}$ —Capacity of Pump per stroke in pounds of water.

$D^2 \times S \times .7854 \times N$ —Capacity of Pump per minute in cubic inches.

$\frac{D^2 \times S \times N}{294}$ —Capacity of Pump per minute in gallons, (— Q).

$\frac{D^2 \times S \times N}{2200.152}$ —Capacity of Pump per minute in cubic feet.

$D^2 \times H \times .3409$ —Total pressure in pounds on the Pump Cylinder when at rest. When at work, add for pipe friction as determined from tables elsewhere.

$\frac{Q}{D^2 \times S \times .0034}$ —Number of strokes per minute necessary to raise a given quantity of water in gallons.

The above formulas will give results correct to the third decimal place.

HOW TO USE CEMENT.

The following general rules referring to the practical use of cement will be found convenient for reference:

Quality of Sand—The sand should be clean, sharp and coarse. When the sand is mixed with loam the mortar will set comparatively slow, and the work will be comparatively weak. Fine sand, and especially water-worn sand, delays the setting of the cement, and deteriorates strength. Damp sand should not be mixed with dry cement, but the cement and sand should be mixed thoroughly and uniformly together, when both are dry, and no water should be applied until immediately before the mortar is wanted for use.

Proportion of Sand—The larger the proportion of cement the stronger the work. One part of good cement to two parts sand is allowable for ordinary work; but for cisterns, cellars, and work requiring special care, half and half is the better proportion. For floors, the cement should be increased toward the surface.

Water in Concrete—Use no more water in cement than absolutely necessary. Cement requires but a very small quantity of water in crystalizing. Merely dampening the material gives the best results. Any water in excess necessarily evaporates and leaves the hardened cement comparatively weak and porous.

Concrete In Water—Whenever concrete is used under water, care must be taken that the water is still. So say all English and American authorities. In laying cellar floors, or constructing cisterns or similar work, care must also be taken to avoid *pressure of exterior water*. Cement will not crystalize when disturbed by the force of currents, or pressure of water, but will resist currents and pressure after hardening only. In still water, good cement will harden quicker than in air, and when kept in water will be stronger than when kept in air. Cements which harden especially quick in air are usually slow or worthless in water.

How to Put Down Concrete—When strong work is wanted, for cellar floors and all similar work, the concrete should be dampened and tamped down to place, with the back of a spade, or better, with the end of a plank or rammer; then finished off with a trowel, thus leveling and compacting the work. Only persons ignorant of the business will lay a floor or walk with soft cement mortar. All artificial stone is made in a similar way to that described, and, when set, is strong and hard as stone.

Delay In Use—Do not permit the mortar to exhaust its setting properties by delaying its use when ready. Inferior cements only will remain standing in the mortar-bed any length of time without serious injury.

Stone and Brick Work—In buildings constructed of stone or brick, the best protection from dampness and decay, and also from the danger of cyclones, is a mortar of cement and coarse sand. The extra cost is inconsiderable, and the increased value of the structure very great. Chimneys laid in this manner never blow down, and cellars whose foundations are thus laid are always free from atmospheric moisture. Cement may also be mixed with lime mortar for plastering and other purposes, to great advantage.

Effect of Frost and Cold—At a temperature less than 60 degrees Fahrenheit, all good cement sets slowly, though surely, but if allowed to freeze its value is seriously impaired. In cold weather or cold water do not fear to wait for your concrete to crystalize.

Damage from Moisture—Good cement is not injured by age, if carefully preserved from moisture. Lumps in bags or barrels of cement are caused by exposure to moisture. They prove the originally good quality of the cement.

WEATHER FORECASTS.

Almanac predictions can be nothing but conjecture, the earth's subjection to many unknowable and undeterminable forces rendering such calculations impossible. It is practicable, however, by the following rules, drawn from actual results during very many years and applled with due regard to the subjects of solar and lunar attraction with reference to this planet, to foresee the kind of weather *most likely* to follow the moon's change of phase.

PROGNOSTICATIONS.

If New Moon First Qr., Full Moon or Last Qr. happens	In Summer	In Winter.
Between midnight and 2 A.M.	Fair	Frost, unless wind is S. W.
" 2 " 4 "	Cold and showers.....	Snow aud stormy.
" 4 " 6 "	Rain..................	Rain.
" 6 " 8 "	Wind and rain........	Stormy.
" 8 " 10 "	Changeable	Cold rain if wind W., snow if E.
" 10 " 12 "	Frequent showers.....	Cold and high wind.
" 12 " 2 P.M.	Very rainy	Snow or rain.
" 2 " 4 "	Changeable	Fair and mild.
" 4 " 6 "	Fair..................	Fair.
" 6 " 8 "	Fair if wind N. W	Fair and frosty if wind N. or N. E.
" 8 " 10 "	Rainy if S. or S. W...	Rain or snow if S. or S. W.
" 10 " midn't.	Fair..................	Fair and frosty.

OBSERVATIONS.—1, The nearer the moon's change, first quarter, full and last uarter *to midnight*, the fairer will be the weather during the next seven days.

2. The space for this calculation occupies from ten at night till two next morning.

3. The nearer to *midday* or *noon* the phase of the moon happens, the more foul or wet weather may be expected during the next seven days

4. The space for this calculation occupies from ten in the forenoon to two in the afternoon. These observations refer principally to summer, though they affect spring and autumn in the same ratio.

5. The moon's change, first quarter, full and last quarter happening during six of the afternoon hours, *i. e.*, from four to ten, may be followed by fair weather, but this is mostly dependent on the *wind* as is noted in the table.

6. Though the weather, from a variety of irregular causes is more uncertain in the latter part of autumn, the whole of winter and the beginning of spring, yet, in the main, the above observations will apply to these periods also.

7. To prognosticate correctly, especially in those cases where the *wind* is concerned, the observer should he within sight of a *vane* where the four cardlual points of the compass are correctly placed

POWER REQUIRED TO RAISE WATER: To find the Theoretical Horse Power to raise water, multiply the Gallons pumped per Minute by the Head in feet and divide the product by 4000 and the result will be the Theoretical Power required. Double the Theoretical Power should be allowed to do the work, although the better grades of Steam and Power Pumps use much less than this.

DUTY OF PUMPING ENGINES is a ratio of the work done by the Pump to the Steam or Fuel consumed, and is usually expressed in millions of foot-pounds per 1000 pounds of steam used

THE PIPING OF PUMPS is a much more important matter than is commonly thought.

SUCTION PIPES should be short and straight as possible, of ample size and arranged to have no "pockets" where air can collect, and must be made up absolutely air-tight. Long Suctions or High Lifts should always have a Vacuum Chamber at the Pump.

DISCHARGE PIPES should be as large and as straight as possible, to avoid loss of power in overcoming the friction. The friction through one common Elbow is equal to that through 50 feet of straight pipe.

Complete tables for Suction and Discharge Pipe losses are on the pages following. See page 297 for further data on arrangements of piping for Steam Pumps, and pages 274 and 275 for information concerning Centrifugal Pumps.

A MINER'S INCH of water is the volume flowing per minute through a square inch of opening under a fixed head—usually 6 inches, and varies from 10 to 12 gallons per minute. The only legal "Miner's Inch" we know of in the United States is the Idaho inch, which is the amount of water flowing through an opening one inch square under a four-inch pressure or head of water above the center of opening

TO FIND THE SPEED OR SIZE OF PULLEYS:

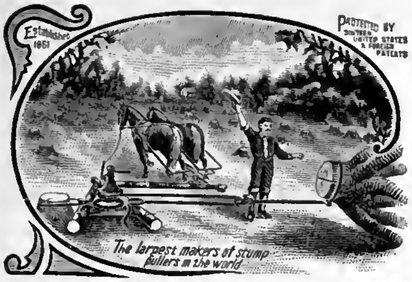
To find the Diameter of the driving pulley: Multiply the diameter of the driven pulley by its speed and divide the product by the speed of the driving pulley.

To find the Speed of the driving pulley: Multiply the diameter of the driven pulley by its speed and divide the product by the diameter of the driving pulley.

To find the Diameter of the driven pulley: Multiply the diameter of the driving pulley by its speed and divide the product by the speed of the driven pulley.

To find the Speed of the driven pulley: Multiply the diameter of the driving pulley by its speed and divide the product by the diameter of the driven pulley.

SPEED OF GEARING is estimated in same way, substituting the *number of gear teeth* for "diameter"



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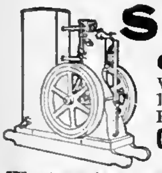

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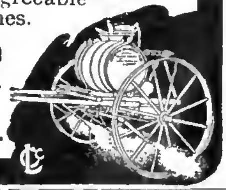

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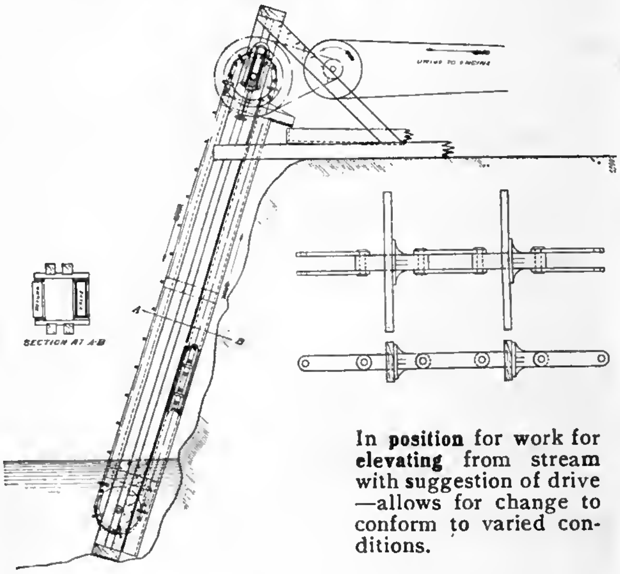

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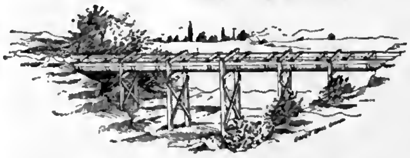

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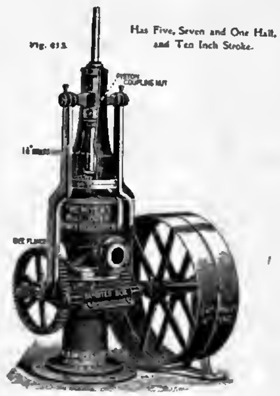

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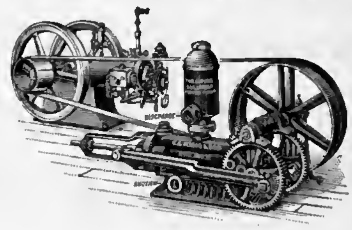

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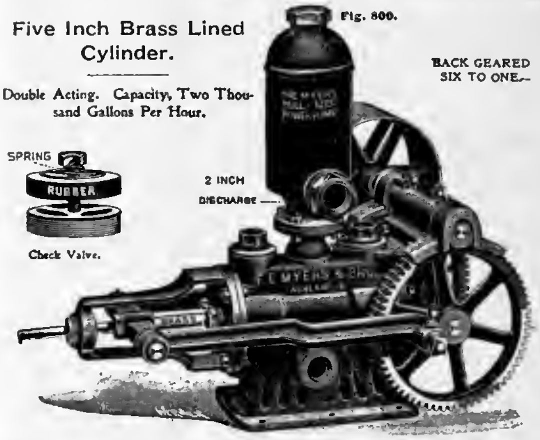

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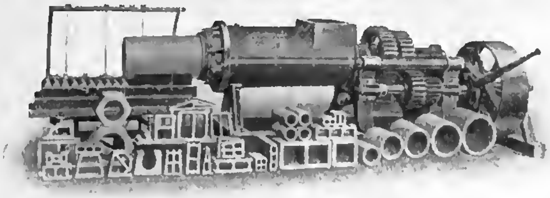

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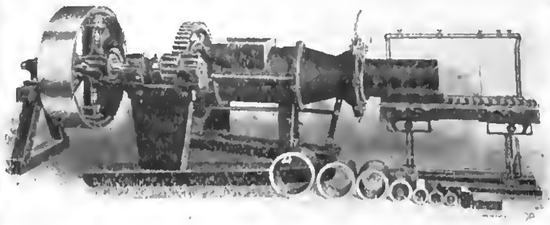

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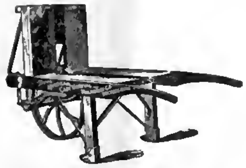

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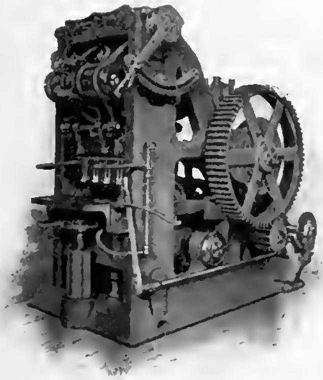

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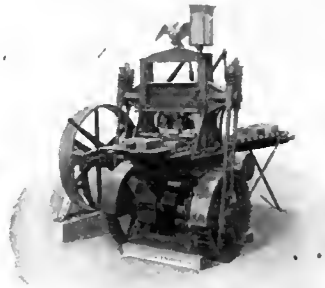

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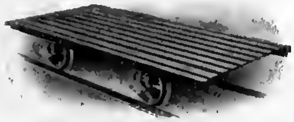

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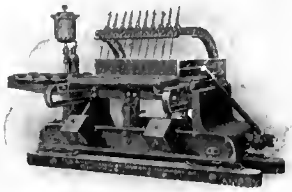

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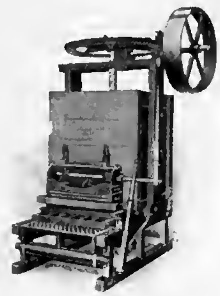

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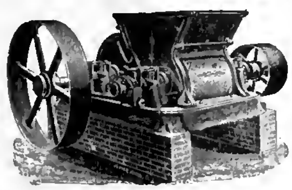

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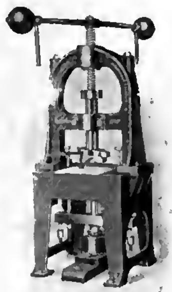

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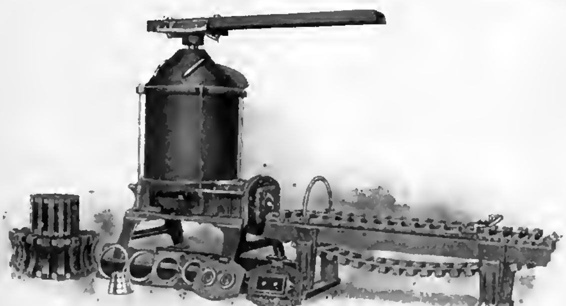

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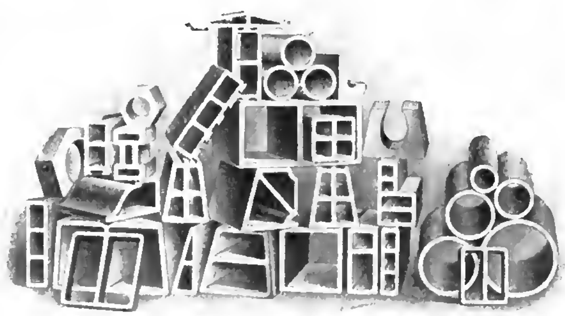

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THE IRRIGATION AGE

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APRIL, 1905.

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ESTABLISHED 1879

CHARLES A. COX CHGO.

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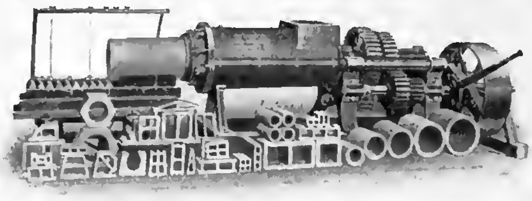

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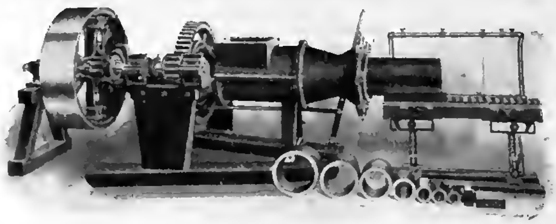

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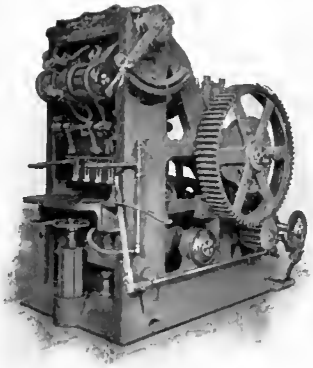

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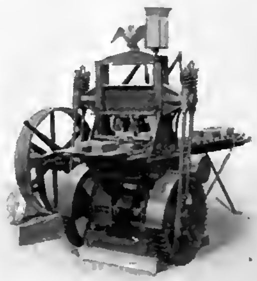

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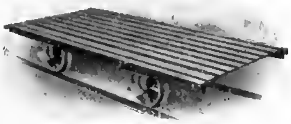

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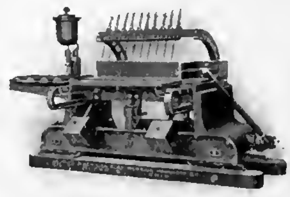

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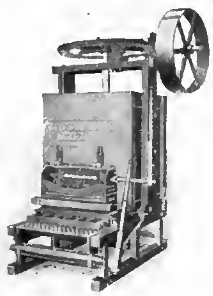

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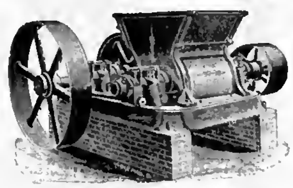

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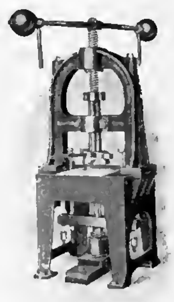

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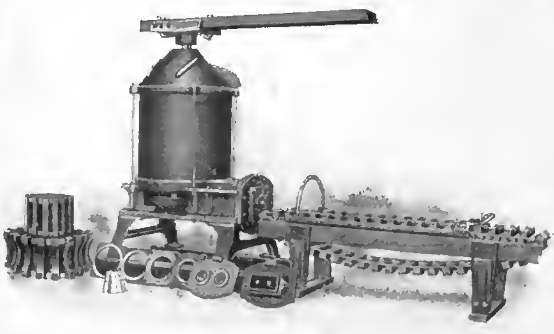

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THE IRRIGATION AGE

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THE IRRIGATION AGE

With which is Merged

MODERN IRRIGATION, THE IRRIGATION ERA, ARID AMERICA, THE DRAINAGE JOURNAL, MID-WEST, THE FARM HERALD

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

Are Courts Competent? Courts are not competent, as a rule, to regulate the use of water by defining the basic principles upon which irrigation law should be founded. Irrigation is a science; the principles upon which good irrigation law should be built are defined by facts—not technicalities of law or mistakes of other courts. If the courts have the power to alter such principles, they should have the power to change the laws which govern the flow of water, since the latter in a large measure affects the applicability of the former. The flow of water is based fundamentally on the laws of falling bodies and the courts would in many cases find it necessary to modify these. After having disarranged so much scientific law it would be a simple matter to regulate the revolutions of the earth and appeal for authority to extend jurisdiction beyond. The question is where shall the laws of man and of nature compromise. All compromises thus far made have been in favor of those promulgated by man and naturally to the detriment of men.

Thanks. THE AGE wishes to thank those who have furnished information relating to the "Influences in the National Irrigation Program," which made possible the preparation of the paper dealing with this most important subject. Former members of the National Irrigation Association have provided most of the valuable material put at our disposal. State officers, irrigation engineers, irrigation organizations and the papers of the West have all been of service. We are glad to see that with the exception of a few of these papers Mr. Maxwell's propaganda has no support from this source at the present time. We have received copies of resolutions from a number of State legislatures which condemn Mr. Maxwell's theories openly or by implication. We wish to thank correspondents of western papers at Washington who have thrown light on the coöperation Mr. Maxwell has been able to secure there.

It was our original intention to simply make public the character of the campaign conducted by the National Irrigation Association, but much has developed since THE AGE first became interested in the matter and it is believed that a plain statement of the truth as to the character of the support which the organization has been able to draft can do nothing but good. We wish to say that our support goes to any officer of State or nation who indicates by public or private speech or published reports that he considers first the interests of the irrigator rather than those of the corporation. More might be said relative to Mr. Maxwell's record, but we feel that enough has been published to convince those open to conviction that he does not merit the encouragement he has received from Government officials in Washington.

Business Men in Charge. It is our impression that President Roosevelt is inclined to put business men in charge of such work as the Panama Canal and the building of the great irrigation reservoirs and projects throughout the West. He has, we are told, offered the position of chief of the Panama Canal to Mr. T. P. Shonts, formerly president of the Clover Leaf Route, and we understand that he is looking around for a suitable head for the reclamation service. This latter is very gratifying news to those who watched development along this line of work. Mr. Shonts is an engineer but he is also a better administrative officer and business man. This makes a good combination for the exalted position which he is to fill. THE IRRIGATION AGE is not in favor of putting work of this character under a business man who knows nothing of engineering, particularly a lawyer. It has very little use for the legal profession in positions of this character. A man whose business it is to work for the side that can pay the most, regardless of the effect upon the people at large, gradually develops theories and prejudices which in every day practice tends to retard all kinds of reform movements. It is sincerely hoped that President Roosevelt may be able to find a man fully capable to head the reclamation service. The position requires a man broad enough to listen to others and act upon that which is good regardless of his personal prejudices or inclination. No man should fill this position who is so narrow as to assume that no opinion is valuable excepting his own.

This irrigation subject will evolve itself into a concrete and cleanly developing condition later on. Perhaps a club or fire will be necessary to purify present conditions.

Model Irrigation Code.

The preparation of a model code of state irrigation laws by the reclamation service was probably a wise step. The model, as it stands, contains many important and good provisions and by slight modifications it can be made to meet the requirements of almost any district in the West. Its provisions will be incorporated in the statutes of a number of States and Territories this year. The laws of the various States will in this way more nearly approach uniformity, and while the model code reserves many rights to the Government which have not been conceded generally heretofore, yet with the proper kind of adminstration of the reclamation service, nothing but good should result. The code recognizes many of the more important principles which experience has shown should govern the distribution and use of water. We hope that through this influence on the part of the Government the irrigator will receive better protection than he has in the past. Litigation over water rights has been a fruitful source of income to the lawyer and a burden to the irrigator. As the irrigator has a comparatively small part in the making of laws it is rarely that he secures relief through the passage of reform measures.

Even the courts disagree where fundamental yet simple principles are at stake. When the supreme courts of two adjoining States having practically the same statutory provisions relating to irrigation, hand down decisions diametrically opposed to each other, it is time that the Government or some other influence is felt. We have two recent supreme court decisions before us which illustrate this point. Nebraska adopted the Wyoming law without material change in 1895. In June, 1904, the State Supreme Court of Nebraska handed down a decision which states that because the laws of that State are taken from Wyoming, where water is appurtenant to and inseparable from the lands irrigated, the same principle must be recognized in Nebraska. (Farmers' Canal Company vs. Frank.) On the last day of the same year the supreme court of Wyoming handed down a decision which holds water to be personal property to be sold like any commodity. (J. R. Johnston et al vs. the Little Horse Irrigation Company.) The former decision was rendered for the irrigator, the latter for the lawyer.

The principle of inseparability of water and the land it serves to irrigate is growing in favor and must soon be universally recognized. If the Government can settle for all time the recognition of such principles it will have performed a good service.

Reclamation Service Abuses.

We are publishing in this issue an article from the pen of one of our regular correspondents on the proposed St. Mary's River diversion canal. This correspondent shows conclusively that the Reclamation Bureau of the United States is weak and this article is well worthy of perusal by all those who are studying irrigation development under the reclamation law. In future issues it will be our aim to illustrate some of the abuses being carried on by officials of this bureau. As stated in former issues many complaints have come to us concerning the arbitrary high-handed manner in which officials of this department carry out their designs regardless of the effect upon the promoters of private projects throughout the West. Well founded and reasonable complaints come to us regularly from many of the western States and these complaints are no doubt also being forwarded to the Secretary of the Interior at Washington, who, it is hoped, may thoroughly investigate all of them so that every legitimate private irrigation project may be accorded fair play. Word comes to us that many of the division engineers pose as absolute dictators where complaints are brought to them personally. In fact, we are told that they wholly ignore reasonable complaints by people who are trying to carry out irrigation projects with private capital. There seems to be a tendency on the part of the press throughout the West to accept all statements made by these gentlemen as law, hence it is difficult for the private individual to secure attention or redress for wrongs committed. This is a pitiable state of affairs, to be sure. There are men who have charge of irrigation districts under the reclamation service who are not competent to conduct an ordinarily successful grocery business. While this may seem a peculiar comparison it is nevertheless applicable from the fact that a man to be broad enough should first be capable of conducting some moderate commercial enterprise for himself, hence our remark that a goodly number of the men who are controlling the expenditure of millions of Government money would be absolute failures in conducting some mediocre commercial enterprise for themselves.

There is no question but that when these facts are brought to the attention of the President and the Secretary of the Interior an investigation will be made in certain cases which will relieve the department of men of this class. The unfortunate feature in the case is, however, that such information may be long delayed in reaching the proper authorities and much damage will result meanwhile, not only to the Government itself and the cause of irrigation under government aid, but to many legitimate private irrigation projects as well.

THE IRRIGATION AGE is well aware of the fact that many good men are to be found in the reclamation service, men who are conscientious and painstaking, who are desirous of performing good work for the Government and who are not made drunk by ambition or unjustified value of their ability or services. These men are a credit to the department and it is, moreover, a pity that they are frequently misjudged as a result of the actions of their superiors and co-workers.

MAXWELL'S HIRELINGS.

As an illustration of the audacity of the active heads of the National Irrigation Association, and the interference of the paid representatives of this association with State affairs, we are reproducing herewith an article from the *Tacoma Ledger* of February 19th. The article is published in full in order that our readers may understand how active the few members of this association are in affairs in which they have no right to interfere. The article also shows plainly that the statements of this journal as to the association being a representative of the Reclamation Service, are quite true. It will be noted in the last paragraph that one of the paid representatives of the association states "it is composed of thousands of great business interests scattered over the country who are interested in pushing this irrigation work as far as possible." The fact of the matter is, that fully one-half of the manufacturers of the country who were induced to support the National Irrigation Association, withdrew this support as soon as they learned the character of the men at the head, and it is safe to say that fully eighty per cent of the original members have drawn entirely away from the association.

In view of these facts does it not appear audacious for Mr. Maxwell and his hirelings to go about the country posing as representatives of the Government while its only means of existence is through the contributions of such individuals as may be secured by such articles as the following. Some day the people in the west will awake to a realization of the fact that they have paid out money without a possibility of either direct or indirect returns.

"A. W. Hadley, traveling representative of the National Irrigation Association, Chicago, and Secretary C. E. Bortle, of the northwest section, National Association, of Spokane, were in the city yesterday conferring with Tacoma business interests regarding irrigation matters. They are en route to Olympia, where they will spend several days in securing support of a bill to be introduced in the present session of the legislature, authorizing appropriations for topographic and hydrographic surveys in co-operation with the Government work of this nature.

"An appropriation of $25,000 will probably be asked for, and if the same is secured, the Federal Government will make a like appropriation. This proposed $50,000 will be used in carrying out surveys over the entire State with a view, for the present, of investigating the sections suitable for irrigation and in this way pave the way and facilitate the work of the Federal Reclamation Service.

TIME FOR STATE TO GET IN LINE.

"When seen yesterday regarding their visit to the capital, Messrs. Hadley and Bortle stated:

"'It is high time for the State of Washington to get into line with her sister States and Territories and secure the co-operation of Government surveys which have been carried out for a number of years in almost all other sections.

"'Washington is far in the rear as regards national reclamation, and the only thing that has placed other States to the fore is the fact that the people of other sections have become awakened to the great benefits it is possible to realize from the provisions of the reclamation act and have therefore put forth every effort to facilitate the investigations which are necessary before actual results can be accomplished.

"'California, we understand, has just appropriated $60,000 for the second time, to be used in carrying on topographic work in conjunction with the Government, and to this activity can be traced, beyond doubt, the recent appropriation of $3,000,000 for the construction of the great Colorado River irrigation project.

WHAT ARIZONA HAS DONE.

"'Arizona has been interested in this work for years, and as a result an appropriation of $3,000,000 has been set aside for constructing the great Tonto basin dam and the necessary canal system, upon which there are already more than 2,000 men actually engaged at this time. It should be borne in mind in connection with this fact, that there has accrued from the sale of Government lands to the national reclamation fund from Arizona but a paltry $166,000, while from the State of Washington there has accrued more than $3,000,000; yet not a shovel of earth has as yet been turned within the boundaries of the State.

"'The National Irrigation Association is composed of thousands of great business interests scattered over the country, who are interested in pushing this irrigation work along as rapidly as possible, for it means increased productive acreage which, in turn, means increased population and trade field. This is one of the ways in which it is trying to facilitate matters and if Tacoma would realize the attendant benefits to be derived from a possible doubling of the population of the State within the next very few years as a result of quadrupling the productive acreage and the enormous influx of settlers which will surely follow, then it is a matter 'up' to every business man in the city to take hold of and 'see it through' with all speed.'"

ST. MARY'S RIVER PROPOSED DIVERSION CANAL.

A Review of the Manner in which the U. S. Reclamation Service, from Its Own Reports, has handled the Project.

BY E. W. H.

Senator T. H. Carter, of Montana, in addressing the Montana legislature on the occasion of his re-election to the United States senate, said, among other things:

"I am not satisfied with what has been done or is being done in the State of Montana in reclaiming the arid lands. I am not criticising, but in the beginning this great work has been turned over to a class of men whose business it is to sort rocks."

A review of what has been done by the United States Reclamation Service in connection with the proposed diversion canal from the St. Mary River to the Milk River, will not be without interest to those who, with Senator Carter, are not satisfied with the work being done in Montana and elsewhere in national irrigation work.

In 1901 Mr. Newell stated before the committee on public lands, house of representatives, that "in northern Montana the principal project is not a water storage plant."

Early in 1902, report No. 254 of the Senate committee on the reclamation of arid lands was published, in which detailed reference was made to "the proposed St. Mary diversion canal (which) is for taking water from St. Mary River in northern Montana, etc." No mention is made in this report of any storage reservoirs, and it is estimated that the probable cost of taking 1,200 cubic feet per second across the divide to the north fork of Milk River will be $686,000."

Later in 1902 a document was put in circulation entitled "A Condensed Statement Taken from the Report on the St. Mary Canal Project," the first sentence of which reads, "The St. Mary project is designed to store flood waters in the St. Mary lakes in northern Montana and conduct these easterly by a canal cut through the ridges at the head of Milk River."

This was the first mention of storage works. In the same report the character of the storage structures is briefly described:

"It is proposed to build a low storage dam at a point about three-fourths of a mile below the present outlet of Lower St. Mary Lake. This will have a maximum elevation of fifty feet above the bottom of the river and will form a reservoir of a capacity of 250,000 acre feet."

In the estimate of cost the following items are given:

Dam	$22,000
Tunnel at head	12,000
Headgates	10,000

It would be almost incredible that a dam half a mile long with a maximum height of fifty feet in the bed of a stream of the character of St. Mary River could be constructed for $22,000.

In the first annual report of the United States Reclamation Service from June 17 to December 1, 1902, from which it may be presumed "the condensed statement" was taken, especially as the reference to the dam at St. Mary lakes is in identically the same words, the first item in the "Estimated Cost of St. Mary Dam and Canal to North Fork of Milk River" is:

Dam and headgates $250.000

in place of the three items above quoted, aggregating $44,000, while every other item is identical with that in the "condensed statement," save that of engineering expenses, which is increased by 15 per cent of the difference in these two items—$206,000.

A dam that, in February, was estimated to cost $22,000 is placed in December at $228,000—over ten times as much.

In Senate report No. 254—1902—this statement is made:

"It is proposed to continue the canal to the south fork as it is not considered practicable for the Canadians to divert water at any point in Canada from the south fork or from Milk River."

In the "condensed statement," the following occurs:

"Milk River in Canada, from the junction of the north and south fork downstream, has a very slight fall—not more than two feet to the mile, and a canal of 100 miles or more in length would be necessary before the water could be brought to the upper branches. It is not, therefore, considered feasible to divert the waters from Milk River in Canada."

Note the precise statements, "Not more than two feet to the mile"—"A canal of 100 miles or more in length."

In the first report of the United States Reclamation Service, this subject is briefly referred to in the following words:

"If the waters are permitted to enter the north fork or the south fork, they will find their way into Canada before they can be used in the lower valley of Milk River but it is believed that they can not be diverted in Canada before they return to the United States."

In the second annual report of the United States Reclamation Service for the year 1903, the diversion of water from Milk River in Canada is referred to as follows:

"The second difficulty is that after St. Mary River has been turned into Milk River, water may be taken from the latter stream in Canada. Such a diversion is possible, and plans are now maturing for the construction of a canal diverting from the North side of Milk River in Canada, about twelve miles below the junction of north and south forks."

And that statement is followed by precise details of the dimensions of the canal, actual construction of which, it should be mentioned, was commenced early in November, 1903.

It has taken the Reclamation Service fully three years, through four separate reports, to progress from a position in which "it is not considered practicable for the Canadians to divert water from Milk River" by way of precise statements why it should be impracticable—the "very slight fall" of the river and a "canal of 100 miles or more in length" and the modifying belief—of which, perhaps, hope was the father—that "they (the waters of Milk River) can not be diverted in Canada before they return to the United States" to the unqualified assertion that "such diversion is possible" accompanied with detailed dimensions of the canal that is to make it possible but without allusion to the fall of the stream or the length of the canal.

The statement is made, however, that "the water is to supplement the irrigation system from St. Mary River above described, and will irrigate lands in the vicinity of Lethbridge, South Alberta," and it could have been added with equal truth and knowledge that the water will also irrigate lands in the Milk River drainage and that the Canadians can couple up their St. Mary and Milk River irrigation works in one extensive and comprehensive work, a fact which should be within the knowledge of the United States Reclamation Service, if it is not.

Reference has been made in the above paragraph to the Canadian irrigation system from St. Mary River. It will be found equally interesting to follow the attitude of the United States Reclamation Service on this feature.

It can not be considered as other than at least a peculiar omission that no reference is made to the fact that water was diverted from the St. Mary River in Canada in Senate report No. 254. The first mention of the fact is in the "condensed statement" and in the following extraordinary language:

"The water of the St. Mary River is not used in the United States, but in Canadian territory, seven miles north of the international line, is a canal completed in 1900. Between the site of the proposed dam at the foot of St. Mary lake and the head of the Canadian canal a considerable number of large streams discharge into St. Mary River, furnishing an ample supply for the land irrigated in Canada. It is not believed that any international complications can arise concerning water rights, since the water which it is proposed to store and divert occurs wholly within Montana, and it would be impossible for the Canadians to store and use this flood of water even if needed in their canal."

In the first annual report of the United States Reclamation Service to December, 1902, from which, as has been previously pointed out, it may be presumed the "condensed statement" was taken, there is not a word referring to Canadian appropriation of water from St. Mary River.

In the second annual report the following occurs:

"The first difficulty arises from the fact that there is already a canal in Canadian territory diverting water from the St. Mary River. This canal is located about seven miles north of the international boundary, and is owned by the Canadian North Western Irrigation Company. The total length of the canal system is 200 miles including laterals."

Then follow some details of dimensions, and

"With these dimensions, the capacity of the canal would be about 400 second feet. It is doubtful, however, if the canal, as at present constructed, can carry more than one-half of this quantity."

There are, in these few quotations, a really great number of statements that are merely stupid—that one is amazed to find in expert reports.

It is difficult to conceive what possible purpose could be served by the expression of belief that no international complication can arise concerning water rights, merely because the water "occurs wholly within Montana." The United States Reclamation Service knows better than that or else it knows nothing of irrigation law or of the previous actions of the United States Government in similar cases.

Recently the water consumers in the lower Milk River valley in Montana have circulated petitions to appeal to the President of the United States protesting against the diversion of water from the Milk River by the Canadians, in the course of which petition it is set forth that "the distribution of water from a stream is the same between nations as between individuals." Yet here is the very governmental bureau, created for the purpose of conducting this national irrigation work, declaring a diametrically opposed doctrine in another international stream not 100 miles removed! And, in the second annual report of the United States Reclamation Service, there is found the following declaration:

"To thoroughly settle the question of water diversion from St. Mary's River and Milk River, it will probably be necessary to come to some international agreement between this country and Canada."

Which, if it means anything, means that without some such agreement, international complications could arise! And that declaration is, doubtless, written by the same hand that penned that extraordinary pronouncement about the water occurring wholly in Montana.

There are, further, a series of bold assertions made that call for more than casual notice.

"Between the site of the proposed dam * * * and the head of the Canadian canal, a considerable number of large streams discharge into the St. Mary's River, furnishing an ample supply for the land irrigated in Canada."

"It would be impossible for the Canadians to store and utilize this flood of water, even if needed in their canal."

"It is doubtful, however, if the canal as at present constructed can carry more than half of this quantity."

In the second annual report of the United States Reclamation Service, it is further stated that "They (the Canadians), however, can only use the natural flow of the stream, as no storage facilities exist above the head of their canal in Canada."

Bearing in mind that every assertion made in these reports regarding the Milk River, its fall, the possibility of diverting water from it in Canada, the length of canal necessary to do so, have been proved inaccurate, is there any assurance that these assertions regarding the St. Mary River are not equally unfounded? The presumption would, naturally, be that they are also wrong.

How, for instance, is it possible for the United States Reclamation Service to know that a considerable number of large streams discharge an ample supply for the land irrigated in Canada?

No surveys have been made by the United States Reclamation Service of the area irrigated, or, what must be properly considered, the area irrigable, and, while considerable attention has been paid to stream measurements in that region, no record is given of the measurements of such "large streams."

As a matter of fact, there are only two streams between the St. Mary lakes and the intake of the Canadian canals.

Neither does the United States Reclamation Service know anything whatever of the storage facilities on the Canadian side of the international boundary. Such facilities do exist both "above the head of their canal in Canada" and elsewhere, that can utilize any flood waters stored, and it is beyond the probabilities that, when the Canadian is heard, there may be irrigable areas and storage facilities tributary to the St. Mary and Milk Rivers two or three times in excess of what the United States Reclamation Service have yet shown capable of development in Montana.

The expressed doubt of the ability of the Canadian canal to carry one-half of its estimated capacity is on all fours with the statement that the Milk River has "not more than two feet fall per mile," when it has between four and five times that grade.

With estimates of cost there is but one slight occasion to deal at the present time. While it is stated in the second annual report of the United States Reclamation Service that "field work was continued during 1903, this being the fourth year of surveys since the examination and reconnaissance in 1900" and 1904, in which further surveys were continued, being the fifth, it is quite evident that the service has still quite a long way to travel before it can submit a reasonably intelligent estimate of cost.

It has already been pointed out that the cost of the dam at St. Mary lakes was jumped suddenly from $22,000 to $228,000.

The cost of the section of 27.4 miles from the St. Mary dam to the north fork of Milk River is given as $553,540, or slightly in excess of $20,000 per mile, which, for a canal thirty feet wide on the bottom to carry ten feet of water, in the remote section of northern Montana, impresses one as a low figure.

A siphon crossing north fork, 2,638 feet long, with 181 feet invert, is estimated at $67,000 (!) and 16.4 miles of canal between the north and south forks are placed at $360,000, or practically $25,000 per mile, while mention is made of "the greatest depth of excavation on the entire line, amounting to 167 feet," occurring on this section.

The total cost to this point is estimated at $1.-397,600.

The section of the first annual report devoted to this enterprise closes with the following paragraph:

"A reconnaissance below Malta to Glasgow has shown that there are 107,000 acres of agricultural land available between the reservoir (Lake Bowdoin) and Hinsdale, and 40,000 acres between the latter point and Glasgow."

West of Malta there may be 60,000 acres, one-half of which is already provided with water from Milk River so that about 177,000 to 180,000 acres would form the extreme limit of the area to be benefited by this diversion canal from the St. Mary's River.

"From the south fork of the Milk River the canal would follow southward for 25.9 miles until Cutbank creek is reached the water, to continue down that stream and the Marian River for 100 miles, more or less, being diverted again near the mouth of Willow creek, and carried in an artificial channel for a distance of about seventy-five miles until it is turned into Big Sandy creek, a tributary of Sage creek."

In addition, therefore, to the 43.8 miles of artificial canal, there would be 100.9 miles of canal to be built. These were estimated to cost, in Senate report No. 254, $450,000 and $810,000 respectively, a total of $1,260,000, and a grand total of $2,657,000.

It is well to note that at the point of diversion from the Marias River, at the head of the seventy-five miles of artificial channels, a dam of about 180 feet in height will have to be constructed *in the bed of the stream,* the cost of which can scarcely be included in the estimate of $810,000 for this division. Beyond that, there has to be added the cost of developing Lake Bowdoin into a storage basin and the cost of construction of the distributing canals in the lower Milk River canal.

And all this cost for the irrigation of probably 180,000 acres, nearly fifteen dollars per acre, as the last item stands without the addition of other items that are essential.

In 1901, Mr. Newell stated before the committee on public lands, House of Representatives, that:

"The cost of providing the most accessible reclamation works would at first probably not exceed $5.00 per acre reclaimed."

This analysis of the reports of the Reclamation Service would indicate that, *except by diverting the water through Canadian territory,* the cost of the proposed Milk River reclamation in Montana will reach nearly three times that limit, on the preliminary estimates of cost, which are subject to great increase for apparent reasons.

Yet the Reclamation Service has toyed with the project for five consecutive seasons without arriving at any definite conclusions about any particular item of it and after having "boxed the compass" on every feature affecting its international importance. Had the enterprise been the child of a private promoter's brain, or subjected to the examination which corporations handling private irrigation securities would have insisted upon—the promotors and corporations Mr. Newell regards with such disdain—it would long ago have been classified as visionary, chimerical and impractical.

All these things may not warrant Senator Carter's conclusion that the Reclamation Service's agents would have been more at home "sorting rocks" but they would suggest that sound judgment and prompt decision are not among their striking qualities, and that by their dilatory proceedings, the farmers of Montana and the friends of national irrigation everywhere may be misled, misinformed and humbugged into endorsing enterprises that have no sound merit.

IRRIGATING ONIONS IN TEXAS.

Two methods of irrigation are practiced. First, a ridge is thrown up around the beds and they are flooded. Second, water is led down the middle of the narrow rows by opening a shallow trench with a hoe.

When the plants are the diameter of a lead pencil they are ready to be transplanted; wet the bed thoroughly, draw the plants and trim the roots with shears to about an inch, and cut the tops to about five or six inches in length; move plants to the field in any convenient carrier and keep moist while transplanting; rows should be straight in order to be conveniently cultivated and about fourteen to fifteen inches apart, and plants set four and one-half inches in drill; cultivation should be shallow and frequent. Never let the grass or weeds get a start.

In the matter of irrigating, when rain interferes, the planter should use judgment and be careful not to put on too much water from December 15 to February 15. From that time on water can not hurt them too much as the weather will be getting warmer and the days longer. As to the cost $100 per acre should cover all expenses, including the marketing. If fertilizer is used this should be added to the cost. As soon as 80 or 90 per cent of the tops have fallen the crop is ready and should be harvested at once.

ADMINISTRATION OF STREAMS IN IRRIGATION.

BY ELWOOD MEAD, WASHINGTON, D. C.

Read before the Western Society of Engineers.

(Continued)

State experimental stations will be expected to construct farm buildings and make other permanent improvements and supply necessary live stock. The department of agriculture will pay running expenses, furnish seeds, trees and plants. The products will be sold to create a fund for payment of the cost of buildings, live stock and other expenditures.

If necessary to discontinue the work the State experimental stations will have the option of taking over all rights of the Department of Agriculture, and if not wishing to do this the property shall revert to the Reclamation Service and be sold for the benefit of the irrigation fund.

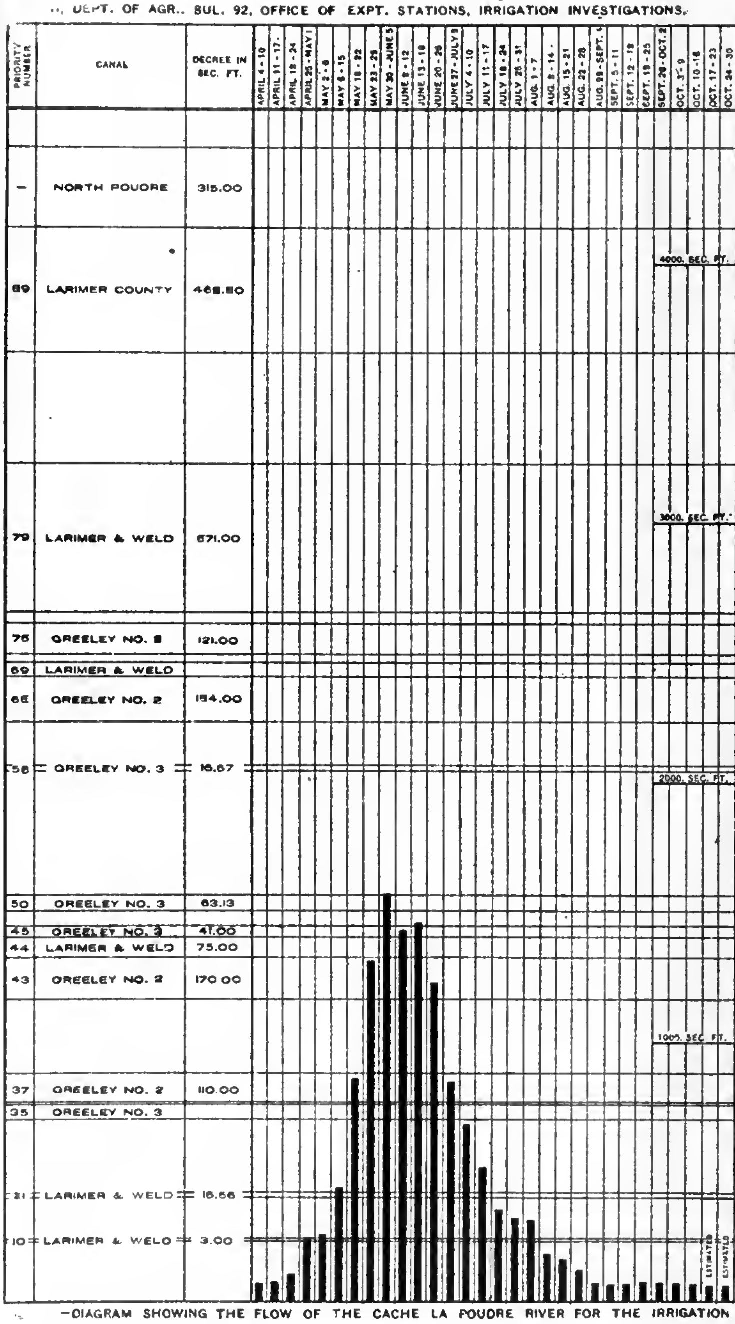
It is proposed by the Secretary of Agriculture that the experimental farms shall be conducted with a view to assisting settlers under various irrigation projects with a view to assisting plants and trees so as to determine the best varieties for use in the respective localities. These farms will be object lessons to prospective settlers, and it is the intention to make them self-supporting.

"Greeley is located—if there be such a thing as locating a baker's dozen slab shanties, as many tool-chests, a great ditch and twenty acres of prickly pears—on a barren, sandy plain, part and parcel of the Great American Desert, midway between a poverty-stricken ranch and a prairie-dog village on two sides, and a poverty-stricken ranch and a prairie-dog village on t'other. It is bounded chiefly by prickly pears."

Awakened at last to the need of public control, farmers, ditch owners and a number of able attorneys devoted much time and study to preparing a plan for establishing rights to the river and for dividing the water supply in times of scarcity. The method finally agreed to required each ditch owner, or appropriator of water, to appear before the district judge and present proof of his right to water. The judge then rendered a decree fixing the amounts of these rights. As the shortage in the stream had shown there was not enough for all, some distinction had to be made between rights in order to know which headgates should be closed in times of scarcity. The first ditch built was given the first right to the stream, and other ditches rights to the remaining water in the order of their construction. Each owner of a right was called an appropriator, using the term "appropriation" in its ordinary sense—to take for one's own. The order of these appropriations was called their priority. The appropriator having the last priority was to be the first cut off when there was a shortage of water, while the holder of the first priority could take the entire stream if he needed it all to supply his right.

When the ditch owners appeared before the court neither lawyers, witnesses nor the judge had enough practical knowledge of irrigation to bring out the facts. The testimony was given miles away from where the water was used, and this encouraged witnesses to use their imagination. No one appeared except those claiming a share of the stream, and, as they were all disposed to be liberal to themselves, more water ran through the courthouse than ever flowed in the river. The result would have been grotesque if its consequences had not been so unfortunate. There had been no disinterested measurement of the stream to determine how much water there was to be appropriated, nor impartial gauging of the ditches to show how much had actually been diverted. Although the decree transferred from public to private ownership one of the State's most vital resources, there was no public official at these hearings to look after the public welfare and keep down the rights recognized to the limits of actual use. The decree gave away over 4,500

U. S. DEPT. OF AGR., BUL. 92, OFFICE OF EXPT. STATIONS, IRRIGATION INVESTIGATIONS.



—DIAGRAM SHOWING THE FLOW OF THE CACHE LA POUDRE RIVER FOR THE IRRIGATION SEASON OF 1899 AND THE STAGE AT WHICH CERTAIN CANALS ARE ENTITLED TO WATER.

cubic feet of water per second, out of a stream which in midsummer often carries less than 100 cubic feet per second and which has an average discharge of less than 700 cubic feet per second. So far as measurements show, it has never in its highest floods carried the full amount decreed. The decree was most generous to owners of small ditches, one of which irrigating 160 acres was given water enough to cover the land seventy-two feet deep in one season, while the owners of twenty small ditches were given water enough to cover their lands to a depth of 250 feet in six months. The rights granted some of the large canals were not excessive, and in a few instances the ditches had diverted more than they were given.

The giving of these rights to the ditches had been strongly objected to by many farmers who believed that they, as the users of the water, should be made the appropriators, and that the rights should go to the land rather than to the canals. This plan was defeated because but little of the land was being farmed. The canal companies were represented by able counsel; they had assumed an ownership of the water before the decree was rendered and had been selling rights to farmers based on such ownership, and they wished for the power which the control of the commodity gave. In some instances the farmers were also ditch owners and the ownership of land, water and means of transportation were all united in the same person, but under the large canals the water was given to those who were not users but who had acquired it in order to sell to users.

The decree was rendered in 1882. At that time one of the large canals had not been completed and there was hardly any land cultivated under it. Under two others there were more vacant sections than there were with houses on them. The farmers who were coming in from the East looked carefully at the land, but they knew nothing about the value of priorities, and all water rights looked alike; hence, settlement went on as rapidly under the ditches with late priorities as those with early ones. Even if settlers had started in to make inquiries, it is doubtful if they would have learned much, because the people themselves did not fully realize the situation. It requires experience to show that a court decree did not increase the flow of the streams and that a paper appropriation, when there was no water back of it, had no more value than a gold brick, even if it had been given an extra gilding by a judicial authority.

In 1884 and 1885 the river was the highest ever known, the water supply was ample, and this gave a breathing spell in which to put the new system in order. It gave time to gauge canals and prepare tables for the use of the water commissioner, the official whose duty it was to enforce the decree and who had authority to open and close headgates in such a way as to give each appropriator his proper share of the stream. The commissioner had little trouble in these years. He could not give appropriators all that had been decreed them, but he could give farmers all the water they needed.

Springs near Thousand Springs, Snake River, Hagerman, Lincoln County, Idaho. This is the flow which will be the source of supply for Lost River Irrigation Company.

When the years of normal water supply returned many of the settlers found that irrigation was no insurance against drouth. Headgates of late appropriators were closed before midsummer, and no drouth in Kansas was ever more severe than prevailed under these canals. Damage suits by the exasperated settlers became common and the companies, which had not planned frauds, had to set to work in some way to provide the water they had sold. There were two ways of doing this. The earlier ditches were all small and had never been able to use one-tenth of the water given them, and they sold the surplus to canal companies which needed it. Transfers of this kind did not, however, increase the irrigated acreage; it simply took the water away from one farmer and gave it to another. In some instances these transfers of priorities robbed orchards that were twenty years old and watered cactus fields which had never been fenced.

When the water commissioner was called to recognize the first of these transfers there was a riot. Men knew that many of the appropriations were excessive, but believed that they were confined to the ditches where acquired, and that, since the owners of these ditches could not use the water, no harm would result. But the sale of these rights to canals with late rights changed the situation, and when the commissioner had an appropriation to be moved upstream ten miles and turned into a late canal there was such an exhibition of indignant feeling that the commissioner had to resign. For a time the validity of these transfers remained in doubt. Later the court sustained them, and now they are a part of the recognized order of things.

To irrigate all the land being farmed required an increase in the available water supply, and this could only be secured by building reservoirs to hold back the water which ran to waste before irrigation begins, and to regulate the discharge during the irrigation period, so that when the snows melt too rapidly the water would not run to waste. It was possible to provide water for all the farmers under these canals, although not to give all the water described in the decree. On the Poudre there is too much water in the first half of the year and too little in the last half. The stream begins to rise nearly two months before water is needed by crops and it falls with startling suddenness in July when the need is greatest.

In the Poudre Valley the need of storage has been increased of late years because of a change in the crops grown. Formerly wheat was the principal product. Its irrigation usually ends in July, but in recent years potatoes, sugar beets, melons, orchards and alfalfa have become the leading crops, and all these require watering after midsummer. These crops have a high acreage value and water for their irrigation commands a higher price and brings a much larger return than when used on land devoted to small grain. Nearly fifty reservoirs have been built to provide for the regulation of this stream, and between 50,000 and 100,000 acre-feet of water will be stored this season.

American Falls Irrigation and Power Company's Ditch, near Morehead, Bingham County, Idaho.

These storage works are filled from existing canals. There was some delay about this at first, because the outlets of these reservoirs are too low to permit of the water being used on the land under the canal which filled them, and it was not until a system of exchanges had been worked out, by which the highest canal turns over the water stored in its reservoirs to those lower down and takes in return the water which the stream carries, that the natural basins that these reservoirs occupy could be utilized. Making these exchanges has, however, greatly increased the labors of the water commissioner. In addition to his division of the stream, he now has to act as an official gauger in the delivery of water from reservoirs to ditches as well as from streams to ditches. Whenever water is turned from a reservoir he has to measure the quantity run out, and to secure greater accuracy in this the Legislature has required that an automatic recording instrument shall register the depth of water flowing over a weir.

The reservoirs are filled any time that a surplus exists. If the snows melt, much water is run in in the spring and in early summer. Sometimes a week's rain storm will serve to fill all of them. The general result is that the farmers are able to secure nearly all the water they need. The canal companies are enabled to make their contracts good and the district, as a whole, enjoys a high degree of prosperity, as the following statistics will show:

When the first settlers entered this valley it was a cactus-covered waste. Land could be purchased from the railroads for $1.25 an acre and water rights sold for $4 an acre. Today over 25,000 people live within the irrigated district. There are three beet sugar factories, one of which is said to be the largest in the United States. From one railroad station 70,000 cars of potatoes have been shipped in a single year. At another station 175,000 sheep have been fattened in one season from the alfalfa grown under the surrounding ditches. The best land, with a water right attached, sells for $100 an acre. The best water rights are worth $40 per acre without the land and few are for sale.

Summarizing briefly the administration of this river, we find it to be as follows: The rights to the stream belong to the owners of ditches and are established by decrees of the court. These decrees are largely in excess of both the capacity of ditches to divert water or the river to supply it. Rights to water in the stream are personal property and are bought and sold like wheat stored in an elevator. The decree of the court represents an ownership in the running water, just as a warehouse receipt represents the ownership of grain in the elevator. In his division of the stream the water commissioner pays no attention to how or where the water is used after it passes the headgate. Its subsequent disposal is under the control of the appropriator and his or its customers.

The building of the storage works gave rise to litigation over the priorities of rights to fill reservoirs. The owners of the early priorities attempted to fill the resevoirs under the right acquired for filling their ditches. Those having late rights insist that rights for ditches and reservoirs should be based on the time when the reservoirs were built rather than on the time when the ditches which filled them were built.

The litigation over this matter has resulted in contradictory decisions, but the indications are that ditch and reservoir rights will be held to be separate from each other, and that there will be two tables of priorities for the water commissioner to look after.

Considering all the circumstances, the results achieved in this district are highly creditable, but the system has dangerous features which should be reformed. The experience of Europe has shown that titles to water and titles to land should be inseparable, and that with each irrigated farm should go a right to water which makes it productive. Nothing can be more dangerous than a divided ownership of land and water. It leads almost inevitably to monopolies in the stream and to the oppression and misery of the tillers of the soil. If the water rights on the Poudre had been given directly to the land irrigated, the needs of this land would have always been a measure of rights and excess decrees would have been impossible. Furthermore, the amount of water controlled would have been diminished with the saturation of the soil and the inauguration of more skillful methods of culture, and this would have left more and more for later appropriators. But under the plan which was followed, those who did not intend to use it have been enabled thereby to levy tribute on those who did. Furthermore, there is no measure by which economy can be enforced or rights restricted to beneficial use. The freedom of transfer, which is recognized, makes it possible for a single individual or corporation to acquire an absolute ownership to the entire river and in this way create a monopoly of an element indispensable to civilized life.

ARTESIAN WELLS.

Snake River Lands will be Irrigated by this Method.

The ranches along the Snake River valley in the locality of the Warm Springs Ferry, have solved the problem of irrigation, says a writer in the Caldwell. Idaho, *News,* and will soon make that section bloom like a rose. They began sinking artesian wells in that section about a year ago, and were successful in striking some strong flows at a depth that justifies them in resorting to that method of securing water for irrigation.

It having been practically demonstrated that artesian water can be produced at reasonable cost, many ranchers are now engaged in sinking wells, there being now five drilling outfits at work, two above and three below the ferry. A good flow of water is struck at a depth of 600 feet.

John Keith, the sheepman, who has 440 acres of land in the Snake River valley, has sunk five wells, which are all flowing strongly, and is still sinking others, as he intends to have a sufficient number to irrigate the entire tract.

The following gentlemen have already secured strong flowing wells on their ranches there: J. C. Bernard, Perry Smith, Robert Noble, Dave Prichard and George Newell.

Land is being taken up very rapidly in that neighborhood, both by parties coming in from the East and by settlers in that section, because of the ease and cheapness by which water for irrigation may be secured.

Desert claims are filed on the land and artesian wells sunk to reclaim it.

There is an immense body of the best land on earth there, and it will furnish valuable homes for many thousands of people.

While there has been a very large quantity of it taken up of late, no considerable portion is yet exhausted.

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, courtesy United States Department of Agriculture.

(Continued.)

COST OF PIPE AND HOSE.

One 40-acre tract, which is eighty rods square, is successfully irrigated with 1,300 feet of pipe and hose, which is just sufficient to convey the water to the lower end of an 80-rod strip. Of the 1,300 feet 500 is galvanized-iron pipe, eight inches in diameter. The remaining 800 feet is canvas hose, most of which has been treated with an impervious coating. This proportion of hose to pipe is much larger than is used in many other cases, and it is doubtful if it is economy in the long run to have so much hose, as it is extremely short lived. The first cost is less, but the necessary replacing of the hose every year or two brings the ultimate much above that of metal pipe. The galvanized-iron pipe is made of No. 24 iron in 12-foot sections and costs 20 cents per running foot. This price is somewhat low for this grade of pipe. The average price is nearer 25 cents per foot, the variation being due to fluctuations of the market. At 20 cents the cost per section is $2.40, or $100 for the entire length of 500 feet. The canvas hose is an inch larger in diameter and cost 7 cents per foot for the plain duck and 9 cents per foot for the prepared duck. The total cost for the canvas hose was $68. For the entire tract, therefore, the necessary pipes and hose cost in the neighborhood of $168, or $4.20 per acre. This cost per acre on larger tracts would, of course, be somewhat reduced, as larger tracts than the one taken as an example are just as successfully irrigated with no more pipe. On larger tracts it is possible to keep the pipes in use all the time, irrigating the sections in turn.

In the two tables which follow the current prices of pipe and hose on the Pacific Coast are given:

PRICE PER FOOT OF GALVANIZED-IRON PIPE RIVETED AND SOLDERED IN 12-FOOT SECTIONS, SAN FRANCISCO MARKET. DECEMBER, 1903.

Diameter of pipe. Inches.	No. 20 iron. Cents.	No. 22 iron. Cents.	No. 24 iron. Cents.	No. 26 iron. Cents.
3	18.5	17	11	9.5
5	25.0	22	15	12.5
6	28.0	25	18	16.0
7	30.0	28	21	18.0
8	37.0	33	25	22.5
9	40.0	37	28	25.0
10	45.0	40	31	28.0

PRICE PER FOOT OF CANVAS HOSE, LOS ANGELES MARKET, DECEMBER, 1903.

Diameter of hose. Inches.	Plain duck. Cents.	Coated with patented preparation. Cents.
1¾	3.0	3.5
2½	3.5	4.5
4	4.5	5.5
6	6.5	8.0
9	8.0	10.0
13	12.5	17.5

The hose quoted in the table is made of 12-ounce double-filled duck, in lengths of 100 feet. Shorter lenghts are made at the same rate, except that an extra charge of from 10 to 25 cents is made for each extra coupling inserted. On orders of 1,000 feet or over it is customary to allow a small discount. Prices, of course, are subject to wide variation, and definite estimates can not be given. It is believed, however, that the figures given represent the average cost of pipes and hose, based on prices which are current in the section where this means of irrigation is most used.

The preparation of land for irrigation with pipe and hose costs about the same as for open ditches and varies from $2.50 to $10 per acre, depending upon the conditions of the lands. While the expense of leveling a field is always money well spent, from the manner of application lands irrigated with pipes require less leveling than those to be irrigated by flooding from laterals. The cost of irrigating alfalfa with pipes and hose may be summed up as follows: With an average stream of seventy inches of water one man can irrigate from one and one-half to two acres per day of ten hours, in addition to tending the pumping plant, where a gas engine is used. This area, of course, will vary with the nature of the land and also with the stage of growth of the crop. The cost of labor for each irrigation,

Citrus Orchard Irrigation Scene, Riverside, Cal.

however, will not exceed $1.25 per acre, and should in most cases fall below $1. On the assumption that six irrigations are necessary during the dry season, the annual cost for labor should come inside of $7.50 per acre. When successfully grown alfalfa will yield from five to seven crops each year where it grows continuously, and each crop will yield from one to two tons per acre, according to local conditions. This gives an annual yield of from seven to twelve tons per acre, which, at the current price of $8 and $9 per ton in the field, produces an annual gross return of from $56 to $108 per acre.

SUMMARY.

The advantages of irrigation with pipe and hose may be briefly summarized as follows:

(1) Losses which would otherwise occur by seepage in the conveyance of water over a field are prevented. Further loss in application due to gopher and squirrel holes is also largely eliminated.

(2) A small stream may be handled effectively over a large area, and the irrigator may apply the stream at any point of the field he desires.

(3) No field laterals are required, which is a direct saving in the crop-producing area of a field, as well as in the time required to construct and repair these laterals.

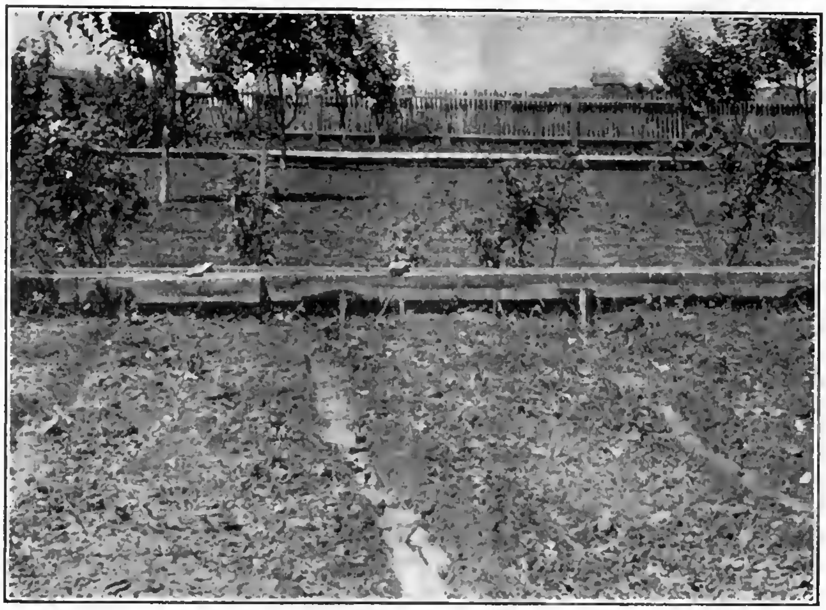
(4) There are no laterals and the surface of the land is free from obstructions. Crops, therefore, can be harvested with greater ease and with less wear and tear on farming machinery.

(5) With pipe and hose land can be irrigated with little or no preparation, although it is better to level land to some extent, if it needs it.

(6) Introduction of noxious weeds into a field is prevented.

The disadvantages are:

(1) Initial cost is high, especially where underground pipes form part of the system.



Wooden Head Flume.

(2) Pipe and hose require careful handling to prevent their being damaged. Canvas hose, even with best care, is short lived and requires frequent renewals.

(3) It is necessary to have pressure head on pipes in order that a fair-sized stream may be carried in conduits of medium sectional area.

Field irrigation with pipes and hose is undoubtedly impracticable in many sections of the West on account of high cost. Numerous other sections, like southern California, possessing a scanty water supply, could well adopt the practice and thus extend the area watered with their small supply.

USE OF METAL CONDUITS IN HILLSIDE ORCHARD IRRIGATION.

In the citrus-fruit region of California the best fruit-producing lands are frequently found along the foothills, where the general slope of the land is quite steep. In the irrigation of orchards on such slopes particular care is required to prevent washing of the loose soil and the formation of deep gullies. This is accomplished in many cases by laying out the orchard so that the ditches supplying the basins can be carried on a uniform grade across the slope. Where this method is not practicable, and where it is not only necessary to prevent erosion but to conserve the water supply to the greatest possible degree, a number of orchardists use cheap metal conduits in which the water is conveyed to the basins without loss in transit. Where these devices are used it is possible to plant trees on steep slopes and still have them so arranged in regular order that land may be readily cultivated. The conduits which will now be described are in use in the foothill orchard district lying to the north of Monrovia, in southern California.

PIPE IRRIGATION IN ORCHARDS.

The pipes in common use are quite similar to ordinary water spouting and are made in lengths of from sixteen to eighteen feet, according to the space between the rows of trees. They are usually made of such length that one section will reach from one basin to the next. The pipes are strung out between two rows of basins and connected. After the first or lowest basins have been filled from the full length of the pipe the last joint is detached, the second basins from the bottom are filled, and so on, one basin after another is filled until the highest trees in the rows are irrigated. As each length of pipe is detached it is laid over in the adjoining row and connected with the one previously detached and moved over. In this way the line of pipe for the new row is placed together while the basins in the first row are being filled and no time is lost in handling the pipes. When the highest basins have been filled the pipe is attached to another stand and the operation repeated for the second row of trees. In this way a head of from twenty-five to forty inches will keep one man busy, but he will have ample time to attend to the basins and see that no water is needlessly lost.

The best pipes for this purpose are made of No. 24 iron, are about three inches in diameter, and are corrugated to give them rigidity. The disadvantages in the use of pipes lie in the fact that the sections are bulky and awkward to handle, one or two pipes being a load for a man to carry. Another and more serious trouble is that the pipe will not stand rough handling and requires great care to prevent the ends from becoming jammed and bent and dents being made in the body of the pipe itself.

Pipes in common use cost all the way from 9 to 17 cents per foot, according to the weight of iron used and their diameters.

The pipes, when in use, are joined to the cement stands by short pieces of canvas hose of somewhat larger diameter than the pipe. This permits the irrigation of several rows of basins from one stand, and also makes it possible to connect with ease a line of pipe which has been connected by sections for the lower tier of basins with the nearest stand regardless of whether the stand be an even pipe length away from the upper end of the connected pipe or not.

METAL TROUGHS A SUBSTITUTE FOR PIPES.

In the place of the pipes just described some orchardists have adopted metal troughs and have much success with them. In making the basins prior to irrigating, channels are formed between the tiers of basins by the levees which are thrown up to form the basins. Troughs are placed in the channels and make possible the quick distribution of a stream to a long tier of basins, preventing loss of water in distribution.

Rectangular flumes made of galvanized iron, about No. 22 weight, in so far as delivering the water is concerned, are effective. They are quite expensive, however, are bulky and awkward to handle, and are easily damaged. The sections are ten feet long and are made of 30-inch iron. The troughs shown in the illustration were comparatively new, yet the edges and ends are considerably damaged.

A much better and less expensive trough is the triangular one. These troughs were made of ordinary black corrugated roofing iron. Each strip of iron ten feet long and thirty inches wide, made two lengths of troughs. The corrugations make the troughs quite rigid and able to withstand considerable rough handling. The troughs are light and as they nest nicely one man can easily carry from eight to twelve at a time in distributing them. As the square troughs will not nest conveniently, two or three lengths are about as many as a man can carry.

No. B. W. G.	30 inches in width.			36 inches in width.		
	Weight per sheet.	Price per sheet.	Price per foot of trough	Weight per sheet.	Price per sheet.	Price per foot of trough.
	Pounds.			*Pounds.*		
22	35.2	$1.44	$0.075	....	....	....
24	29.0	1.19	.06	....	....	....
26	22.7	.99	.05	24.8	$1.14	$0.06
27	21.1	.95	.05	24.2	1.15	.06

FURROW IRRIGATION IN THE YAKIMA VALLEY, WASHINGTON.

The furrow system of irrigation is employed for all crops in a portion of the Yakima Valley, Washington. This is due to the fact that flooding causes the surface to bake slightly because the soil is so finely divided that the particles run together when the surface is saturated with water. Irrigation by small furrows, which produces wetting of the surface by capillarity, has been found better adapted to this character of soil.

Making Furrows with Single Shovel Plow.

HEAD DITCHES.

In laying out head ditches choose the side of the field from which the most uniform slope can be obtained. Turn four furrows together; then with the same plow, or, if the ditch is to be small, with a large single-shovel ditch plow, plow out the center, cutting only a little deeper than the original surface. The head ditch should be divided into levels by means of drop boxes if the surface has much slope, so that the water can be taken out through spouts into the irrigating furrows. But the attempt should not be made to carry the water too far on a level, as this will make the banks so high on the lower end that they will break. Drop boxes cost about $2.50 each when put in complete. Nothing will take the place of the shovel and hand work in dressing up a head ditch. The sides should be sufficiently strong where the water is raised above the surface to be reasonably secure from breaks; for a break will more than offset the extra care required in strengthening the ditch banks. The ditch should receive special care until the banks become hardened and silted. A rough estimate of the cost of head ditches is $10 for eighty rods, in addition to $2.50 each for the drop boxes.

(To be continued)

IRRIGATION IN TEXAS.

Address Delivered to Texas Cattle Raisers' Association by Joseph A. Kemp, President City National Bank, Wichita Falls, Texas.

Mr. President and Members of the Texas Cattle Raisers Association: I esteem it a great privilege indeed to be permitted to address this large and representative body, and I assure you it is with unfeigned diffidence that I attempt to do so. The compliment paid in thus honoring me is due, not to any reputation I have made as a public speeker (for speechmaking is entirely out of my line), but I feel sure I owe this great honor chiefly to the reputation I have established among some of the prominent members of this great association as a crank upon the subject of irrigation.

I am aware that I have had the distinction of being known as the irrigation crank of Texas for a number of years. I assure you, gentlemen, that the title is not in the least offensive. I realize that men who become enthusiasts upon any subject which is out of the ordinary are usually designated as cranks. Until very recently the question of irrigation has been little understood by Texas people. I frequently meet people now who, hearing the word "irrigation," seem to experience a peculiar feeling—they have a feeling that it is something a great way off and hard to reach, intangible, something mysterious. They imagine that the art of supplying water to cultivated lands is some complicated and wonderfully intricate process, not easily understood or attained by mortal man.

The magic science of irrigation has been practiced since the earliest dawn of civilization—in fact, it was in vogue during the semi-barbaric days of prehistoric times. The use of irrigation for the production of crops probably antedates Noah's deluge by several thousand years. Twenty-seven centuries before the Star of Bethlehem shown so brightly by night, a clever Egyptian ruler turned the course of the Nile so as to carry the turbid waters well out upon the higher ground, and today Great Britain is completing the largest dam in the world upon this very site and is spending millions of dollars in constructing canals along the River Nile.

We find history repeating itself throughout the world. Here in our own country, America, the National Government is preparing to spend millions of dollars for the reclamation of her lands in the arid and semi-arid portions of North America. Irrigation was practiced in southwest Texas nearly 200 years ago. With the erection of the Spanish missions in the vicinity of San Antonio began the cultivation of the soil by irrigation. Evidences of these old ditches are yet to be found.

It is only within the last few years that the people of Texas have begun to give the question thoughtful consideration. The agitation of the question really dates back to the time when your worthy and distinguished President was an honored member of our State Senate. It was about eight years ago, after experiencing two crop failures, that the people of the west became very much aroused upon the subject of irrigation. A number of the citizens of west Texas who had given the subject considerable investigation became convinced that storm water irrigation was entirely feasible for our section if we could only find the means by which to construct the works necessary to impound the water, and it was determined to make an effort to secure legislation that would enable land owners to provide means by a system of taxation. The legislature was in session at the time, and a committee was sent to Austin to confer with the legislators. This committee was composed of a number of men from towns in west Texas. It was decided that before any law could be enacted which would permit of the character of taxing system desired our State constitution would have to be amended. Senator Turney seemed to understand the subject better and take more interest in the question than any other member, and he was therefore asked to "father" the bill, which he consented to do. He introduced in the Senate a resolution submitting to the people of Texas, at a special election, an amendment to the constitution providing for the organization of irrigation districts in the western counties, and authorizing the owners of irrigable lands in such districts to issue bonds and vote upon themselves a tax to pay interest and provide a sinking fund for the liquidation of the bonds, the proceeds arising from the sale of the bonds to be used in the construction of irrigation works. After considerable hard work on the part of Senator Turney and other western members, the bill passed both houses by the requisite two-thirds majority, but it met with quite a different fate before the people. As you all remember, the amendment was defeated by an overwhelming majority. This was a great surprise, as well as disappointment, to many of us in the West. There was perhaps no other class of our citizens more strongly opposed to this amendment than the live stock men. I do not make mention of this fact in any spirit of criticism or complaint, for I believe sincerely that you were prompted by your honest convictions. You simply were not sufficiently informed upon this all important subject, and it is very gratifying to me to find that a great change has taken place in the views entertained by the intelligent and progressive members of this great association upon this, in my humble judgment, one of the most important subjects that you will have to deal with in the future. The far-seeing and observing cattle man realizes that a great change has taken place in the last few years in the live stock industry. I am not a cattle man but my long residence in west Texas and constant contact with men engaged in that line of business has enabled me to learn something about the business. I went to western Texas over twenty-two years ago; it was the beginning of a new epoch in the live stock industry. The Texas & Pacific railroad was completed to El Paso; the Ft. Worth & Denver was being built through the Panhandle. With the building of these two railroads came the "man with the hoe." The day of open range and free grass was soon to be a thing of the past; the State began to sell its lands to farmers, the railroad companies began to put their lands on the market, and the country which for many years had been an open range and the exclusive habitation of the cattle man, was soon dotted over with farm houses and ranchmen were compelled to buy or lease lands. The price of lands has been steadily advancing until today those cattle men who failed to purchase lands while they were cheap are finding it unprofitable to either purchase or lease lands in large bodies for strictly grazing purposes at prevailing values. And in many instances stockmen who did acquire large bodies of land are now cutting those pastures into small tracts and selling same to farmers. The demand for homes is increasing. Far out upon the plains the country is rapidly being settled by farmers. The change which has taken place, all thoughtful men must realize is not temporary. You gentlemen, who are soon to pass from the scene of action and turn over to the younger generation this great business which you have spent a life-time in building up, do so under greatly changed conditions from what they were when you began twenty-five or forty years ago. There has been a complete evolution in that period. The business, to be profitable, must be conducted upon an entirely new basis. You can no longer afford to graze large herds upon lands which will sell for $5.00 to $10.00 per acre when it requires ten to twenty acres of native grass to support a cow. To quote one of our great statesmen, "You are confronted with a condition and not a theory." You must reduce the number and increase the quality. You must make this $5.00 to $10.00 land produce (instead of $1.00 worth of native grass) $40.00 worth of hay. Instead of ten acres to one cow, you must make one acre take care of ten cows.

Now, gentlemen, this is what can be done in west Texas, and what is being done in a few places and will be done in many places within the next few years. There is not a man within the sound of my voice who will gainsay the proposition that west Texas is as well adapted to stock farming as any part of the United States, but for the irregularity of the rainfall. Nature has provided us with the soil and climatic conditions unsurpassed by Illinois, Missouri or any of the great States where stock farming has been conducted upon a profitable basis for many years where lands are worth $50.00 to $100.00 per acre.

It is a fact that nearly all of the arid or semi-arid lands in the west are possessed of marked fertility. It is seldom that absence of abundant production is caused by want of fertility; but is nearly always caused by want of moisture. The trouble does not lie in the fact that rain of the aggregate quantity to produce good crops does not fall, but the shortage of crops is due often to the failure to get a single rain at a critical time. When it rains, it pours and pours, and when it stops it remains dry a long time. There is scarcely any crop grown in North America which can not be grown in western Texas with the aid of irrigation. Alfalfa will grow as well in west Texas as any part of the country. There is no better hay crop known than alfalfa for maturing and fattening live stock. The yields obtained in west Texas will be much greater than in Colorado or many of the arid States where it is being grown successfully and profitably; our seasons are much longer and we could always get at least four cuttings, and most years five, which should give an average yield of at least six tons per acre. Alfalfa hay, when made, is worth to a stockman to be fed to the live stock which feed upon the ranges, at least $7.00 per ton. How many of you who had large herds upon the ranges last month would not have gladly paid twice that amount for a few hundred tons stacked on your ranches? One million acres of land is not many acres to a man living in western Texas, and when I speak of west Texas, I mean that country west of the 98th meridian. Did you ever stop to think what an immense area this is? Draw a line from the north boundary line of Clay county on Red River straight through Texas, following the 98th meridian, and you have an area containing over 120 million acres—an empire within itself. Suppose one million acres of this country was planted in alfalfa which produced yearly six tons per acre, worth seven dollars per ton. You have six million tons, worth forty-two million dollars, and these figures would not fully represent the value of the alfalfa crop to the country. When the ranchman whose cattle graze in the summer on the adjacent upland ranges are feeding alfalfa to their stock in winter, what are they doing? Why, they are keeping the animals growing all the winter months, whereas if they had to winter out upon the open range they would lose much in flesh, to say nothing of the hazard of loss through privation. When the young cattle are wintered on the open range, usually they weigh less in the spring than they did in the preceding autumn. When wintered on alfalfa they gain from 100 to 150 pounds during the winter season. This fact has been demonstrated at many experiment stations in irrigated sections. This means that the ranchman can shorten the period of production by one-third at least, that is to say, an animal that requires three years to grow it on the open range, can be made to attain the same weight in two years when fed on alfalfa in winter. This makes it possible to increase the production from the pastures of the open range by 50 per cent. Alfalfa thus grown also makes it possible for the ranchman to finish the stock grown on the ranges before it is shipped to market. Especially is this true if some grain is grown on the irrigated land, as for instance, corn, oats or barley. Experiments conducted at experiment stations have made it clear that when cattle are finished on alfalfa along with grain that one-third of the amount of grain usually fed will give as good results along with alfalfa as a full grain ration in the corn belt where cattle are fattened on corn. There is no question but what with irrigation we can grow as fine corn, oats or barley as Illinois, Missouri or Iowa, and with a greater degree of certainty when we are supplied with water to insure us against failures for want of moisture. Now I do not undertake to say that all of this vast domain can be irrigated but I do claim that millions of acres of it can be.

My observation has been that there are few years but what at some time during the year that rain does not fall in excessive torrents upon the plains and hillsides and over the valleys of all this broad land. At some period nearly every year, every water course becomes a raging stream, carrying the floods to the rivers that flow through the low lands of south Texas, oftentimes causing ruin and disaster to homes and lands, to railroads and other property. The value of this water which after causing wreck and ruin in the fruitful valleys of the Brazos and Colorado, has lost itself forever in the sea. During the last sixty days enough rain has fallen in the arid and semi-humid belts of Texas to have watered millions of acres in that vast territory.

There are hundreds if not thousands of places along the dry creeks and canyons where storage reservoirs could be constructed at compensatory cost to conserve the water to irrigate vast areas of land. Near our little city of Wichita Falls stands an object lesson that will convince any man who has any doubt as to the feasibility of storm water irrigation. About six miles south of the town an earthen dam, over a mile in length, was built across Holliday Creek valley, a little dry weather creek—that is, dry nine months in the year—and as a result we have an artificial lake that covers nearly 3,000 acres. Irrigation ditches convey the water to the lands below in addition to furnishing our city with all the water it requires (even though the city were to grow in population several times its present size). We have an ample supply of water to irrigate ten thousand acres of land.

I doubt if there is a ranchman here today who is the owner of a large body of land but what could find places in his pasture where storage reservoirs could be built that would furnish water sufficient to irrigate hundreds of acres of his land.

Gentlemen, it will pay you to investigate this question carefully. If you construct irrigation plants and raise plenty of alfalfa, Milo maize, Kaffir corn and have it stocked around in convenient places where the old cow can find it during a spell of weather like we experienced last month, it will relieve you of much anxiety. You can sleep better and will live longer yourselves—I know some of you have not gotten over the fright yet, and I don't blame you for feeling uneasy; it is indeed marvelous how light your losses were on the open range and I do trust that many of you will profit by this experience and begin to prepare for such severe winters which are likely to come again at a more critical time for the cattle. The way to insure crops in west Texas is to prepare to irrigate. In many places irrigation can be done cheaply and profitably from artesian wells, and in some places from running streams by pumping. We do not require near so much water as they do in the strictly arid States where irrigation is practiced; we only need irrigation to supplement our rainfall. Irrigation in west Texas insures against failure of crops. With the aid of water at your command you become master of the season. The territory embraced within the area west of the 98th meridian is larger than the three great corn and fine stock producing States of Missouri, Illinois and Iowa combined. With the proper effort it is within your power to hasten the time when this vast region will become the most prosperous stock farming country in America. Let us find a way to store up the flood waters which run to waste and thereby aid in making Texas what Destiny intended she should be—the imperial commonwealth of the great sisterhood of States.

ATTRACTIVE IRRIGATION.

The farmer of the humid regions is apt to look on agriculture by irrigation as a poor sort of makeshift that will do when crops can't be raised in any other way, but hardly the sort of farming that a man would voluntarily choose. On the other hand, the farmer who has learned and practiced irrigation looks upon farming that relies on nature's bounty in rain to be a very careless sort of farming. Both kinds of farming have their drawbacks and their advantages. It is noteworthy that though the unoccupied lands of the humid belt of the Canadian west are so extensive as to stagger the imagination, there is a steady call, by preference, for lands where irrigation is desirable. Thus, the Canadian Pacific Railway Company, with millions or acres of land not requiring irrigation, is planning an irrigation system in Alberta that will put water onto 5,000,000 acres. In ancient times the world's most populous regions were those where irrigation was practiced. Such was Egypt; such was Mesopotamia; and history will repeat itself on the American continent. In the heart of the great American desert there are already hundreds of oases made by men, and the time is coming when the hundred million of acres Uncle Sam is planning to redeem will constitute one of the richest of the agricultural regions of the nation.—*Opportunity.*

PROTEST SENT TO THE PRESIDENT.

The People of Minidoka, Idaho, Object to the Segregation of the Reclamation Fund—Diversion of Money to Other Projects Would, it is Stated, be Ruinous.

Minidoka, Idaho, March 26, 1905.—The people of Minidoka, many of them new settlers on what is known as the Minidoka reclamation tract, have finally awoke to realize the fact that the withdrawal of one million dollars from the fund recently set aside for work in this district would be ruinous to a large number of settlers and materially injure the town of Minidoka as well.

The settlers held a mass meeting in this town last night to protest against the segregation of $1,000,000 from the Minidoka project to use on the Boise-Payette enterprise. The big wigwam on Center street, capable of seating 700 people, was secured to accommodate the large audience. W. N. Shilling was elected chairman and F. A. Evelyth as secretary.

The object of the meeting was explained by Frank Riblett, of Cassia county, in an interesting 15-minute talk on the situation showing that 400 bona fide settlers would be practically thrown out of house and home for years and in the majority of cases permanently.

He was followed by other prominent men speaking along the same lines, among them Messrs. Scherrer, Cheney, Burgess, Sears and Huggins.

PROTEST SENT TO THE PRESIDENT.

A committee consisting of Frand Scherrer, R. L. Cheney and F. A. Evelyth was appointed to draft a telegram to President Roosevelt urging him to investigate the proposed segregation of the Minidoka project funds and see that justice was done to all parties. The committee dispatched the following telegram to the President:

Minidoka, Idaho, March 25, 1905.—To the Honorable Theodore Roosevelt, President of the United States, Washington, D. C.: Not less than 400 settlers, the majority of them with wives and children, having full confidence in the statements and assurances of the reclamation and land department and in conformity with the plats showing farm units and instructions issued by the Interior Department, have made bona fide entries on lands proposed to be covered by the pumping section of the Minidoka project. The proposed withdrawal of $1,000,000 from this project, thus indefinitely postponing the installation of the pumping system, will cause untold hardships, financial loss and practical eviction to these settlers. Will you look into this matter? All we want is a square deal.

"Submitted by a committee appointed at a mass meeting held at Minidoka, Idaho, on March 25, 1905.

(Signed) "R. L. Cheney,
"Frank Scherrer,
"F. A. Eveleth,
"Committee."

SMALL FOR PANTRY SHELVES.

We acknowledge the receipt of a copy of "Maxwell's Talisman" with thanks. It is extravagantly circulated, and as extravagantly worded, and took a heap of railroad money. Its reception in the West will not be very marked—the people take no stock in its pet hobby, and the paper's too small for the pantry shelves.
Big Horn County News.

DRAINING THROUGH THE LANDS OF ANOTHER.

D. W. STOOKEY, CEDAR RAPIDS, IOWA.

Owners of adjoining lands that need draining have often experienced difficulty in coming to an agreement as to the method of procedure, division of the expense and time of making the contemplated improvement.

Sometimes the man owning the higher land wants to drain his wet land, but his neighbor next below and through whose land the water must run is not ready, wants the man above to bear an unreasonable share of the expense or even goes so far as to say that he don't want to drain his land.

Such conditions as these create ill feeling between neighbors and retard improvement of the lands.

The Iowa Legislature took this matter up last winter and passed a bill providing for draining through the lands of another. Herewith are appended extracts giving the essential features of the law:

"When any person who is the owner of any swamp, marsh or wet land which, on account of its condition, may endanger the public health, or is not for that reason in a proper condition for cultivation, shall desire to construct any open ditch, tile or other underground drain for the purpose of draining such swamp land through the land of another and shall be unable to agree in regard thereto with the owner of such land through whose land he desires to construct the same, he may file with the clerk of the township in which such land is situated an application therefor, giving a description of the land through which it is desired to construct said drain, and the general course, character, size and depth of the same. The township clerk shall forthwith notify the trustees of the township of such application, who shall fix a time for the hearing of the same not more than forty nor less than ten days distant." The clerk shall then notify the parties of the time and place of such hearing. At the time set for such hearing, the trustees shall "hear and determine the merits of said application, objections thereto, and claims for damages that may be occasioned by the improvement contemplated. * * * The trustees shall make a decision in said matter. * * * They shall reduce their decision to writing which shall be filed with the clerk of said township, who shall record it in his book of records and cause it to be recorded in the office of the recorder of deeds of the county in which said land is situated, and said decision shall be final unless appealed from."

The law also contains clauses governing appeals, costs and damages, repairs, penalty for obstructing, connecting drains, along highways, across highways and railways, and provision for construction of said drain.

DRAINING FLAT CLAY LAND.

J. H. Lay, Warsaw, Mo., writes in substance as follows: "Your reply to the O. S. U. student about keeping plowed ground freshly harrowed to save moisture is all right for dry weather. But I have found that in a wet time the unharrowed plowed ground, full of open places, holds more water. For the last ten years I have been engaged in draining several tracts of very level land underlaid with tight clay and too wet to cultivate in its natural condition. Tiling would cost too much, and I did not believe water would get through the clay into the tiles anyway; so I put in open ditches, a main one with necessary side ditches and furrows. Having graded the surface smooth the water now runs off nicely into these open furrows and ditches, draining the land well and fine crops are produced." Loose plowed furrows on a water-tight subsoil would certainly hold more water when it rained hard than would a surface well harrowed down. The hard rain would pack the fine surface and then run off, on clay land, where there was good surface drainage. But such a condition as this is not the best for agriculture. I am sure you agree with the spirit of my article. The student said, you know, that "we should not harrow and roll or drag the ground in the spring when preparing for a corn crop. The way to retain moisture was to leave the ground as plowed until time to plant." This was the general rule laid down as reported, with no exceptions, a rule that all good, practical farmers know to be wrong.

But now I have seen this level clay land in Missouri frequently, and understand the condition it is in nautrally, and I have seen many farms on similar soil that has been tile drained successfully. So kindly allow me, Friend Lay, to give a little advice to yourself and those similarly situated. It is easy to see that this surface drainage, with ditches and furrows and smoothly graded surface, will help matters considerably. There are thousands and thousands of acres thus treated in various parts of the country. The surface water can be rapidly taken off. But with it goes some fertility that comes down in the rain water. Some is washed from the surface of the soil. The air can not penetrate the ground to any great extent. Fair crops can be grown for a time, some seasons, but not as great ones as the soil is capable of producing. These flat clay soils are full of fertility, but they want tile drainage to take the water out from below and draw the air in. This with proper tillage and handling will bring enormous crops. Much of the section I wrote about two weeks ago, along the southern shore of Lake Erie, is about the same kind of land. There are large areas of it in various States. There is much of it in Ontario, where plowing in narrow lands, surface drainage, is so commonly practiced. In a very wet season, like the present one with us, farmers suffer terribly from the stagnant water and the excess of water in the soil. Now, my good friends, the water will get into the tiles. I write after many years experience with drains in the tightest kind of clay. I have never known of a field being drained where the water failed to get into the drains in due time, where rotation was practiced, clover grown, or vegetable matter got into the soil in some other way, and stock was not allowed to tramp on the land when wet. Water will not go down at first, particularly if the land is tramped by animals, but in time it does, very nearly to the level of the drains, if they are not more than two rods apart. In such level sections tiles should be made near where they are wanted, to save freight. There are scores of level counties, or have been, where the tile factories are but a few miles apart, in some parts of Ohio, Indiana, Illinois, etc. The productiveness of the land has been greatly increased by using these tiles. The farmers in other level sections where there is not natural drainage, are making a great mistake, financially, in not tile draining their land in the same way. The work may be thoroughly done, once for all, for from $25 to $30 an acre. The increased crops in one or two wet seasons would pay the entire cost. If one year with another the crops were worth only $2.40 an acre more, that would be 8 per cent on the investment, a great interest in these days. And with good farming it may always be more than that. Many tiles have been carelessly laid and failed, but there is no need of this. Attend to the matter yourself. See that every one is hard enough to stand; that it rings clear when struck against another one. See that water runs uniformly in the groove in bottom of ditch before you put the tiles in. These are the most important matters. Now is the time to be getting ready to drain land you put in corn next year. Put in a single drain, if no more, and do it right and watch results. You will soon be satisfied, if the work is well done and you manage rightly. A man's best efforts are often thrown away on land in need of tile drainage. A good manager may get along fairly, on the average, but he could pay the interest on cost of tile drainage and do much better. He can get larger crops and with greater certainty. He will be a poor manager if he does not make this chance bring him $3 an acre extra on his cultivated land, that is 10 per cent on the cost of tiling, on the average. He will be an extra good manager if he can make underdrained, level clay land pay him half that interest on its value, net, on the average. Now I have no tiles to sell, no interest in the matter, only to be truly helpful to those who have not had experience along this line.

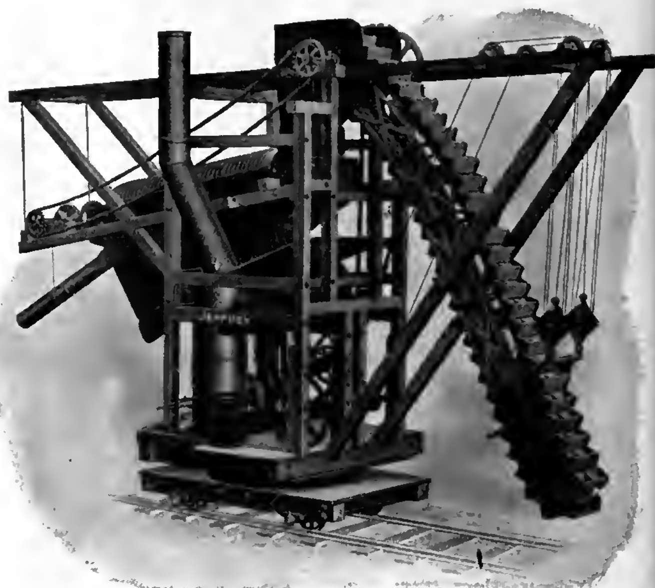
ELEVATING AND SCREENING MACHINERY FOR HANDLING GRAVEL.

The equipment shown in the illustrations consists of an elevator and revolving screen mounted on an ordinary flat car, for digging sand and gravel from a loose bank.

The elevator is placed to one side of the car, being composed of continuous elevator buckets mounted on an endless chain, which extends some two feet below the track level and projecting in front of the car six feet. The car is run directly to the face of the bank and owing to the loose nature of the gravel handled, a man being placed at the top of the bank can very easily supply the elvator with a sufficient amount of gravel to keep it filled at all times.

Elevator and Screening Machine for handling Gravel.

The gravel is raised a sufficient height so that it can be spouted to the revolving screen placed in the center of the car and covered with two different sizes of wire cloth to obtain two different products. The first cloth that the gravel comes in contact with is fine, thereby securing sand. As the screen is set on an angle, the particles that are too large to pass through



Elevator and Screening Machine for handling gravel.

the first section will move by gravity to the next, which has larger openings and the large stones or tailings pass over the end of the screen and are spouted to the ground.

Alongside of the screen are placed two contractors' dump cars, into which the sand and gravel are discharged by means of belt conveyors placed directly beneath the revolving screen.

This equipment has been in use the past summer in securing sand and gravel for the construction of a large concrete bridge, which has only just been completed.

The outfit was furnished by the Jeffrey Manufacturing Company, of Columbus, Ohio, who make a specialty of machinery of this type.

BROUGHT BY THE POSTMAN.

Letters from Correspondents to The Irrigation Age.

Grand Junction, Colo., March 18, 1905.

Editor Irrigation Age:

The irrigation system of the Grand Valley at Grand Junction, Colo., is second to none in point of cheapness, service and water supply.

The present canal covers 40,000 acres of land on the north side of Grand River, with a system of ditches eighty-four miles in length and a capacity of 400 second feet.

Water is turned into the canal April 1st of each year and flows continually until cold weather interferes, in December, usually about the 15th.

The duty of water is one cubic foot per second for eighty acres of land, and this amount has been found sufficient for all crops in this soil and climate.

The average cost of water per acre per annum is 62½ cents.

The ditch is owned by the farmers and operated by them as a mutual company, each farmer owning stock in the company in proportion to the number of acres which he has in cultivation.

A water right or water stock now sells at $12.50 per acre. The stock, not being attached to any particular piece of land, finds a ready sale in the open market at that figure.

The farmers bought the canal eleven years ago, since which time they have replaced every structure on the system and put in a new head gate of stone and steel, at a cost of $17,000.

Lying immediately above the line of this canal is a tract of land (approximately 70,000 acres) more than 60 per cent of which is Government land, which it is proposed to irrigate by means of a high line canal.

Efforts have been made to secure private capital to construct this canal and at one time a district was organized under the "Colorado District Irrigation Law," but this failed by reason of the promoters being unable to place the district bonds when voted. The owners of the deeded lands under the line of canal are now taking the necessary steps to secure the construction of the canal by the Government under the provisions of the Reclamation Act.

A Water Users' Association has been formed along the lines suggested by the Interior Department and the Department has been asked to undertake the construction of the canal.

The work of securing the subscription of the owners of the deeded lands, the articles of incorporation and their agreement to take water from the Government Canal, is progressing satisfactorily and in a short time the required amount of 90 per cent will have been subscribed.

As there is more water in the Grand River than can ever be used in irrigating the lands adjacent thereto, there is no question of priority of water rights to be adjusted and the land owners under the Grand Valley Canal having all the water they require with sufficient ditch to convey it to their land, they are in no way interested in the Government canal, except as it will promote the general prosperity of the country.

The criticisms that are often made on the Government projects, namely: that it antagonizes private capital and confiscates vested rights in water acquired, do not apply here, as the Government took no step to do anything so long as private capital was making an effort to construct the canal.

While the two tracts of land lie adjacent, there is no conflict of interests between them. The building of the Government canal will take nothing from the land owners under the present system.

W. S. WALLACE.

EDITOR IRRIGATION AGE:

Dear Sir—The following item may, perhaps, find an appropriate place in your pages.

The legislature of North Dakota last week passed a comprehensive irrigation code, which follows closely the provisions of the suggested State irrigation code drawn up last summer by Mr. Morris Bien, of the United States Reclamation Service. This is the first effective legislation on the subject in North Dakota, and will put irrigation investigations upon a well established and permanent basis, so that it is now possible to secure the exclusive services of a competent man as State engineer. The first State engineer, Prof. E. F. Chandler, who began that work last season and has been carrying it on in addition to his work as resident hydrographer for the United States Geological Survey and to his regular duties in the State University, now transfers the office to Mr. A. L. Fellows, of Denver, Colo., who has been for the past two years district engineer for Colorado of the United States Reclamation Service, and who now, under the new law, is appointed by Governor Sarles as State engineer of North Dakota. Yours very truly,

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NORTH YAKIMA, WASH., Feb. 3, 1905.

EDITOR IRRIGATION AGE:

Dear Sir—I have been reading your criticisms of the Government irrigation crowd with a good deal of interest. They have certainly got a great pull for all time to come if they succeed in pulling the wool over the eyes of the western legislatures, and it looks as though with the help of most of the newspapers out here they will accomplish their desires with the exception of, perhaps, the State of Washington. The people of Yakima and other valleys see the great danger to the title of the water right if the Government engineers have their way, and are making a determined and united stand against the crowd meddling with these valuable water rights already established. The courts have settled many of these rights and all is peace and prosperity now, but with the advent of the "Ozone Maxwell" crowd claiming the water of the earth, hades would be to pay; land values would depreciate 50 per cent. The people of Yakima and other valleys who have made them the most valuable sections in the northwest, are perfectly able to go on and develop that location until it is unsurpassed.

The "Ozone Crowd" are agitated greatly over the turn affairs have taken and are flocking to Olympia to try to overcome the fight of the people against the great water steal.

We hope you will continue the good work that you have started until the people see clearly what is being done to them. I am, Yours respectfully,

C. E. BURLINGAME.

[NOTE.—The above letter was mislaid, otherwise it would have appeared in our March issue.—EDITOR.]

EDITOR IRRIGATION AGE:

Dear Sir—With the repeal of all land laws except the homestead act, by which to acquire public domain, the question arises what is to become of the permanently semi-arid and arid lands? The nature of the lands exclude the possibility of their entry by homestead, and that is the only law to remain by which they may be entered. One wonders if this is not a part of some premeditated plan to give herdsmen, without charge for unlimited time, undisputed possession of all that remains of the public domain, and by stopping entries on public lands to curtail the fund available for reclamation.

However, repeal of the present land laws may have the effect of opening a way to new legislation to result in permanent good. Surveys will soon have established which lands are permanently beyond hope of reclamation by irrigation, and they may be segregated to that class. Then a lease law upon the following basis could not find logical opposition.

To any one person (citizen or head of family) a maximum of ten sections: that will furnish pasturage for 200 to 300 head of cattle, or its equivalent, which is competent for support of a family.

Leases may not be subject to sublease, transfer or assignment, and leasehold requisites should be: continuous residence upon or in vicinity of lands, and use thereof. Entire acquirement to be fenced and subdivided into at least three divisions, each one of which be permitted to rest, recuperate and reseed at least one year in three (native grasses, while classed as perennials, require reseeding to retain their vigor). All leased lands to be subject to regulations of a committee composed of the chief forester, the chief Agrostologist, and the United States land commissioner, who shall constitute an executive board. Leaseholders to pay annually to the receiver of the United States Land Office, in which district the land is situated, not less than three cents nor more than ten cents per acre (lands to be classified according to forage capacity. This will furnish summer pasturage for cattle at not to exceed one dollar per head for season). Such payments to be due and payable in advance on January 1st of each year. If delinquent for thirty days thereafter, lease may be forfeited and lands declared vacant.

The fund thus acquired, after deduction of regular fixed fees, may be applied as follows: Five per cent to county, 5 per cent to State, 45 per cent to the reclamation fund, and 45 per cent to grass and forestry experiments. Experimental stations should be located, at least one in each of the semi-arid States, to be builded and operated entirely within the fund thus created.

Maximum period of life of lease may be ten years, but at the expiration of that period may be extended for any number of years not exceeding ten, resident leaseholder holding preferencial right.

If a permanent possession for a period of years is attainable, possessors will build substantial homes, where now are ephemeral structures of sod and adobe. Other benefits would be to make the maximum number of homes, and constant improvement, and constantly increased productive capacity of the range, and restore that practically exhausted empire to rejuvenated vigor and perpetual profit. Should meteoric or geological transfiguration, superabundant rainfall or discovery of mineral, stone or salines render lands under lease more valuable for other purposes, the authority may lie in the Federal Board to abrogate a lease at any time, appraise improvements, pay for and sell them, and turn the lands to other uses for which they may be best adapted.,

G. L. SHUMWAY.

EDITOR IRRIGATION AGE:

Dear Sir—Intense interest in the negotiations of the National Reclamation Bureau has been manifest in Idaho for the past six months, during which time surveys and plans have been made for the reclamation of over a million acres of land in the Payette and Snake River Valleys.

A large portion of this vast acreage is contiguous to the Oregon Short Line Railway and the highly developed farms and orchards of southwestern Idaho and Eastern Oregon.

Already the suburban telephone system has spread its net of wires throughout the fertile valleys and the rural mail routes extend from the cities and villages of recent development to the interior settlements which have sprung up during the past few years under the magic wand of the irrigator.

All the canals of the Payette Valley are owned and operated by the farmers; these are the most successful canals in the State, with an ample and never failing supply of water and efficient and economical management. The largest of these canals, known as the Farmer's Co-operative Irrigation Company, is thirty-five miles in length and will irrigate 20.000 acres of land. The Noble Ditch and the Lower Payette Ditch are about twenty miles long and will each water about 10,000 acres of land.

The seven or eight tons of alfalfa hay per acre raised on these farms each year is fed to the sheep and cattle which find pasture during the summer months in the surrounding mountains. The large orchards of apples, prunes, peaches, pears and cherries furnish employment for an army of fruit pickers and packers, and the luscious and tempting fruit is marketed to the far East as well as in the intermountain States, being handled through the large packing house at Payette owned by the fruit growers' association.

Adjoining this prosperous valley the Government now proposes through its Boise-Payette project, to reclaim some 250,000 acres of sage brush desert, using the Payette lakes as a great reservoir and diverting from the Payette River with a dam over seventy feet high.

Directly across the Snake River in Oregon it is proposed to irrigate 100.000 acres from a reservoir to be constructed by the Government on the Malheur River, a short distance above Vale.

The Water Users' Associations are just now trying to cope with the many complex difficulties which must be removed before Government aid can be secured.

The Boise-Payette project has the merit of having sufficient land which can not be watered by other canals to warrant the proposed expenditure of some three million dollars, and contracts will probably be let before the end of the year for this great work.

The Malheur proposition is more difficult to handle and it is doubtful if the benefit to be derived will warrant the incurring of the estimated cost of three million dollars for the reclamation of less than 50,000 acres of land *not susceptible of irrigation* from other canal systems.

Much indignation has been felt in this section against Mr. Newell on account of his attempted interference with the completion of the canal and reservoir system of the Malheur Irrigation Company, which has been in course of construction for more than a year past, and will reclaim over 50,000 acres of choice land when completed.

On account of the heavy cost of the Malheur reservoir and the limited amount of acreage which could be reached, aside from the land already reclaimed, it was thought necessary to secure about 30,000 acres from the lands under the partly constructed canals of the Malheur Irrigation Company and notwithstanding the fact that the officers of the company were well known capitalists, who had already made a success of the largest canals in southwestern Idaho, and had done more in the way of *home building* by colonizing the lands in that section, during the past four or five years than had been accomplished by all other sources combined during the preceding decade, Mr. Newell kept some of his Government employes engaged for several days in making a personal canvas and misrepresentations to the farmers until he secured the required amount of acreage from the lands under the partly constructed canals of this company. Many of the stockholders of the company were those having homesteads and desert entries and their ability to make final proof and hold their claims depend upon the prompt completion of the canals and reservoirs of this company, as the Government does not contemplate building its reservoir and canal system in time to be of any service to these entrymen in their immediate need.

As yet no official protest has been made to the Interior Department, but a vigorous one is being formulated which will not reflect any credit on Mr. Newell as the chief engineer of the National Reclamation Bureau. (Exerie.)

The following interesting letter was recently received by the Morris Machine Works, Baldwinsville, N. Y., from their New York office, with reference to a pump that was sold to a machinery man in the Philippine Islands:

Near Manila is an immense rice field of something like half a mile square, owned by the widow of a Spaniard, who was a leading judge here and was deported to Spain shortly before the American occupancy, and dying there. The widow is upward of seventy years, a native Filipino and very wealthy. She takes an active interest in the farm and is a hustler from early morning until night, knowing every detail of her large estate.

Her oldest daughter is married to an American, a friend of mine, who suggested the irrigating plant in question, the losses in the previous year being upward of $50,000 on account of the drought killing the rice. While the plant was being erected the old lady expressed much doubt as to its success, and was on the keen lookout for a failure, in order to bring her American son-in-law to a realizing sense of the unworthiness of himself and his countrymen.

A neighbor of the old lady had shortly before put in a refrigerating plant, a composite affair, having obtained the pump from San Francisco, and an old local boiler, and in addition to paying more at the outset than I had charged the old lady, he had spent over $1,000 gold in having it tinkered up, and it had proved a flat failure. Between this neighbor, old Captain Jose, and the old lady was a friendly rivalry as to their respective rice plantations, and the new fangled method of irrigation, both having used carabos in times past. The heart of the old lady was palpitating between a failure of her pump and the consequent loss of money paid for it, and a hope of glorying over the old captain in the event of success.

I made a private trial of the pump and assured myself that all was in good order, and allowed the old lady to see enough of its working to satisfy her that it was not a failure. She then planned a great fiesta, invited all the neighbors for the coming Sunday, and prepared to properly dedicate the plant, and incidentally show the old captain that she, a woman, could succeed where he had failed.

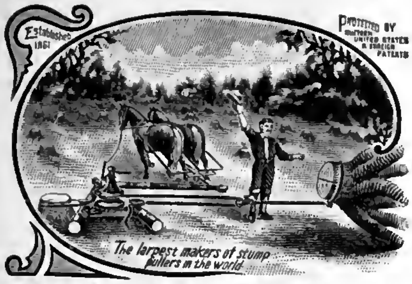
The fiesta was a grand success. The old lady had her servants prepare a dinner for 150 guests, the tables being spread near the plant out in the rice fields. Two whole hogs were roasted over slow fires by having a bamboo thrust lengthwise in them, and other food was in abundance. An excellent Filipino band was in attendance, all the leading men and women of the village were there in their best, old people and babies without end and pretty Filipino girls and their swains.

I had on a full head of steam, started the pump, and, as the solid stream of water five inches in diameter swept down the ditch toward the rice fields, there was a comical look of wonder on each face. Smoothly and almost noiselessly the machinery worked, and the old lady's face wore a look of serene joy as the minutes went by and the pump kept up its steady whirl, and the heavy rush of water went tumbling down the long ditch. It was a success. A look of infinite superiority came over the old lady's face as she looked at the crestfallen captain, who stood silent by the swift flowing stream. He had spent over $2,000 gold on his pump and it could not be used. She, a mere woman, had had sufficient "Savey" to buy a good Morris pump from Senor Strong, and Senor Strong was an Americano who saveyed mucho.

And now came the ceremony. The good priest was present in his full robes, his two attendants stood on either side, the candles were lighted, and the incense burned, and with his holy book before him he impressively read the dedication service. Closing, he stepped up to the boiler and solemnly blessed it, sprinkling it with holy water. Next he repeated the ceremony with the engine and pump, the reverent silence being broken only by the whirl of the pump and the rushing water.

Now came the fiesta, the lunch, the jollification of the young people, and the music and dancing. Commencing at ten o'clock in the forenoon, it lasted through the whole day.

You might say to the Morris Machine Works, who supplied the pump and engine, and the James Beggs Company, who furnished the boiler, that I have little doubt but in times past much, if not all, of their machinery has been cussed by the purchasers, but they have here, in the far-off Philippines, an instance where their machinery has been blessed. And the blessing has availed, for there has never been a stop or break since the first, and the poor old Captain Jose is still bemoaning his luck that he has not purchased a Morris pump from Senor Strong.



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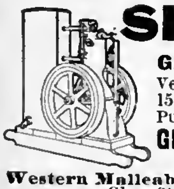

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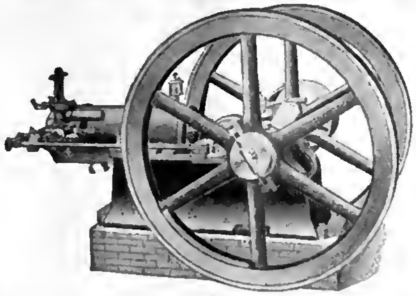

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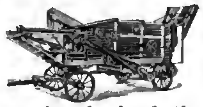

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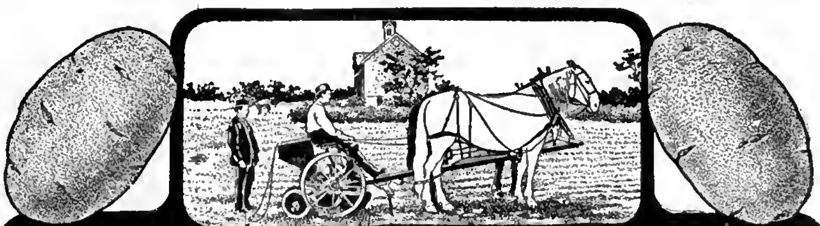

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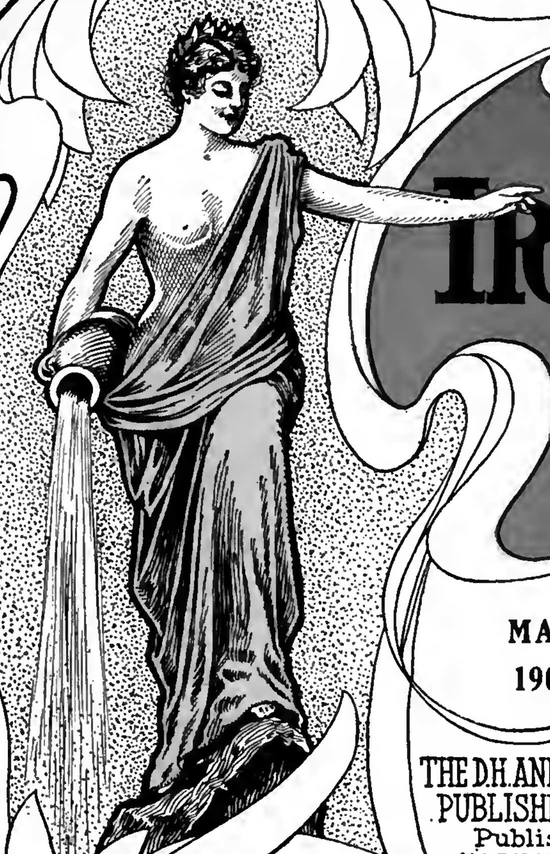

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MAY, 1905.

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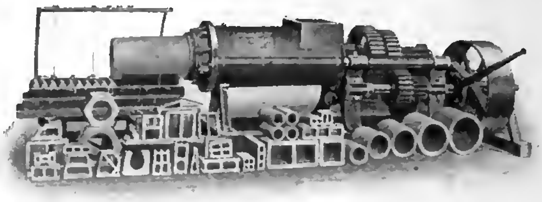

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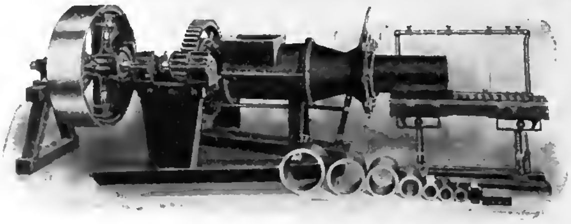

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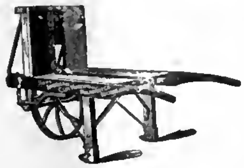

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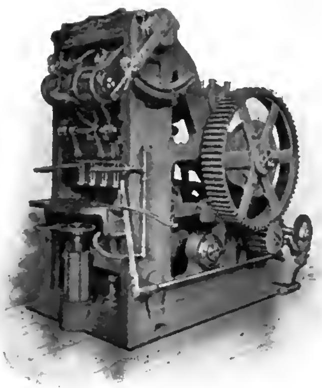

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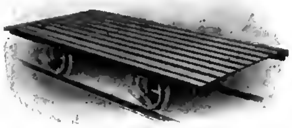

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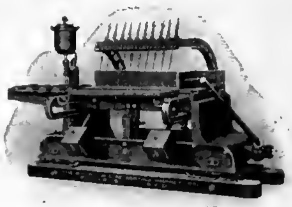

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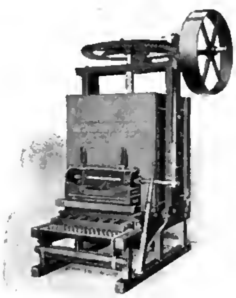

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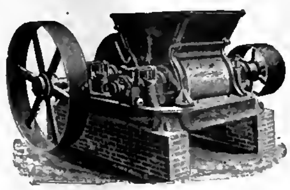

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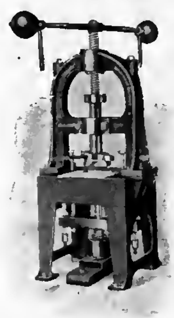

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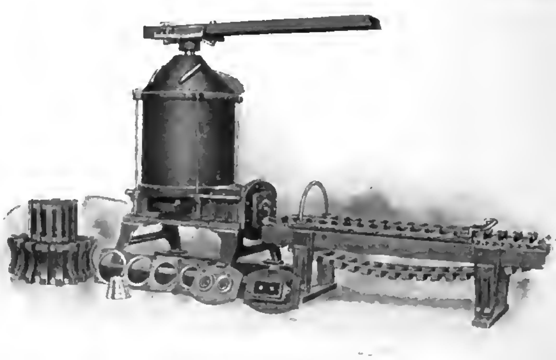

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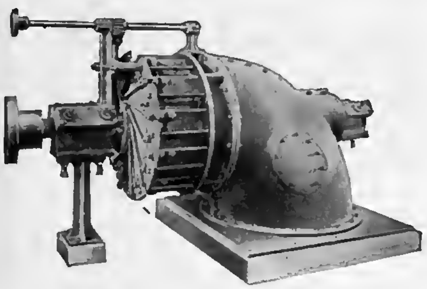

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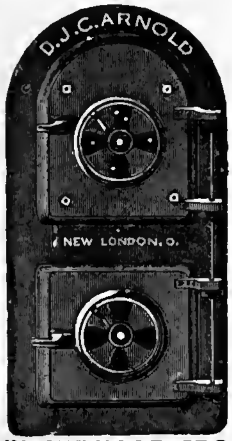

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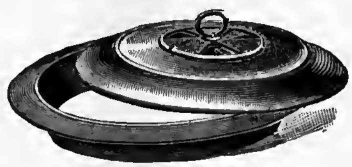

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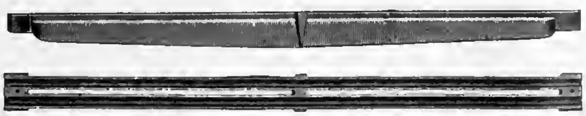

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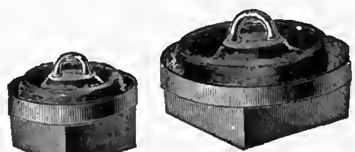

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Reclamation Bureau. The President has at last appointed a competent head for the Reclamation Bureau in the person of Mr. C. E. Grunsky, late of the Panama Canal Commission. The friends of irrigation everywhere will welcome a change which permits the possibility of clearly and expeditiously carrying out the provisions of the law. One particularly good feature of this appointment is that the many interests in the West in control of private irrigation enterprises will be recognized and all grievances may be readily brought to the attention of the Department of the Interior with no likelihood of being sidetracked, as has been the case under the mismanagement of F. H. Newell and his band of followers.

All reports concerning Mr. Grunsky are favorable and lead us to believe that an earnest and consequently successful effort will be made to carry out the provisions of the Reclamation Act. Recent information from Washington informs us that Mr. Grunsky will act as advisor to the head of the United States Geological Survey.

Large Circulation Increase. The publishers of THE IRRIGATION AGE have started a circulation crusade which will, unless all signs fail, increase our paid list of subscribers 50,000 or more. Returns from the first four weeks' work along this line show an average daily increase in paid subscriptions of over 100, and on several days during that period the addition to the list has exceeded 300 new names of people directly interested in irrigation farming and kindred lines. Does this not appeal to the men who have goods to sell to this class of readers? Many of these subscribers are new to the arid West and have gone out to that country ready to establish themselves as irrigation farmers. They have, moreover, in many cases been recruited from the farms in the central and eastern States; many of them sold out their holdings before moving West and are in the market now for re-equipment in all the lines necessary to establish new homes. Among the many necessities in establishing a new farm home in the West may be mentioned all kinds of agricultural implements, wind mills, pumps, creamery supplies and household goods of all kinds.

If you are a manufacturer and looking for a good market patronize the advertising columns of THE IRRIGATION AGE.

Official "Sunbursts." We are pleased to inform our readers that our old time correspondent, Uncle Silas, is again in the harness and is writing for the columns of THE IRRIGATION AGE. Elsewhere in this issue will be found an article from his pen on the Reclamation Service in Idaho, which will prove interesting to those who have followed the articles in our former numbers concerning the methods of the Reclamation Service.

In order that all may understand more about the methods of Washington officials who are "playing to the galleries" throughout the West, we quote below a paragraph in which Uncle Silas clearly illustrates some of their methods:

"The following incident will serve to illustrate not only the methods of the Reclamation Service but some of the personal characteristics of some of its officials.

It was during the 'campaign of education' that was being so vigorously and systematically conducted throughout southern Idaho in the interest of the Boise-Payette project. The campaign had been in progress for some time, meetings had been held up and down the country, in the towns and villages, at the country school houses and wherever it was possible to gather an audience. These meetings had been addressed by the local officials of the service and hired venders of eloquence and such county and district officials as could be induced to lend their services, and yet there were many obdurate farmers who had failed or had declined to appear at the reclamation headquarters and sign over the titles to their farms and homes and sign away their birthrights. So it was decided to hold a series of climax meetings and spring upon the unsophisticated 'sagebrusher' some of the much-advertised chief officials from Washington. The local papers began a week or two in advance to announce with all possible blandishments the coming of these official sunbursts under the caption of 'press news' dated at Washington. They finally came and a public meeting was announced for a certain evening in one of the leading towns of the district. In addition to columns of advertising matter and adulatory personal notice in the town papers, posters and handbills were distributed throughout the town and surrounding country. In the evening the brass band paraded the principal streets and afterward 'rendered a number of selections in front of the opera house.' The audience was large, well composed, and the ladies were there in their Sunday best. The distinguished citizens were assembled on the stage and the mayor presided. After one or two short addresses by the local lights, the mayor made his introductory speech and closed by saying, "and now, ladies and gentlemen, I have the flattering honor to introduce to you the Hon. Professor Frederick H. Newell, the chief engineer of the United States, and the greatest living authority on irrigation in all the world. Ladies and gentlemen, you will now listen to Dr. Newell.'

"While this was being uttered the honorable "doctor's" countenance was so beaming with unctious delight that it actually became radio-active under the influence of which the very thoughts in the minds of 'Dr.' Pinchot and 'Dr.' Ross, who sat near by, were revealed to those in the rear seats of the audience.

"The aphorism, 'a stream will not rise above its source,' was never more applicable than to the United States Reclamation Service."

Misleading Telegrams. Among the many clippings to reach our hands, one in particular, which is quoted below, arrests notice. This clipping bears all the earmarks of the Maxwell-Newell press bureau, and evidently emanates from that source. To those of our readers who are posted, much may be read between the lines. "Whom the Gods would destroy they first make mad."

We wonder how the administration authorities at Washington will take the implied criticism contained in the following telegram from a subordinate and we are also anxious to know how the Congressmen and Senators will take it when their attention is called to the fact of its origin. These two bodies have the power to ascertain the source of all of this newspaper criticism. It will readily be seen by reading the following telegram that Maxwell-Newell & Co. are not at all pleased with the appointment of Mr. C. E. Grunsky, late commissioner of the Panama canal, as advisor to the head of the United States Geological Survey.

This crowd wish to convey through the telegrams which they are sending forth to the leading newspapers throughout the West that Engineer Grunsky is only a side issue, has been appointed supposedly as a sort of an advisor to the Interior Department and the President, with no authority over the men employed in the Reclamation Service.

The combination who are sending out this class of matter are very well aware of the fact that the President and the Secretary of the Interior have not placed a man in so an important a position as that now held by Mr. Grunsky without giving him some authority over all employed in that particular bureau. It is evident that the object in sending forth such telegrams as this is to mislead people throughout the West so they may believe that it is still necessary to communicate with or keep in touch with the Newell, Maxwell & Pinchot combination in order to secure proper attention and their rights.

There is no doubt but under the able management of Mr. Grunsky the affairs in the Reclamation Bureau will take a decidedly better turn and much good work will be accomplished.

The following is a copy of the telegram mentioned above, which was wired from Washington to a prominent Idaho daily:

"President Roosevelt caused quite a flurry in official circles by the recent appointment of C. E. Grunsky, late a Panama canal commissioner, as consulting engineer of the Reclamation Service at a salary of $10,000. The appointment is applauded in some quarters, elsewhere it is severely denounced. The President's critics say that he had no authority of law for creating such a high-salaried office without the sanction of Congress. They point out that under the President's order the consulting engineer of the Reclamation Service will receive $6,000 a year more than the chief engineer and head of that bureau; will receive $5,000 more than the director of the geological survey, the next highest officer, and will get $2,000 more than the Secretary of the Interior.

The fact is Mr. Grunsky will be paid out of the Reclamation fund. The national irrigation law gives the President full authority to appoint such officials as may be needed to build the great Government irrigation works; there is no restriction as to number or salary. Under this sweeping authority Mr. Grunsky was appointed, at the earnest solicitation of Director Walcott, head of the Geological Survey.

There are some Senators and some Representatives who "have it in" for the Reclamation Service. These men made an effort in the last Congress to pass a bill authorizing the appointment of a chief engineer of the Reclamation Service at $10,000 per year, their intention being to create this office, and fill it with some "good politician" who would lord it over Chief Engineer Newell and the present reclamation force. But the bill failed. The men who were behind that measure are gloating over the appointment of Mr. Grunsky, for they look upon his selection as a rebuke to Mr. Newell. But their assumption is incorrect. Mr. Grunsky is to be what his title implies, a consulting engineer. Mr. Newell will continue as chief engineer and will be at the head of the Reclamation Service."

It will be noted that the Secretary of the Interior ranks third in classification with Newell and Walcott.

Mr. Walter H. Graves. We are presenting herewith a half-tone photo of Mr. W. H. Graves, a prominent civil engineer of Boise, Idaho. Mr. Graves is one of the best known irrigation engineers in the United States and is recognized as authority on irrigation subjects throughout the world.

We are pleased to be able to state that arrangements have been made with Mr. Graves to contribute regularly to the editorial columns of THE IRRIGATION AGE and it is our impression that with his assistance we will be able to make the paper much stronger than ever before.

Mr. Graves will furnish illustrations to accompany his articles, which will be so comprehensive that our readers will be able to surmount engineering difficulties along irrigation lines.

We have asked Mr. Graves to prepare for us a lot of short articles, properly illustrated, showing the construction of head gates, flumes, etc., etc. This sort of matter will be exceedingly interesting and instructive. We hope to begin the publication of articles by Mr. Graves in our issue of June.

The Great Falls, Mont., Tribune of February 20 has the following bit of irrigation news:

T. E. Lowery, the local agent of the Fairbanks-Morse Company, states that the largest irrigation pumping plant in northern Montana is that of Lohr Brothers, at Tampico, about twelve miles west of Glasgow, which consists of a 60-horsepower boiler, a 50-horsepower automatic steam engine, and a 12-inch centrifugal pump, its capacity being about 5,000 gallons per minute. On a test run of sixty-six hours it covered 143 acres to a depth of five inches, the cost of the run, with wood valued at $2.00 per cord, and wages for engineer and other help, being at the rate of sixty-five cents per acre. With proper ditching the plant is calculated to irrigate about 800 acres, flooding that area twice during the season.

CARL EWALD GRUNSKY, C. E.

ADVISOR TO THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

Mr. Carl Ewald Grunsky, who was recently appointed consulting engineer and advisor to the director of the United States Geological Survey, was born in San Joaquin County, Cal., on April 4, 1855. He attended the public schools of Stockton, being the only male member of the first class graduated from the Stockton high school in 1870.

After teaching school for a year as principal of South school in Stockton, he determined to acquire a professional education in Germany. Accordingly he spent nearly six years in Stuttgart, Wurtemberg, as a student in the "Real-Schule," and in the Polytechnic

CARL EWALD GRUNSKY, C. E.

Institute, from which he was graduated as civil engineer at the head of his class in 1877.

His first professional employment was as topographer with a river surveying party of the State Engineering Department of California in 1878. He was made assistant state engineer in charge of computations and office work relating to stream gaging in 1879, and was advanced to chief assistant in 1882, continuing as such till 1887.

From 1887 to 1899 he was in private practice at Sacramento and in San Francisco, also serving during 1889 and 1890 as a member of the examining commission on rivers and harbors for California. In 1892-93 he was one of the engineers selected to design a sewer system for San Francisco and served on the sewerage board of that city. In 1893-94 he again served the State of California as a consulting engineer to the commissioner of public works, dealing with drainage and river rectification problems.

A board of public works was created by a new charter for San Francisco in January, 1900. This board, under the presidency of Col. G. N. Kendell, appointed Mr. Grunsky city engineer of that city, which position he held until appointed Isthmian Canal Commissioner, 1904-5. As city engineer of San Francisco he made plans for a municipal electric light plant, a municipal gas works, a municipal telephone system, waterworks for a supply of water from the Sierra Nevada mountains, estimated to cost about $40,000,000, a city railway system and various public improvements, including a system of main canals ($7,250,000) public buildings and parks for which bonds have been voted aggregating about $17,000,000.

While in private practice he was engineer for several irrigation and drainage districts and consulting engineer for a number of cities on sewerage and water supply systems. In 1897 he contributed several water supply papers to the United States Geological Survey's publications and in 1899 and 1900 was one of the experts reporting to the Agricultural Department of the United States upon irrigation and use of water from rivers in California. Some of his reports that have appeared in print are:

Report of the Examining Commission on Rivers and Harbors for California, 1890; Report of the Consulting Engineers to the Commissioner of Public Works, California, 1895; Report on the Reclamation of District 108, California, 1896; United States Geological Survey, Water Supply and Irrigation Papers, Nos. 17, 18 and 19; United States Department of Agriculture Bulletin, No. 100, Chapter on Irrigation from Kings River, California; Report on a Sewerage System for San Francisco, 1893 and 1899; Reports on the Water Supply Investigation for San Francisco, published in Municipal Reports of San Francisco, 1900-01, 1901-02, 1902-03, and 1903-04 (the last not yet in print).

The Municipal Reports named contain also his other reports relating to public utilities and to public improvements of various kinds which are to be made in San Francisco under bond issues.

He is a member and director and has been president of the Technical Society for the Pacific Coast; member of the American Society of Civil Engineers; member and one of the Board of Trustees of the California Academy of Sciences; member and president of the German General Benevolent Society of San Francisco (German Hospital); member of many other societies and organizations.

He was married March 12, 1884, in Sacramento, Cal., to Mattie Kate Powers, daughter of A. H. Powers, now of Kings River, Fresno County, Cal.

He has four children—Carl Ewald Jr., Kate Louise, Eugene Lucius and Clotilde.

In a recent communication from an official in the Interior Department, Washington, D. C., we are informed that the position which Mr. C. E. Grunsky is to occupy is that of advisor to the Director of the Geological Survey. This information reached our hands after other matter on the subject appearing in this issue was in type.

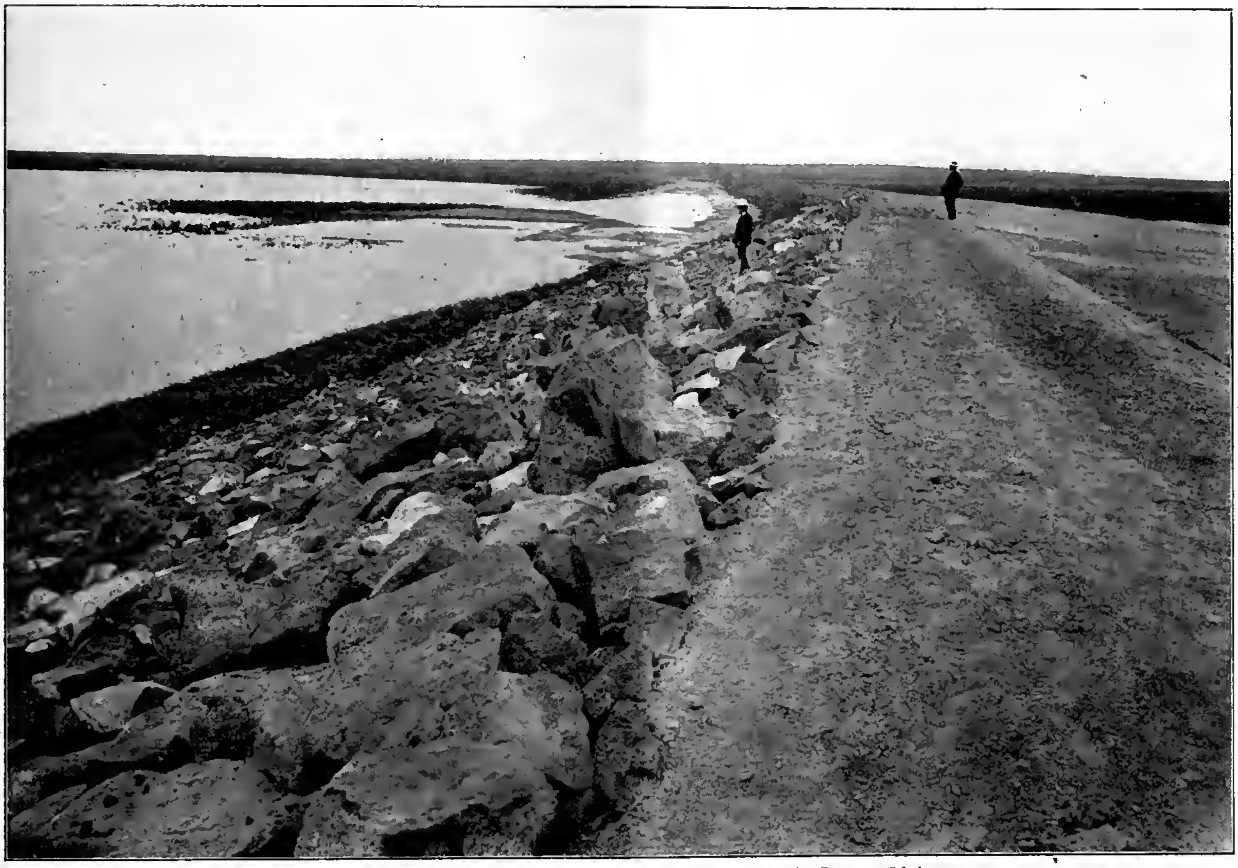
THE RECLAMATION SERVICE IN IDAHO.

BY "UNCLE SILAS."

In glancing at the map of Idaho it will be observed that the Snake River almost encircles the southern portion of the State. Snake River proper is formed by the confluence of numerous streams and forks descending from the lofty and rugged mountainous region in and about the Yellowstone National Park in the northwestern corner of the State of Wyoming. As these streams debouch from the mountains they distribute themselves over the lava plain forming the western flank of the mountains through innumerable channels, finally uniting, as already stated, to form the Snake River near the eastern boundary line of the State of Idaho. The fan-like course of these numerous streams centering toward a common point has given rise to the term, "The Delta of the Snake." Owing to the abundance of water and the excessive slope of the plain and the shallowness of the various channels, all contributing to lessen the difficulty and expense of diverting the water for the purpose of irrigation, this was one of the first portions of the State to be occupied by settlers and to be reclaimed by irrigation and is today a thriving, prosperous, well-populated district. From this part of the State Snake River flows toward the south gradually swinging to the west, thence toward the north and finally veering to the east, making almost a complete semi-circle about 250 miles in diameter. In a distance of 300 miles in its course across the State the river falls over 2,000 feet, the general slope of the country in a measure corresponding with that of the river. The drop of the river is not on an even slope, but is accomplished through a succession of "over-shots" or cascades on a large scale. Above these falls the river approaches the general level of the adjoining country and at or near the crest of the falls are to be found sites favorable for the diversion of the water necessary for irrigating the contiguous country, and practically every available location for such a purpose along Snake River had been appropriated by individuals or corporations organized for the purpose, at the time of the passage of the law instituting the reclamation work on the part of the Government. In most cases these projects were well underway and some of them had progressed to that point where the work of construction was about to begin—plans formulated, extensive surveys made and financial backing procured, when the agents and officials of the Government Reclamation Service appeared upon the ground and took possession of them, appropriating everything the projectors had acquired up to that time—a ruthless, high-handed outrage. The first step taken by the Government was to segregate the land and withdraw it from entry. Of course, this step was effective and put an end to the enterprise at once. Some of the companies were wise and made peace with the officials at once. It is alleged that it cost one of these corporations $100,000 to secure immunity and it is a noticeable fact that the enterprise concerned in this rumor is the only one that has been allowed to proceed, and the consummation of this project is a striking demonstration of the success of "private enterprise" in this direction. The Minidoka Company placed such absolute reliance upon receiving fair treatment and just consideration from the authorities at Washington that they ignored the reclamation officials altogether; a course which has resulted—up to this time—in the confiscation of their entire scheme, plans and all, and this is practically the history of every other irrigation undertaking along the Snake River that had been projected prior to the time the Reclamation Bureau began its operations in that field. Had the "private enterprise" concerns been allowed to proceed most of them would doubtless have had the construction of their systems well along toward completion by this time, as has been the case with the Twin Falls Irrigation Company, which has, at an expenditure of over $2,000,000 dollars practically completed within the last three years one of the largest and most complete irrigation systems in this country, or, for that matter, in any other country. Most of these projects were organized under the provisions of the "Carey Act," which requires a contract with the State authorities covering every detail of construction and operation, a bond to enforce the fulfillment of every specification of this contract, and the fixing by the State officials of all charges to be made against the water users, so that the people living under and patronizing these irrigation systems enjoyed every possible guarantee and protection against imposition or injustice.

Under such an arrangement it would have been impossible for one of these corporations to have misled and deceived 500 settlers by inducing them to enter upon lands and improve them through widely published and persistent announcements that the lands were to be supplied with water and then subsequently discover the project to be impracticable and abandon it, as has been done recently by the Reclamation Bureau at Minidoka. It may be possible to do this under the provisions of the Reclamation Act, but it is hardly possible to do it under the provisions of the "Carey Act," without someone paying pretty dearly for the blunder.

Under the Carey Act system the water user has the assurance of knowing in advance not only what the water will cost him in the first instance but also the subsequent charges for maintenance and operation, which are determined by the State authorities. Upon the purchase of his "water rights" he becomes a stockholder in the enterprise and when the majority of the stock is sold the management passes to the control of the stockholders. He is not hedged about by innumerable and onerous restrictions and conditions and he is as free to carry on his business and conduct his own affairs as the ordinary citizen. The contrast between this system and that proposed under the Government Reclamation Act is striking—at least as the reclamation officials have announced and promulgated their methods and plan of operation. Under the Government plan the settler is required at the very beginning to sign an agreement conveying to the Government or its agents a perpetual lien or mortgage upon his lands, the purpose of which is to enforce the collection of any and all charges of whatever sort and amount that may be assessed against him and also to enforce compliance with all of the conditions and regulations that may be arbitrarily established by the officials of the Reclamation Service. He is required to limit his land holding to whatever area the Government agents may be pleased to fix for him, which has been variously



Dry Creek Reservoir, Twin Falls Land & Water Co., Lincoln County, Idaho.

stated in the numerous manifestos that have been issued to the public. to be all the way from forty acres to 160, depending upon the quality of the land (and presumably how well the settler stands with the official in charge, for it is entirely discretionary with him), and the amount of water to be allowed each user is also to be determined, not by the user nor by the requirements of his land or the character of the crop he raises, but by the official in charge and at his discretion and pleasure, as he is supposed to be an "expert" in such matters, having just passed an academic civil service examination in botany, astronomy and civil government at Washington, although he may never have seen an irrigating ditch in his life. The settler is further required to be a perpetual occupant and a personal cultivator of his land and under no circumstance can he own or hold any land that may be in excess of the amount fixed by the reclamation officials, or that he does not personally occupy and cultivate, and should he at any time decide to sell his land (and if he should, by any reason whatever, be incapacitated for occupying or cultivating his land he would be compelled to sell it) he could not go into the market and sell it to the highest bidder, but he would have to find some one that would agree to personally occupy it and cultivate it, otherwise his sale would be void. A failure to comply with any of the numberless regulations governing the occupancy of the land under the Government irrigation systems that are to be controlled by the Reclamation Bureau implies the foreclosure of the lien held by the Government and the forfeiture of ownership. There are so many other requirements and prohibitive conditions, as set forth in the numerous proclamations issued by the Reclamation Bureau, that it would seem that these Government projects were to become practically penal settlements.

While Snake River is a stream of considerable importance and during the greater part of the year carries enough water to supply all of the irrigation ditches depending upon it now constructed, yet there are times when the supply is short and insufficient to meet the requirements of the land already reclaimed, therefore the question of paramount importance to all concerned, both in existing systems and in projected systems, is the development of additional water supply, especially during the low water period.

This is also the case in almost every section of the irrigated West. The crying need is "more water." There is no difficulty in securing all the money necessary to construct ditches where it can be shown that there is a sufficient area of suitable land contiguous to reliable water supply that would justify the expenditure.

It was generally supposed that the Government Reclamation Bureau would address itself at once to the consideration of this most important and far-reaching problem—the conservation and storage of the flood waters—and this was undoubtedly the idea and belief of those chiefly responsible for the Reclamation Enactment. Instead of this we find the time and energies of those charged with the responsibility of executing the law chiefly engaged in petty competition with local and private institutions, in laying out townsites, selling town lots, planning electric lighting plants and street car systems and promoting private interests and operating press and advertising agencies. The lavish use of the columns of the country press and the prostitution of the news agencies have for the time being beguiled the public, but this can not last. There are some capable and brainy men connected with the Reclamation Bureau, but as a rule such men are modest and will take time to reveal them. They would undoubtedly comprehend the scope and opportunity of this institution and if given a chance would give it the standing and dignity that it is entitled to in the estimation of the public.

According to the published statements of the Reclamation Bureau $1,600,000 have been appropriated for the construction of the Minidoka irrigation system, and to inaugurate this undertaking it became necessary to strangle a "private enterprise" for which all preliminary preparation had been made, including financing. For the Malheur project $2,700,000 have been appropriated to reclaim less than 90,000 acres, and to make room for this undertaking it became necessary to stifle another "private enterprise" that had planned to reclaim 140,000 acres of the same territory at an estimated expenditure of over $300,000 less than the Government has appropriated. For the Boise-Payette project $1,300,000 have been appropriated for enlarging an existing ditch that covers much more land than there is water in the river to supply. Had this vast sum of over $5,000,000 been devoted to the storage of the flood water either at the head of Snake River or on the upper reaches of the Boise River, or divided between these streams it is more than probable that enough additional water supply could have been developed to have reclaimed three acres of land where one can be reclaimed under the present apportionment of this expenditure.

The appropriation and utilization of this additional supply of water might have been left with all propriety and assurance to the owners of the land to be reclaimed and at no expense whatever to the Government, and moreover, there would be obviated under such an arrangement all likelihood of conflict between the Federal and State authorities over the administrative control of the distributing ditch systems.

To those not familiar with the inner workings of the Reclamation Service the much-vaunted Boise-Payette project presents some features that are as peculiar as they are dubious. The scheme is laid principally in the Boise Valley. A district that is supplied with ditches galore, but is short on water. The scheme contemplates the relinquishment of scores of well-improved profit-producing farms, with long-standing legally-established water rights that are exceedingly valuable, being operated under customs and laws that are well understood and recognized, and the acceptance in lieu thereof of a minimum unit of land, the ownership of which is conditioned on the perpetual occupation and personal cultivation by the owner and with a water right that is as uncertain in tenure as it is indefinite in quantity and manner of use, and to be operated according to the dictation and discretion of an alien agent and to be prorated and placed upon the same footing as farms that are yet to be carved out of the sagebrush plain, which the owners of such farms are expected to do without a murmur of protest for the glory of the Reclamation Service and the benefit of a coterie of land speculators that are trying to "get rich quick" through the popularity of the Government reclamation idea. Considering the strenuous and persistent efforts that have been made to create popular support and favor for this scheme, the unstinted use of money, the employment of every agency and influence that could possibly be invoked or enlisted, the use of specious argument, the appeal to civic and local pride and the constant reiteration of the statement that the funds that were available for this project and that could be used for none other within the State of Idaho, would be diverted to other States unless secured at once, and the resort to sensational methods usually adopted by fake advertisers, there is every reason to believe that there is some inspiration and actuating influence behind this project other than public spirit or philanthropy. However, one does not have to look far to discover evidences of the promoting influences.

As the project was first outlined to the confiding public it involved an expenditure of some $5,000,000, and was to reclaim practically all of the land in the Boise and Payette valleys including the lava overflow, the escarped and rocky slopes of the foothills, surfaces vertical as well as surfaces horizontal, "any old thing" so long as it counted into acres, and a given number of these acres was to support its quota of a "dense population," all to be made individually and collectively wealthy by the great and benevolent Uncle Sam. Under the influence of the music of brass bands and through the eloquence of hired "spell binders" at the country cross-roads as well as at the festive banquet board, the project grew and it grew until it attained colossal proportions, variously stated to cost from $10,000,000 to $20,000,000. It was officially affirmed, repeatedly, that this gigantic project could and would be completed within the short space of two years and then all the blessings so glowingly described would immediately follow; but it was never intimated that the consummation of such project would require the refunding of all the money expended, including the frills and the fiddler's expenses, or that it would place a blanket mortgage over the community that would abide to vex a generation yet unborn. Even the modest estimate of $5,000,000 proposed in the beginning would require the refunding annually of $500,000 for ten years and to undertake this would bankrupt a community wealthier than the residents of Boise valley. In all the discussions and proclamations relating to this great project few references have been made to the question of increasing the water supply, and when it is remembered that there are miles of ditches that are idle during a part of the year for want of water and that the river is practically dry at times, it certainly does seem that the reasonable and sensible thing for the Government officials to do is to devote their efforts to the consideration of the storage of water and the construction of reservoirs and leave the farmers to manage their own domestic affairs and construct and operate their own ditches.

It is now announced that the Boise-Payette project is to be realized, having been submitted to the authorities at Washington and approved by them, not, however, as a $10,000,000 or even $5,000,000 hallucination, but a paltry $1,300,000 scheme and therefore it is not to be expected that all of the citizens of Boise valley will be made "rich"—just a few, those that it was designed to benefit.

The project, as it is to be, according to the latest announcement, consists of a reservoir located at the lower end of the Boise valley, which, of course, will be of no advantage except to those lands lying below it at the extreme end of the valley (lands belonging to the coterie of land speculators already referred to), and this reservoir is to be supplied through the Ridenbaugh canal, which, of course, will have to be purchased and enlarged.

The Ridenbaugh canal is one of the oldest on the river, although its point of diversion is lower than some of the others. The selection of this canal for the purpose of supplying the proposed reservoir, it is alleged, was to avoid interfering with the interests and operations of the Barber Lumber Company, the dam and water power of this company being located above the intake of the Ridenbaugh canal. It has been supposed, and so stated repeatedly by the reclamation officials, that the New York canal, which is the highest canal in the valley and taking water from the river some three or four miles above the Barber Lumber Company's dam, would be taken over by the Government in carrying out the design of the Boise-Payette project, as this canal would cover practically all of the land in the valley on that side of the river, 100,000 acres of which lies above the Ridenbaugh canal, and would also supply several proposed small reservoirs and also the one that it is now proposed to construct at the lower end of the valley, but to divert this water at a point above the Barber Lumber Company's dam would be to rob that company of a portion of its water power, hence the decision to abandon the New York canal and the 100,000 acres covered by it. The selection of the Ridenbaugh canal and its enlargement would be of no benefit to the farmers living under it and now supplied by it, as the supply taken from the river is not increased and the reservoir is too low to be of any value to them, and for them it is simply a question as to whether it is preferable to have the Government control and operate the canal or for them to do it.

So it would appear that this much-advertised and much-exploited Boise-Payette project turns out to be a "pipe dream" for most of the people living in these valleys, and is to be materialized only for the benefit of a few interested owners of land in the lower end of Boise valley. Now that the real purpose of the project is disclosed, there are some sore and disappointed people, and rumor is rife with all sorts of ugly charges of chicanery, jobbery and graft. It is asserted that the Government engineers have been employed by the Barber Lumber Company and the land speculators to connive and contrive in their interests. These are ugly rumors and the Washington officials owe it to themselves and to the public to investigate the matter thoroughly and without any attempt at whitewashing either.

The following incident will serve to illustrate not only the methods of the Reclamation Service but some of the personal characteristics of some of its officials. It was during the "campaign of education" that was being so vigorously and systematically conducted throughout southern Idaho in the interest of the Boise-Payette project. The campaign had been in progress for some time, meetings had been held up and down the country, in the towns and villages, at the country school houses and wherever it was possible to gather an audience. These meetings had been addressed by the local officials of the service and hired venders of eloquence and such county and district officials as could be induced to lend their services, and yet there were many obdurate farmers who had failed or had declined to appear at the reclamation headquarters and sign over the titles to their farm and homes and sign away their birthrights. So it was decided to hold a series of climax meetings and spring upon the unsophisticated "sagebrusher" some of the much-advertised chief officials from Washington. The local papers began a week or two in advance to announce with all possible blandishments the coming of these official "sunbursts" under the caption of "press news" dated at Washington. They finally came and a public meeting was announced for a certain evening in one of the leading towns of the district. In addition to columns of advertising matter and adulatory personal notice in the town papers, posters and handbills were distributed throughout the town and surrounding country. In the evening the brass band paraded the principal streets and afterward "rendered a number of selections in front of the opera house." The audience was large, well composed and the ladies were there in their Sunday best. The distinguished citizens were assembled on the stage and the mayor presided. After one or two short addresses by the local lights the mayor made his introductory speech and closed by saying: "And now ladies and gentlemen, I have the flattering honor to introduce to you the Hon. Professor Frederick H. Newell, the chief engineer of the United States, and the greatest living authority on irrigation in all the world. Ladies and gentlemen you will now listen to Dr. Newell."

While this was being uttered the honorable "doctor's" countenance was so beaming with unctuous delight that it actually became radio-active, under the influence of which the very thoughts in the minds of "Dr." Pinchot and "Dr." Ross, who sat near by, were revealed to those in the rear seats of the audience.

The aphorism, "a stream will not rise above its source," was never more applicable than to the United States Reclamation Service.

The registers and receivers of the United States land offices in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Nevada, North Dakota, Oklahoma, Utah, Washington and Wyoming, today were instructed by the commissioner of the general land office to notify all persons who have heretofore entered, or who may hereafter enter any of the lands which have been segregated under the provisions of the Reclamation Act of June 17, 1902, that the leasing of such lands or portions thereof to other persons who have been and are conducting the business of selling alcoholic liquors on said lands, principally to the employes engaged on the Government works, that such leasing either by themselves or others will be deemed sufficient cause for the cancellation of the entries embracing the lands so used or occupied.

The officers of the land offices are further directed to give the widest possible publicity to the fact that such use of any lands withdrawn under this act, whether such lands have been entered or are unentered, will be prevented by proper actions in ejectment, by injunction, or otherwise.

These instructions have been called forth by the deplorable conditions existing in Nevada, where the Government work employs several thousand men. Homesteaders have leased a portion of their lands to persons engaged in the liquor business, and murder and robbery have been rampant in consequence.

IRRIGATION INVESTIGATIONS, UPPER SNAKE RIVER, IDAHO.

BY E. B. DARLINGTON,
Field Manager for State Engineer.

The Office of the State engineer of Idaho has just completed maps and reports upon irrigation conditions in the Upper Snake River valley, an examination of which was undertaken about a year ago.

These maps and reports are for the use of the court in adjudicating water rights, and serve as evidence in probably the most important and comprehensive suit at law ever brought in the State. This is the famous case of the Rexburg Irrigation Company et al., vs. the Teton Irrigation Canal Company et al., which involves all the water rights on Snake River and its tributaries in Fremont and Bingham Counties. It is estimated that there are at least 30,000 parties in interest in the suit.

The survey embraced the measurement of all irrigation ditches and canals diverted from Snake River and its many tributaries above American Falls, and a determination of the irrigated and irrigable areas dependent thereon.

About 250 canals were thus measured and their courses and dependent lands acurately mapped and 175 detailed reports describing each canal, the point of diversion, the condition of the works, listing the irrigated and irrigable lands and furnishing all other information that would be of service to the court in adjudicating rights, have been made up and copies sent to the court having jurisdiction. In connection with these reports 240 large maps were required, showing the lands in various colors, to correspond with the canals which serve them. It is safe to say that the data thus presented forms a record that has never been duplicated in the history of the State.

The compiled statistics show that 290,679 acres are at present irrigated in that locality, 502,501 acres are susceptible of irrigation and over 50,000 acres lie under mountain streams which are inadequate for irrigation purposes. In the accumulation of the data probably 1,500 square miles were covered. The field parties were engaged from March until December, and though working under very adverse circumstances, the examination was thoroughly and successfully carried out.

Work was begun about the middle of March, 1904. At that time five parties were organized, but this number was afterward increased to six. Each party consisted of a transitman, a field draughtsman and two stadia rodmen. It was found that at times a third rodman could be used advantageously, but on the whole four men proved to be the most economical and mobile party organization.

Each party was assigned a territory estimated to contain two or three weeks' work from one camp, but effort was made to distribute the parties in such a way that two teams could handle them all. This arrangement was found to be quite satisfactory and resulted in a considerable saving for team hire. In emergencies extra teams were engaged from the farmers without difficulty.

Usually when a party commenced an assignment the headgate or point of diversion of the most important canal in the territory was tied to the nearest section corner by course and distance, the true meridian being determined by solar observation. The alignment of the canal was then run out, each plate angle of azimuth and stadia distance being read by the transitman to the field draughtsman, who responded by calling the calculated course, which was checked by a glance at the needle, the magnetic declination being set off on the plate. The draughtsman then platted the readings and sketched in the canal, the laterals and such other features as were thought desirable. The field maps were drawn upon a scale of 500 feet to the inch.

After all the canals in a given territory were accurately located and the points of departure of laterals indicated, needle traverses were run along controlling lines, from which radial shots to determine boundaries were recorded and platted. Contour traverses were sometimes necessary to cut out land above the gravity lines of canals. Land was classified as "irrigated hay, irrigated tilled, dry but irrigable, and non-irrigable under existing systems." The boundaries of these tracts were indicated on the maps by different colored pencils. The draughtsman also sketched in the feed laterals to show how and by what system the lands were watered. Notes as to the character and porosity of the soil were taken by the transitman. It was found that ordinarily about two square miles could be mapped by each party daily, after the canal lines had been run.

Measurements for capacity were made at representative points along each canal. In determining cross-sectional areas, rod readings were taken at two-foot intervals on large canals and at every foot on small canals, and the mean of several measurements was assumed to represent the true cross-sectional area. The grade for several hundred feet was then determined, and the condition of the bottom and sides of the channel minutely described as a basis for the evaluation of the co-efficient of friction (n). By these means, complete data were obtained for computing Q by Kutter's formula. The use of meters in gauging velocity was impracticable, as canals were seldom or never flowing at their maximum capacity.

Measurements, sketches and descriptions were also made of diversion dams, headgates, waste gates and flumes in order to show the condition of works.

In the office, profiles of every cross-section were constructed and the computations of capacity were made. About 245 detail maps, showing the land in colors to correspond with the canals that serve them, and an index map of the whole valley on a much smaller scale, was made to expedite reference to the detail sheets. Progressive maps were also furnished to the United States Geological Survey monthly.

Perhaps the most remarkable feature about the undertaking was its comparatively low cost, no doubt due principally to the size and scope of the undertaking, making an economical organization possible.

Big Cut, on Mink Creek Canal, Oneida Irrigation District, Idaho.

The total expense of the survey was $28,000, which, divided by the number of acres involved, gives a cost of approximately 3½ cents per acre. The Reclamation Department of the United States Geological Survey assumed a portion of the cost, amounting to $9,735, in order to obtain the information for its immediate use, and the balance is assessed to the litigants. As the maps are of public record, every landowner in the Upper Snake River valley has the benefit of an excellent map of his property at a cost to him of 2.3 cents per acre. In other words, every 80-acre farm was surveyed and mapped for $1.85.

The work was under the direction of State Engineer James Stephenson Jr. The writer had immediate charge of the survey as chief engineer, and was ably assisted by Mr. Z. N. Vaughn, of Boise, field supervisor; J. W. Shepperd and H. C. Smith, of Moscow; W. N. Gibb, of Genessee, Idaho; J. P. Taylor, of Pocatello, Idaho; Lindsey Hudson, of Salt Lake, Utah, and A. D. P. Janney, of Leesburg, Va., instrumentmen.

At Henry's Lake, the extreme head of irrigation on Snake River, it was found that about 15,000 acres of land lying about the lake and along the outlet were topographically susceptible of irrigation, but that the small mountain streams upon which the land depends are entirely inadequate to serve this area. In fact, only about 4,500 acres of this fine body of land are actually watered and the entire flow of these streams is now in use. This is a cattle-raising country and considerable land in Henry Lake bottoms requires no water to make it suitable for grazing.

In Sheridan valley and along Shotgun Creek practically the same conditions obtain, there being something over 5,000 acres for which there is no water supply.

At Island Park, which lies in a bend of the river, there is a fine body of land owned by a number of the officials of the Oregon Short Line. They have built fine summer houses there and have a splendid farm, of which about 1,300 acres is irrigated.

After passing Island Park the river flows through a canyon, along which are some magnificent cataracts, but no water for irrigation is diverted until a point perhaps six miles above St. Anthony is reached. The Marysville country, a very fertile though somewhat rolling and broken tract, is entirely dependent upon Fall River for irrigation. Fall River is a large tributary to the Snake, sometimes called Middle Fork. A large rolling country on the south side of this river is also under irrigation and is being rapidly settled up.

The country surrounding St. Anthony is remarkable for the porosity of its soil, composed largely of loose sand and gravel, which absorbs water very rapidly. So great are the percolative qualities of this soil that sub-irrigation is practiced very extensively. The Egin bench, to the west, seems to be a catchment basin filled with gravel, and after the gravel is once saturated, which may be done during the high water, the ground can be kept moist by simply holding water in the canals and laterals. The duty of the water through this section, however, is extremely low, ranging from eight to fifteen feet per acre; i. e., water equivalent to a depth of eight to fifteen feet, spread over the entire irrigated area, is applied during the irrigation season. An ordinary duty, under normal conditions, is two to three acre feet.

South of St. Anthony and between the branches of the Teton River lies an almost uniformly level and well watered area, surrounding the new beet sugar factory at Sugar City. The duty of water all through this section is rather low, but irrigation is so easily accomplished that so long as there is sufficient water in the streams the farmers are satisfied with the conditions.

The Teton basin is a little world by itself at the foot of the magnificent Teton peaks. These towering sentinels stand guard over the destines of an isolated community, and their snowy summits take on that infinite variety of light and color effects so marvelous in the higher altitudes. The basin is a group of great plains, with stiff slopes toward the Teton River, and their irrigation is dependent on this stream and its mountain tributaries, which are entirely inadequate, there being over 40,000 acres of splendidly situated land for which there is no water. Some of the ditches which serve the irrigated portions head in Wyoming, and all have excessive grade and are badly gutted out. Part of the basin lies in Fremont County and part in Bingham, and the people living in the latter county are very seriously cut off from the county seat at Blackfoot both by distance and by the difficulty of travel to and fro.

A rather remarkable condition exists a few miles south and west of Rexburg, where water appears to flow in opposite directions. Several large canals from the South Fork take a northerly course and meet and overlap upon other canals from the Teton River having a southerly direction. As a matter of fact, the land has a light slope to the west, which may be taken advantage of by either set of canals. Every indication of delta formation is here apparent, and the deposits of centuries have brought the valley up to such a uniform level that the channel of the South Fork, from where it leaves the canyon to its junction with the North Fork, is badly broken up and is constantly changing. Poole's Island and Butler's Island are bodies of land of considerable area cut off by various sloughs and channels from the rest of the valley. The soil here is a porous gravel of great depth, which absorbs water so rapidly that irrigation is only accomplished by the extravagant use of water. In some instances the rough, shallow channels of natural sloughs serve as irrigation aqueducts, and the loss in these by seepage and evaporation must be enormous.

Shortly after the irrigation season opens, it is apparent that the gravel becomes saturated, as water rises in the various creeks and springs through the locality, and is then frequently used again for irrigation. Some of the lowlands sub-irrigate quite freely when water is applied to the lands above. It is probable that a large percentage of the water lost by the excessive seepage finally finds its way back to the river, and thus becomes available for systems farther down. As wells ten to fifteen feet deep almost anywhere in this part of the valley produce a constant supply of water, and as wind is one of the characteristics of the country, it would seem that windmills might be a good irrigating proposition where surface water is not obtainable.

In some cases, notably that of the Great Feeder, the erratic course of the river has been checked and its waters directed into the channel most favorable for man's use. The owners of the Great Feeder have constructed a diversion dam of piles and cribbing over a mile long, which diverts some of the water of the South Fork into an old channel of the river known as the Dry Bed, through a canal carrying 2,060 second feet. By this means water is supplied to a number of canals heading on the older channel.

South of the South Fork lies a fine body of farming land, which also receives the benefit of the waters of Willow Creek and other mountain streams, but is mostly served by the many large channels from the South Fork. Some of these use Willow Creek as a channel. This, however, is not good irrigation practice, as the bed of the creek is so rough and the alignment so irregular that there is excessive loss by seepage and evaporation.

On the west side of the river the Butte and Market Lake canal, constructed by former Secretary of State

Mart Patrie and associates, heads at the foot of the Crater Buttes, which are extinct volcanoes, and waters a large tract surrounding Market Lake, famous for wild ducks and mosquitos. A few miles below the town of Market Lake the lava reefs close in upon the river, but swing away again a few miles above Idaho Falls and from the western boundary of the New Sweden irrigation district.

East of Idaho Falls, near Iona, a large new beet sugar factory stimulates the industry of the community and the prevailing crop is sugar beets.

At Ammon a peculiar and somewhat disconcerting situation arises from the fact that the large drifting sand hills to the south are threatening to overwhelm the town. These immense mounds of sand keep combing over and over in the strong winds and are moving gradually northeasterly. Senator Steele, who has lived near Iona for twenty years, remembers when these sand dunes were at least half a mile farther south and west.

CARE OF EARTH ROADS.

Mr. J. A. Sager, road supervisor of Climax township, Mich., has prepared an excellent pamphlet on Earth Roads. He treats the subject in the light of personal experience in such a practical way that we take this privilege of making a few extracts which at this time of the year are pertinent and seasonable.—Editor.

I went over the whole of District No. 1 in Climax, Mich., with the road machine at two different times this season, with one-half of the road tax reserved to pay for the machine, only having one-half of the regular tax to be performed in labor. We put the road grade and side ditches of about three miles of poorly repaired road, and a portion of the same without any grade, in good condition, with straight, uniform outside ditches, with outside slope and inside slope. In some portions, where there is no grade, it should be made higher, and in others it should be rounded up fuller on the sides, and we have left plenty of well-rotted soil, without sods to interfere, to complete the grade with next year.

In the winter there frequently come times when the road is full of holes and ruts, while the surface soil is dry and mellow. This condition occurs most frequently when the ground below the surface is frozen. If at this time a harrow is run over the road, it will fill up the ruts and holes, and leave the surface smooth. This improves the road for present travel, and gives a smooth surface, which will greatly decrease the deterioration of the road by subsequent rains.

TREATMENT IN THE SPRING.

In the early spring, just after the frost goes out of the ground, earth roads are usually full of deep ruts. At this time the roads can be greatly improved by running over them with the road machine. It is much more economical to make the road smooth than to wear it down by travel. This early work should be done to prepare the road for travel before the overseer gets his road warrant. Do not wait to wear the road smooth, but scrape it lightly to a smooth surface, not moving any more earth than is necessary to fill up the ruts and uneven places.

It is somewhat unfortunate that this tool (road machine) is ordinarily called a road grader, since the name has possibly led to a misconception as to an important use of the machine. As an instrument of road construction this machine is used to give a crown to the road, but as an instrument of maintenance it should be used only to smooth the surface and restore the original crown. Apparently, some operators assume that the machine is not to be used in this way, and they run the blade too deep in maintaining or repairing the grade, and a big ridge of loose earth and sod is left in the middle of the road, which only slowly consolidates and which is likely to be washed into the side ditches to make trouble there. Since the introduction of the road machine there has developed, in some localities, a strong tendency where their grade is narrow, to increase the crown of the road unduly. Doubtless, the object is to secure better drainage of the roadbed, but piling up the earth is an inadequate substitute for tile drainage. Side slopes steeper than just enough to turn the water into the side ditches are a detriment. Other things being equal, the best road to travel on or to haul a load over is a perfectly flat one.

THE SOIL SHOULD BE WET.

In smoothing the road, the road machine should be run over the ground lightly, so as to smooth down the ridges and fill up the ruts. Only enough earth should be moved toward the center of the roadway to replace that washed down by the rains. The blade of the machine should stand nearly square across the road, and considerable earth should be shoved along in front of the blade so as to have enough loose earth to fill any depressions. The surplus of earth should be evenly distributed along on the surface. This work should be done early—before the ground becomes hard and difficult to work, before traffic has been compelled partially to do the work of the road machine, and while the surface is in condition to unite with the loose earth left by the machine. Unfortunately, this work is often postponed until the ground is so hard that it is impossible to do a thoroughly good job. If the ground is a little too wet for agricultural tillage, it is all the better for road making since it will pack better than if it were drier.

CARE OF ROAD AND DITCHES IN FALL.

Finally, during the fall the roads should be repaired with special reference to getting them into good shape for the winter. Any saucer-like depressions or ruts should be filled with earth like that of the roadbed. The material should be solidly tramped into place. Holes and ruts should never be filled with stone, bricks, or coarse gravel. The hard material will not wear uniformly with the rest of the road, but will produce bumps and ridges, and usually result in making two holes, each larger than the original. It is a bad practice to cut a gutter from a hole to drain it to the side of the road. Filling it is the proper course, whether the hole is dry or contains mud. The holes most requiring attention are found at the end of bridges and along the sides of small wooden box culverts.

The side ditches should be examined in the fall to see that they are free from dead weeds and grass; and late in the winter they should be examined again to see that they are not clogged with corn stalks, brush, etc., washed in from the fields. The mouths of culverts should also be cleared of rubbish and the outlet of tile drains should be opened. Attention to side ditches prevents overflow and washing of the roadbed, and will also prevent formation of ponds at the roadside and the subsequent saturation of the roadbed.

PREPARING LAND FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, courtesy United States Department of Agriculture.

(Continued.)

SETTING SPOUTS.

A man ordinarily sets forty or fifty spouts in a ditch bank in a day, but as many as eighty are sometimes set. They are made of wooden strips or laths one-half inch thick by two inches wide and three feet long. Four of these are nailed together, forming a square spout. The strips cost $6 a thousand, or 0.6 of a cent each. It costs 1.1 cents to make each spout. This makes the cost of each 3.5 cents. If a man sets fifty in a day they will cost in place 6.5 each. Placed four feet apart there will be 330 in a length of eighty rods, making the spout system cost $21.45 for each 80-rod line. With furrows eighty rods long this will serve forty acres, making the cost about 54 cents per acre. When set they must be well puddled in. The quantity of water which is passed through them is regulated by a piece of lath or shingle placed vertically in the ditch against the end of each spout. The best work can be done by having the head ditches at short distances from each other, enabling the owner to save water and irrigate with greater ease and efficiency. One of the best irrigators near Sunnyside, Wash., has this to say upon the subject:

"I made two serious mistakes when I started to improve my forty acres. I did not use a sufficient number of drop boxes in my head ditches and I placed the ditches too far apart. I attempted at first to make one head ditch serve a length of eighty rods, but it was too far to run the water profitably in the irrigating furrows."

THE IRRIGATING FURROWS.

Furrows are run down the slope from the spouts. The practice of irrigators varies much with respect to their depth and distance apart. Some land wets up more easily and speedily than other land, giving rise to the difference in furrowing. One point to be particularly noted in irrigating by this method, so careful farmers tell us, is to have the furrows carry as nearly full as possible without breaking over the sides. One successful irrigator says:

"I run my furrows as full as they will hold until the water gets half way across the field, then I shut of the supply. The water already in the furrows is sufficient for the balance of the field and I have no waste. I have the best success with new seeding when I make the furrows six inches deep and eight inches wide on top, and four feet apart. I make them with a shingle shovel plow drawn by two horses. I keep the furrows straight by means of a side gauge which makes a mark parallel to the last furrow, which I follow on the return passage. (Pl. VI, Fig. 1.) A man and team will furrow five acres a day, making the cost of furrowing 50 cents an acre. I can thoroughly wet my land in four days, while my neighbor over the slope has his furrows two feet apart and runs water in them for a week before the two wet streaks meet midway between the furrows."

Fig. 1. Furrower Used on Nevada Experiment Station Farm.

The irrigating furrows when only two feet apart are mere marks not over three inches deep. When the crop is once established every alternate furrow is abandoned.

FIELD FLUMES.

Instead of head ditches, wooden flumes or troughs are frequently used. (Pl. VI, Fig. 2.) In many respects they are superior to the ditch, especially where the slope of the land is considerable. Water may flow at a good velocity down the flume, and yet be delivered to the distributing furrows as desired. Auger holes are bored through the side of the flume flush with the bottom at points where water is to be delivered to the furrows. A swing gate or stop placed on the inside of the flume covers or partly covers the hole as may be desired. A cleat across the bottom below each hole swings upon a nail through the middle in such a way that it may be used as a movable dam to increase or diminish the quantity of water discharged at each hole. This is a favorite method of distributing water with many, especially in gardens and fields where a great number of drop boxes will otherwise be required. A flume one foot wide with 6-inch sides can be built for about 7 cents a foot. This plan does away with the use of both drop boxes and ditch spouts.

How often to irrigate and how much water to apply must be decided by each individual in accordance with the character of his soil and the crop he wishes to produce. One experienced irrigator says:

"You can't irrigate by the clock. You must put water on when the crops need it and take it off when the want is supplied. Enough water is better than too much. Two irrigations are usually sufficient for a crop of alfalfa or grass. Four or five are required for young orchards. Melons and beets should have no water for some time previous to maturity of the crop. Alfalfa, clover and timothy should have no water during the maturing of the seed if seed is desired. Some foresight is required in using the water at your command, so that sections of the land may be irrigated consecutively for economy of both water and labor of applying it. Above all, watch your work. Do not start the water over a field and then go to town to spend the balance of the day. Each little stream requires attention."

One of the Sunnyside irrigators, with much commendable pride, showed the writer a field of sandy slope which he had seeded, and in the process he "had not lost a barrel of water." It had all been used upon the land.

IRRIGATION BY FLOODING IN GALLATIN VALLEY, MONT.

In Montana the usual method of irrigation is by flooding between field ditches. Alfalfa, timothy, blue joint, clover, pasture lands, and cereals are irrigated in this way. With a few exceptions, the only other method practiced is furrow irrigation, and it is confined to vegetables, root crops, and orchards, the total acreage of which is small in comparison with that in grain and forage crops. Fully 90 per cent of the water utilized each season is distributed over the fields in small field ditches and spread over the land from openings made in the ditch banks. The methods of applying water as practiced by the Gallatin Valley farmers have been introduced with certain modifications into many of the other farming districts of the State.

Much of the land was acquired in the first place by homestead entry in quarter sections. In course of time many of the original homesteads were divided into 80-acre and 40-acre tracts, and others were increased to 240 and 320-acre tracts. The average size of the farms at the present time is probably not far from 100 acres. In Gallatin Valley water for irrigation is distributed for the most part in continuous streams, because the farms are large and an irrigator receives as much through his head gate as he can properly take care of. Instead of having the water turned off when one part of his holding is irrigated he applies it on another tract, and when all of the land on a farm of 160 acres has received one irrigation it is usually time to begin to apply the second. Such a practice would be entirely unsuited to the small farms of Utah, for example, for the reasons that it would involve a needless waste of labor and expense in irrigating, and a continuous stream apportioned to a field of from ten to twenty acres would be too small to be distributed to advantage and would be wholly absorbed by portions of the field before it covered the remainder.

Fig. 2. Furrower Used by D. C. Wheeler, Reno, Nev.

In grain fields the distances between the field ditches vary from sixty to ninety feet and probably average about seventy-five feet. The ditches are made with a fourteen or sixteen-inch double-moldboard plow attached to a sulky frame which is drawn by three horses.

The ditches are cleaned out with a fourteen or sixteen-inch steel shovel (Fig. 27) attached to a beam having handles like those of a walking plow and drawn by one horse. This implement also forms the earth dams in the ditches and is locally styled a dammer. The horse walks in the furrows made by the ditch plow, and the loose earth in the bottom and sides is carried forward by the steel shovel and dumped in a heap by simply raising the handles which guide the dammer. If sufficient earth for each dam is not obtained in the first trip the horse is driven back along the furrow and more deposited as needed. These dams or earth checks are usually about sixty feet apart.

A stream of, say, 100 miner's inches is turned into the supply ditch and divided between two adjacent field ditches. Various devices are used to make the division, but the canvas dam (Fig. 28), with an opening controlled by a flap of canvas, is one of the most convenient. One of these is placed at A (Fig. 29) and an ordinary canvas dam at B. The earth dams at C and E are then cut and part of the stream flows into the field ditch CD and the remainder escapes through the opening in the canvas dam at A and flows to the point B, where it is checked and diverted into the field ditch EF. The earth dam at D checks the flow in CD and permits the water to be distributed through a number of openings to irrigate all that portion included in C, D, F and E. When this piece of ground is thoroughly soaked to a depth of twelve inches the dam at D is opened and the water rushes through until checked by the next earth dam. The strip below EF is irrigated in a similar manner, one man attending to both. By this method and with a good head of water one man can irrigate on an average five acres per day. If the flow of water is small and intermittent the average may not be more than two acres.

The second irrigation is applied in the same way, but the amount of water used is considerably less. Some time after the last watering and before harvest-

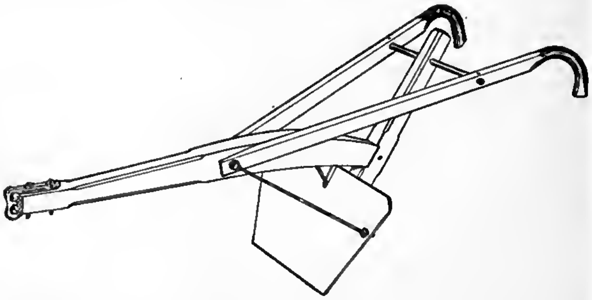


Fig. 27. Dammer Used in C eaning and Damming Field Laterals

ing the field ditches are leveled so as not to obstruct the binder. This is often done with a small walking plow by turning two furrows toward the ditch. A better contrivance, and one which is used on some of the Gallatin Valley farms, is made from a worn out disk harrow. Four disks, two on each side of the center and set at an angle, are attached to a short beam and drawn along the ditch.

Clover and alfalfa are irrigated in a somewhat different manner. The ditches in grain fields seeded to clover or alfalfa are spaced farther apart than for grain crops, in order to be adapted to the forage crops of the following years.

In ordinary practice the ditches for clover and alfalfa are located 100 feet apart, and the dams are made of manure instead of earth. Some time before a field is to be irrigated and after the ditching is done, manure, containing considerable straw, is deposited in small heaps about sixty feet apart along each ditch. A day or two before the water is turned on each heap is arranged in a more compact form and receives a covering of earth from one to two inches thick on its upper face. This manure and earth dam retains the water in the ditch sufficiently long to water the small intervening space. It is then broken and the water passes on to the next dam.

After the first irrigation the coarse manure and straw are deposited on the edge of the ditch and may be used a second or even a third time.

Manure dams similar to these just described are frequently used for the second irrigation of grain crops. It should be stated, however, that this practice is less generally used now than in former years. Steel dams are now quite commonly used instead of earth dams in grain fields, and the ordinary canvas dam is being substituted for manure dams wherever clover and alfalfa are extensively grown.

In some sections of Gallatin Valley, particularly under the West Gallatin Irrigation Company's canal, the field ditches are parallel and extend down the steepest slope from the supply ditch at the top of the field to the catch ditch at the bottom. In this method both earth and manure dams are used in a manner similar to those of grade ditches, but the distribution of the water is different. This may be seen by a glance at figure 30. Water flows out of the ditch from both sides and, the grade being steep, it is distributed from openings made just above each dam.

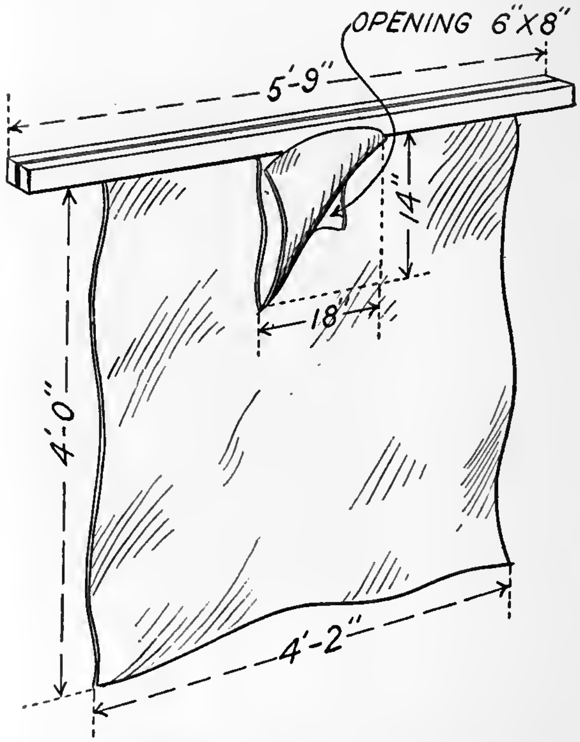


Fig. 28. Canvas Dam with Opening to Divide an Irrigating Stream.

The common practice of irrigating from steep, parallel field ditches in Beaverhead County, Mont., is thus described by Mr. E. C. Lamme:

"The laterals are made with a lister attached to a sulky frame and drawn by four hourses and are spaced from 30 to 150 feet apart, according to conditions. The size of each lateral varies from sixteen to eighteen inches in width and from ten to twelve inches in depth. Stable manure or half-rotted straw is used for check dams. These are spaced about sixty-five feet apart.

When the grain is from three to five inches high the first irrigation is begun. On the extensive farm of J. E. Morse, of Dillon, each irrigator is given 125 miner's inches of water, which is divided between two laterals. The water is kept running night and day, the men changing at noon and midnight. As soon as the first irrigation is completed the dams are reset for the second irrigation. In resetting the dams the manure or straw is mixed with the earth while both are kept damp, which forms a stronger and more impervious dam. For this reason a larger head of water can be used for the second irrigation. This irrigation follows the first in from twelve to twenty-five days. Each irrigator is given 200 inches of water, and this stream is kept running night and day as in the first irrigation."

IRRIGATION PRACTICE IN NEVADA.

The conditions under which the various crops are grown in the scattered valleys of Nevada differ widely. The observations of the writer during his one year's residence in the State have been confined mainly to the practices in the Truckee Valley. In this valley there is and always has been an abundant supply of irrigation water, which must account in part for the methods used. To one who is familiar with the economy practiced by ranchers in other regions where this abundance does not exist the practice in this valley seems wasteful. Reports from other parts of the State, where at times a scarcity of water exists, seem to indicate that there, as in the Truckee Valley, the number of irrigations uesd in growing a crop is limited only by the amount of water to be had.

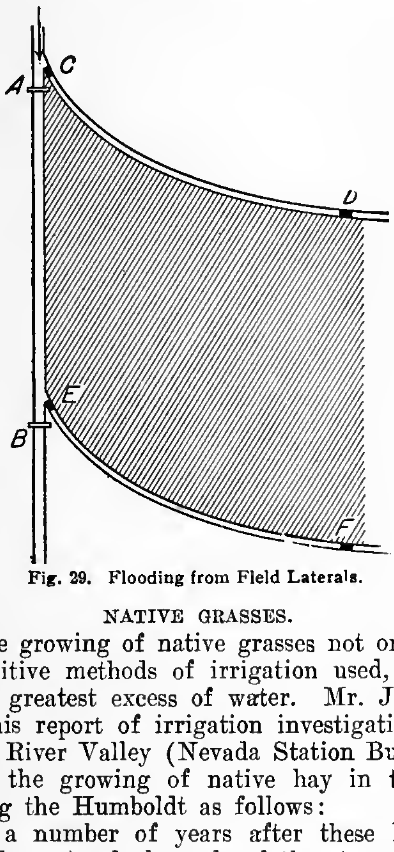


Fig. 29. Flooding from Field Laterals.

NATIVE GRASSES.

In the growing of native grasses not only are the most primitive methods of irrigation used, but apparently the greatest excess of water. Mr. J. D. Stannard, in his report of irrigation investigations in the Humboldt River Valley (Nevada Station Bulletin 54), speaks of the growing of native hay in the bottom lands along the Humboldt as follows:

"For a number of years after these lands were occupied the natural channels of the stream were not of sufficient capacity to accommodate the volume of water that came down during the floods of spring and early summer. The streams at these times would overflow the meadow lands for a sufficient length of time to produce a crop. As more and more water was taken out by irrigators higher on the stream, the volume of water during the flood seasons became inadequate to irrigate those meadow lands as was formerly done, and dams were placed in the channels to force the water out of the streams and over the meadows as in former times."

This is called irrigation by natural flow. Wherever native grass is grown it is customary to flood it, and in some cases water is allowed to run over the land throughout the entire growing season.

ALFALFA.

Alfalfa is grown in Nevada with from one to twenty-two irrigations in a season. Mr. Stannard states that in the Humboldt River Valley the crop is irrigated from one to eight times; that the lands receiving one, two, and three irrigations have given practically the same yields of hay, or yields greater than those obtained from other lands irrigated six, seven and eight times; and that the highest yields were from lands irrigated four or five times.

In the Truckee Valley the common practice is to give alfalfa ten or twelve irrigations, though some men irrigate less and others as many as twenty-two times. The character of the soil will in many cases account for differences in the number of irrigations required by a crop. Much of the valley soil is so gravelly and porous that it does not hold water well and therefore requires more frequent irrigation than a closer, more compact soil.

The character of the land upon the station farm is such as to indicate that it would require the maxi-

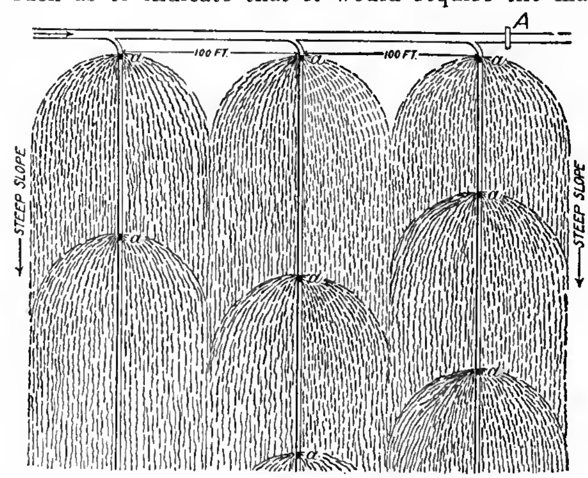


Fig. 30 Flooding from ditches running down steepest slope.

mum amount of water to grow a crop, and here good results were had from seven irrigations. In fact, an originally poor stand of alfalfa has been much improved by using less water than was used by the former owner of the land.

Mr. Stannard's report suggests what the station experience indicates, that an excessive use of water is not only unnecessary, but is detrimental to the crop. Alfalfa is a plant that thrives best in warm soil and atmosphere. The water of mountain streams is always cold. The too early and too frequent applications of water keep the soil cold, and thus retard the growth of the plant. These conditions that check the growth of alfalfa stimulate the growth of the less desirable shallow-rooted grasses, which are then said to "run out" the alfalfa.

Two methods of irrigation are used in the cultivation of alfalfa—the so-called flooding method, where the land is flooded by means of parallel ditches extending across the field forty or sixty feet apart, and the more extensively used furrow method.

The furrow method is used alike for alfalfa, grain, and garden. It finds favor because it makes possible the irrigation of land that could not be flooded on account of its rough and uneven character. Many fields that have been producing hay or pasture for years have never been plowed because they are so stony. Many more might profitably be leveled and irrigated by a less wasteful method. By this method the water is carried over the land from the distributing ditches, or laterals, by means of shallow furrows from two to four inches deep and from twenty to forty inches apart. These furrows are generally made at right angles to the head ditch, but often a more desirable fall is secured by running them at a different angle. The aim is usually to lay out the furrows so as to secure the least fall. In irrigating, the water must run through the furrows until the spaces between them are thoroughly soaked, and this is where the apparent waste of water comes in. The fact that the land between the furrows is not flooded and subsequently baked by the sun is a theoretical advantage of furrow irrigation over flooding, but the difference in crop yield does not always uphold the theory. One great inconvenience is the necessity of having to drive over the furrows in cutting and hauling the crop.

The furrows are made by the use of machines built for the purpose. These machines are not on the market, but are usually constructed by local blacksmiths, directed by the ranchers themselves. Old mowing machines furnish the main parts, such as wheels, tongue, levers, seat, etc. Two styles of furrowing machines are shown in Plate VII, figures 1 and 2. In alfalfa fields the furrows are permanent but need to be opened up, or "furrowed out," every spring before irrigation begins, this being done with the same machines used in making them. After refurrowing the ground is rolled. It is much more difficult to get the water over the ground the first time in the spring than at later irrigations; because it is necessary to see that every furrow is clear, that the water may run unobstructed from the head ditch on the one side of the field to the waste ditch on the other. It is clear, then, that the amount of water one man can handle has its limit. After the first irrigation this will depend largely on the size and shape of the field, the contour of the land, and the degree of economy practiced. Water should not be allowed to run to waste after the ground has been thoroughly soaked, nor should it be allowed to stand long on the field. On the station farm in the irrigation of a 33-acre field of alfalfa a stream of about 2.5 cubic feet per second was generally used. The field was irrigated three times for each of the two hay crops and once for the pasture crop that followed. The first irrigation was May 15th. The cost of irrigation for the season was about $2 per acre.

We are in receipt of an elaborate and finely illustrated catalogue recently issued by the Morris Machine Works, of Baldwinsville, N. Y., builders of centrifugal pumping machinery for irrigation purposes as well as manufacturers of stationary and marine engines.

This concern is the largest in the country building this class of machinery and is fully acquainted with the theoretical and practical requirements of the work.

All of those interested in centrifugal pumps for irrigation machinery are requested to write for this catalogue, in which is contained very valuable tables as well as illustrations that will make them fully acquainted with the goods turned out by this firm.

THE FUTURE OF THE UNITED STATES AS INFLUENCED BY THE WESTERN IRRIGATION PLANTS.

BY J. T. RIDGEWAY, PRINCIPAL WASHINGTON SCHOOL, KANSAS CITY.

(Read before the Greenwood Club. Kansas City, Mo., January 27, 1905.)

The co-operative force of society compelled colonies to go out from their native country, take ship, unite their forces in felling trees, erect houses, rolling logs from the fields, and protecting themselves against the savages of their new and adopted country.

Our pilgrim forefathers brought with them some excellent principles of political and religious freedom, which they had learned of the Dutch, not only from direct and personal contact, but from a century, or more, of commercial intercourse. Had the pilgrims landed in a low marshy country as Holland, they would have been better able to dyke and drain than any other colony, except the Dutch themselves in New York.

It would be an interesting speculation, had we the time and space as to what a contrast in our history would have been made, had our early colonist landed in the West, that is to say, had commenced the settlement of North America on the western, instead of the eastern, coast. To be sure the humid valleys of our western coast would have been occupied first, as the colonists had been in western Europe accustomed to the humid condition, but these spots are small in area compared to the humid regions of the eastern half of North America. This condition would have soon forced the population to irrigation long, long, before this. The cotton gin and "king cotton" would not have had such a chance to fasten slavery upon the country. Invention, in all probability, would have taken a different direction but of no less intensity. The mountains and the widely separated valleys capable of supporting life would have tended to make the colonies more independent of each other—without interest enough to make a coherent nation as we now are. Thus we might cite other speculative phases of the subject under the supposed reversal. But once more; the Babylonians, Egyptians, and Chinese civilizations began in arid regions. In fact the cradles of the different human races were rocked in arid countries; they were and continue, with one exception, the most populous countries on the globe, because a human being can be reared cheaper there than anywhere else. Talk as much as you may, cheapness of rearing people is what makes population count up rapidly. Not all of our arid West has abundant water as Egypt, or Assyria, but portions, as the Sacramento and Columbia valleys, compare favorably with those of the Nile and Euphrates. Then, as far as the power of sustenance is concerned, had our settlements begun on the western coast, there is no reasonable doubt our population would have increased as rapidly as did the eastern coast in the first century of our history. Agricultural scientists find by ample analyses that the arid soils are richer than the humid. There are no continual drainings and drenchings by the rain storms in arid regions to dissolve and to wash away some most important elements that go into plant life, if water comes upon it only by irrigation. Twenty acres of land in the arid West before irrigation scarcely supported one cow, after irrigation support ten cows. Before irrigation twenty acres could not support one human being, will now, after irrigation, support a family of five persons. In Southern California before irrigation you could buy land for one sheep per acre, but now, after having been irrigated and planted in orchards, the land is worth from $500 to $1,000 per acre. The Southern California lands are peculiarly adapted to citrus fruits. They are such varied climates, altitudes, latitudes, and other varied circumstances to make the arid West furnish some one locality, or more, especially adapted for each of the orchard, garden, and field products. One chief industry is grazing, and will always be so.

The arid West was first in the interest of miners, second of cattle and sheep kings, and third of land speculators; all are marked strongly of speculative craze to make big money. The evolution of these several periods are of social and economic interest, because they have retarded the bona fide farmer settlers. While farming is the mainstay of any country, yet it can not afford to pay more than 6 per cent interest during all series of years. The speculative regime of the West has, till within the last few years, kept interest up to 12 per cent, or more. This has been a hindrance to the proper development of irrigation, or irrigation farming. Hence, had our pilgrim fathers landed in the West instead of the East the agriculturalists would have escaped the speculative disadvantage with which they have had to contend.

The United States Government is forcing the cattle and sheep kings to take their fences from around Government land, encouraging homesteaders to take from forty to 160 acres each upon proof of five year residence, and a reasonable amount of improvement, and finally is making other and most liberal provisions by which bona fide settlers can buy other lands capable of irrigation and enable them to have their lands irrigated in parcels from twenty to 160 acres each, with partial payments of ten-year installments. When the major part of the money is paid toward the cost of the irrigating plant consisting usually of the reservoir, head gates and main canal, the management of the irrigating plant is turned over to the owners of the land so irrigated. The United States Government policy seems clear to encourage the bona fide homesteader of small capital. This policy is very fortunately in line of the natural evolution of every country that has excess, or lack, of rainfall. That is toward individual ownership of small land holders. Expensive drainage, or expensive irrigation forces small holdings in the land. Small holdings force intensive farming, careful rotation of crops and necessary enrichment of the soil by fertilizers. The happiest and most successful small farmer is the owner of the soil. He is assured of bread and butter for himself and family.

Under this regime the small farmer becomes socially and economically the mainstay of the State. North Scotland, Holland and Central China, are historical examples. The first and second is the regime of getting rid of excessive water in swamps and bogs. Holland, as a government policy, credited tramps and hoboes for labor done till a small sum was saved up for which the state gave each a piece of the land reclaimed. It is said many of these hoboes have become substantial farm owners in the low lands of that country. Poor people of Scotland were credited for labor performed in reclaiming the swamps and afterward became owners of small parcels of the land their labor helped to reclaim. The Bank of Scotland did this by issue of bank notes. Such issue in this country has swamped our state and private banks nearly every time it has been tried. The typical American is such a speculative "cuss" he never has attempted such free banking without going beyond all reason and ending in bankruptcy. I cite this, not so much to illustrate the excellent free banking of Scotland as to illustrate the certainty of profit in reclaiming swamp and arid lands. These lands are so wonderfully productive after they are once prepared for cultivation. Nature has ordained that where capital and labor are properly and justly combined to bring together two, or more, of her great forces, naturally, or ordinarily, separated, she will reward man not only in fifty, seventy-five, but an hundredfold; such, for example, are air and sunlight to swampy soil, and water to an arid soil.

Thus nature points out the way how labor and capital together may win her prizes. Not only this, but she points out how the laborer may become the small owner of her soil and co-operate with others to win a spot of ground which shall not only spread their paths with flowers, but their tables with plenty.

The land owners in an arid valley must coöperate in storing the water that runs away in flood season and in conducting the water by canals and ditches, where and when it is needed for the growing crops. One of the greatest needs of our country in this age of deadly competition among toilers for wages and the vast consolidation of capital in manufacture and speculative enterprises is coöperation. The coöperation in log rolling was only temporary among the earlier colonists, but the coöperation in managing irrigation, or drainage, will be a continued process, constantly exercised and improved by time and experience. Our general government and the several arid states are looking to that end. While some, or perhaps all to some extent, of the arid states have anticipated somewhat in passing ideal, or theoretical, laws, regulating irrigation plants, yet already it seems wiser to let the owners of the irrigated land work out somewhat for themselves what they find best in many minor details of management, then the law may be enacted rather in accordance with the experience of owners in any given community; because the same regulations under different conditions as they are in different states, or territories, will not answer in all. For that matter, conditions differ very materially in the same State, especially since any one of our western States is very large admitting of varied circumstances —the point is, the coöperative experience and effort gives the cue to State action in the manner of regulation.

The Mormon settlement in Utah having had scarcely no capital their coöperative and personal labor demonstrated beyond all quibbling a successful coöperation in irrigation farming. Their isolation far from any older community and their lack of experience in dealing with arid conditions made their success wonderfully brilliant in planting homes in the arid regions. So, also, the Greeley colony in Colorado, on the tributaries of the South Platte. These two colonies built no expensive dams, but their irrigation consisted of diverting ditches from the streams and directing the main ditches so as to accommodate as much lands as they owned, or as far as the amount of water sufficed.

In some instances, corporation capital has built great reservoirs, but failed because the capitalist did not beforehand calculate the amount of water obtainable through a succession of years. They failed again by charging more than the farmers could afford. For several years now the general Government has carefully measured the amount of water running in the streams for a succession of years, so it is approximately known how much water can be obtained for irrigation, also how much land can be irrigated. The result of this latter investigation shows about 10 per cent of the seventeen arid states and territories, excluding Alaska, can be irrigated,—that is, there is sufficient water to irrigate 10 per cent of the arid West. The general government has and is now engaged through the geological and engineering departments to determine the best sites for the reservoirs and their approximate cost throughout the West. By this means mistakes in location, in character of the constructive material of the dam, in the manner of building, in short, all areas in investments of capital may be avoided. For several years the government has withdrawn all public lands capable of being irrigated from the ordinary entry. If, after thorough investigation, any of this land withdrawn from entry is found not to be irrigable, it is replaced on the list for a general public sale as originally.

A few years ago the government commenced a reclamation fund to be used in the building of reservoirs for the storage of waters to be used in irrigation. *Bona fide* settlers may buy the land to be irrigated by said government reservoir, not to exceed 160 acres, nor less than forty acres, paying in ten annual instalments the proportional part of the actual cost to the government in building the irrigating plants—that is, the reservoir, head-gates and the main canal. When the major part of the costs shall be paid in, the management of the plant is turned over to the owners of the land so irrigated. The title to the plant still vests in the government, to be finally disposed of by Congress. After the management is turned over to the land owners, each owner, whether he is owner of forty, eighty, or 160 acres, has one vote, and no one has more than one vote in determining this, or that, policy to be pursued. So that there is an effort made to prevent "freezing out" of smaller stock or shareholders and to prevent the management getting into the hands of the few. The management is a pure democracy. Every shareholder is such by virtue of his owning a tract of land, whether it be large, or small, and his vote is equal to every other. A share, or shares, represent a definite tract of land. Overcapitalization for fraudulent purposes, or watered stock, is prevented.

The government's care in properly locating reservoir sites ought to prevent a mistaken investment of capital. At least, that is a sound reason for the government's part in the enterprise. The government builds lighthouses and expects no direct returns, or direct reimbursements. But in the matter of building great reservoirs in the arid West the government arranges for direct reimbursement to be reapplied in building other reservoirs where needed. Corporation capital may be employed in these enterprises with reasonable profits, but care should be taken that the corporation is never allowed to foreclose the irrigated lands, or charge more than a reasonable rate of a certain and definite percentage on capital actually and prudentially invested and for reasonable periods of franchise, after which the title to the plant should revert to the land-owners. English capital in Egypt and India has put in great dams at 5 per cent return for a term of thirty years, after which the title to the plant in Egypt reverts to the Khedive. At Assuan is the greatest dam in the world, built at a cost of $24,000,000 upon a 5 per cent return. It was finished in 1902. It is now worth $100,000,000. In the valley of the Po in Northern Italy there are numerous irrigating plants under three distinct systems of management—the state, corporation, and the coöperative. This region is humid, and the rainfall is thirty-six inches annually, but not being well distributed through the growing season, irrigation pays. Some of the main canals are used for transportation also. This region being humid, drainage also must be provided, which increases the cost very materially. The valley of the Po is the granary for Southern Europe. The state and the coöperattive system in Italy are said to keep the corporation system in check as to rates. Our government is studying the valuable lessons which both Egypt and Italy have to teach. Egypt is already teaching us how to deal with alkali soils. The Chinese produce vast amounts of food and fertilizers in the canal ditches themselves, while we as yet regard the ditch nothing more than the conductor of water to the soil.

The riparian law which prevails in the eastern and middle states obtained without modification at first in the arid West. This law allows the owner of land to use the water on, or running through, the same to the exclusion of others owning land back, or away, from the stream. Even owners of the land above him could not divert the water that customarily ran through the land below. Seldom or never did any of the western states or territories make a law directly adapted to an arid country. Hence all water right in the West is in accordance with the riparian law, modified by custom and numerous decisions of the local courts. This litigation has cost the West an immense amount of money. In some localities the cost of litigation has been quite enough to build the ditches. The riparian law, adapted to the humid country only and having been attempted in our arid West, has resulted in many difficulties. The first entry man who occupied the land along the streams cut off others who might have entered and occupied the lands farther back, had they a chance to secure water. This circumstance enabled the first settlers to use immense tracts of government land back for grazing purposes without hindrance or expense. He was in every sense "the dog in the manger." The cattle and sheep men not only fought each other over these conditions, but both these great interests kept out the small farmer, and retarded irrigation development for farming purposes. One thing of interest, however, is to be noted here. The cattle and horse men in many instances so competed with each other for the free range that the grass was so closely grazed during the spring and summer seasons nothing was left to support the stock through the winters. Hence these stockmen found it necessary to raise feed to supplement the shortage of grazing. To raise feed it was necessary to irrigate. Hence the stockmen themselves, to avoid loss of stock during the winters, began to irrigate in order to raise fodder and hay. Still, on account of the injustice of the workings of a riparian law framed for humid regions only, and saddled upon arid regions, enable these stockmen to monopolize not only all the water available, but the use, free of any cost, of all the government grazing lands surrounding their claims. Priorities along the banks of streams have worked great injustice. Both state and federal laws recognize prior claims, but owing to social forces at work throughout the West, these priorities have been finally limited by saying that a land owner's claim to water is limited to a "beneficial use" of the water. The State of Wyoming deserves the credit for the first enunciation and practice of this principle of justice. Hence Wyoming has been justly called the "Law Giver of the Arid West." In whatever way irrigation plants are to be built and managed, the nature of the circumstances forces coöperation in any given valley. This coöperative force among the Mormons in the early settlements about Salt Lake assured them success not only in irrigation, but in coöperative banking, which stood the test of the great financial panics which have swept over this country within the last forty years, better than our own private, state, or quite as well as the national bank. The Mormons succeeded also in coöperative boot and shoe manufacture and coöperative grocery store keeping. Doubtless the peculiar social force brought to play in the Mormon religion, in the persecution that followed, and in the admittedly great leadership of men possessed by Brigham Young, will account largely for the success of these various coöperative enterprises. Coöperation in all lines of production can not, however, be recommended in any and all communities, except as the individuals of the coöperative company shall learn submission and become adepts in the particular business under coöperation. But in irrigation the necessity of the social force is such that there is no escape. Hence, the foresight and the wisdom of the Almighty in placing his children upon portions of the earth where they must associate in effort to reap the rewards He has in store for them, in the proper combining of elements of air, water, soil, and sunlight. Thus our arid West has for this whole country a standing example, or illustration, of how to make as many people as possible share in the benefits of ownership in the land and of the right to enjoy the fruits of their own toil, not only in irrigation, but in other enterprises of production.

Again, what is in the future for our arid West? Irrigation includes all means used to put water on the land when and where needed, and to take excess of water from shallows, swamps, and bogs to make the land available for cultivation. Irrigation in any country is first done by diverting the water by ditches directly from the stream. Travelers in Egypt years ago gave us the impression that the Nile afforded abundant water for all irrigating purposes in Egypt; but this is not so. Until within recent years most irrigation in Egypt was only *annual* irrigation and by diversion ditches. Now the English government is building great reservoirs and canals by which irrigation becomes *perennial* and the crops are doubled, or trebled. Within the last fifteen years the population of Egypt has increased 43 per cent, enabling the Khedive to support not only his increasing population, but to pay the enormous tributes to the sultan of Turkey and to England. Instead of elevating the water upon high lands by means of sweeps and buckets as the Egyptians do we are lifting it by means of windmills, gasoline, or steam engines, either from the rivers, or deep wells as in western Kansas, Colorado and the Dakotas. Thus will water be lifted from the deep canyons of the Colorado River and sent coursing over the parched plateaus of Arizona and California. So long has oppression, wars, and slavery, overrun Egypt, her native population has no inventive genius to apply improved tools and machinery. Our people, quick to adapt themselves to new circumstances, with our Government making every endeavor to encourage homesteads, ownership of small land holdings, and keep in check the speculative land grabbers, we may expect not only one valley equal to the Nile but five or six valleys in our arid West, each of which may be made as valuable. The general Government is already committed to the proposition of damming the streams, so that the storm waters may be utilized upon the arid plains. What a pity it was to see so much water go to waste as did about Kansas City May 31, 1903. When the flood waters of the Arkansas River are stored Kansas and Colorado may dismiss their suit over water rights. The Government has discovered that there is not water enough both in natural and flood flows together to irrigate all the lands irrigable, or that lies in a position to be irrigated. But with 10 per cent of all our arid West irrigated and capable of two to five crops a year, and the unirrigated but tilable lands planted in such crops as can be found adapted to dry culture and grazed by stock, together with the great forests and mining interests, and altogether the most healthful climate on the globe, what may we not expect? No one dares predict; for the imagination of one situated as we are can not conceive the wealth, health, and happiness that nature has in store for our future generations.

The human race has for many ages revered the memory of a Prometheus who discovered the use and control of fire. But today, in view of past history and of what is promised us, we need to extoll another Prometheus who has discovered the control of too much water by drainage, or the right use of too little water by irrigation.

Irrigation encourages the inhabitants to group their dwellings into villages. The village life enables the people to avoid the lonely and isolated condition of the large farms in the humid regions, or ranches of the plain, where libraries, schools, churches, and other amenities so necessary to human society are very difficult, or well nigh impossible. The villages in the same valley will not be so far from each other that they can not be connected by trolley car to transport passengers and products. Thus many other conveniences and comforts of the city will be brought to the very doors of the farmers themselves.

IRRIGATION BY PUMPING.

Joseph Jacobs, of the United States Reclamation Service, has made some interesting and instructive observations relative to irrigation by the pumping method. He asserts that irrigation by pumping is in no sense a new method, although it has been taken up seriously only within the last few years.

In the popular mind irrigation implies a gravity or surface system for delivering water to the land, but in recent years pumping has come more and more to be recognized by engineers as a legitimate and profitable means of supplying water for irrigation, and it is destined to grow in importance with the development of cheaper power. Lands that lie beyond the economic scope of gravity supplies are often entirely reclaimable by pumping, and numerous cases are on record where both systems being available, the advantage as to first cost and to operating expense has been with the pumping plant.

Of the many types of pumps available and in use the most common is, perhaps, the centrifugal pump. They are made in standard sizes, ranging from two to fifteen inches for diameter of suction and discharge pipe, and on special order can be made any size required. The first cost will depend on size of plant and type of engine used. For small plants capable of serving 100 acres or less, the first cost has usually been $12 to $15 per acre, and operation and maintenance from $2 to $3 per annum per acre irrigated. For larger plants the relative cost has been materially lower.

A recent estimate made by the United States Geological Survey for an extensive pumping system to serve some 300,000 acres of land, indicates the first cost of plant to be about $4 per acre and the annual cost of operation and maintenance to be about 50 cents per acre-foot, or say, $1 per year per acre irrigated. When it is borne in mind that the average cost of installation of gravity supply systems has been about $13 per acre and the average annual charge for irrigation $1.60 per acre, the great possibilities of pumping can be appreciated.

The gasoline engine has proved to be a very efficient power for driving pumps, and the cost per acre by this method is sufficiently low to make this means of securing power very economical for irrigation purposes.

SOUTH DAKOTA IRRIGATION.

A. J. Glidden, the pioneer irrigator of Beadle County, South Dakota, whose farm is near Hitchcock, gives an interesting account of his experiments and the results attained by irrigation from artesian wells during the past few years. Mr. Glidden began experimenting seven years ago, and each season the results were most satisfactory, and he has demonstrated that the system employed is both easy and practical, and successful.

The well from which the water comes, flows about 550 gallons per minute, and this is turned into a reservoir, covering about twenty acres. The lay of the land is such that crops are quite exempt from early frost in fall and late frost in spring. Mr. Glidden's report for the year 1902 is as follows:

Eighteen acres of cabbage yielded 95 tons; 3 acres of onions, 1,600 bushels; 2 acres of tomatoes, 150 bushels ripe and 500 bushels green; 6 acres of potatoes, 500 bushels; 2 acres popcorn, 80 bushels; one-half acre parsnips, 200 bushels; one-fourth acre beets, 200 bushels; one-half acre carrots, 250 bushels; 2 acres squash planted with corn, 5 tons; 1 acre pumpkins planted with corn, 4 tons; 2 acres cucumbers and melons were seriously damaged by frost; 1 acre small "truck"; 1 acre Iowa Gold Mine corn, very poor stand, 300 bushels; 25 acres Texas red oats, 1,300 bushels; 5 acres speltz, 200 bushels; 20 acres corn, caught by frost, 500 bushels; 10 square rods strawberries, 14 bushels; 1,000 plum trees (only few bearing), 25 bushels; 1,000 currant bushes, 200 bearing, 10 bushels; 500 apple trees, 60 cherry trees, 250 crab apple trees and 50 sand cherries, all bore well; also big yield from 100 gooseberry bushes.

Please mention THE IRRIGATION AGE when writing to Advertisers.

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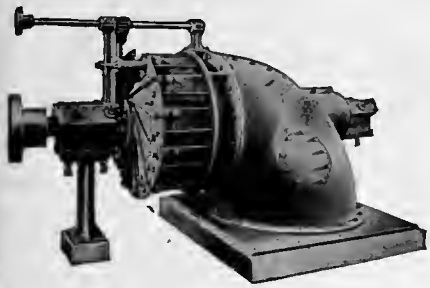


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THE IRRIGATION AGE

VOL. XX CHICAGO, JUNE, 1905. NO. 8

THE IRRIGATION AGE

With which is Merged

MODERN IRRIGATION — THE DRAINAGE JOURNAL — THE IRRIGATION ERA — MID-WEST — ARID AMERICA — THE FARM HERALD

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

Current Wheels. We will present in our issue for June an elaborate article on current wheels and their use in lifting water for irrigation. This article is prepared from data secured from official records, and will be embellished with a fine lot of illustrations, twenty-six in all, among them being a number of outline drawings which will be of great value to those contemplating the construction of an outfit for raising water. The drawings are simple and the accompanying matter so comprehensive as to be valuable to all.

Watch for Bulletins. If the officials of the Reclamation Service who will have charge of the party of Senators and Congressmen that will start on a tour of inspection of the various Government irrigation projects June 1st have their way, we may expect to see some elaborate illustrated articles in the metropolitan press. It has been noted that "Dr." Newell has used Guy Mitchell as his mouthpiece to the press, and as Mr. Mitchell is one of George Maxwell's assistants, it may be readily imagined that the Tonto or Roosevelt dam in Arizona and the Nevada project will be duly "boosted." By the way, why did not Newell call the Nevada dam "The Newlands," after the genial Senator for that State, whom, we are informed, is considerably interested in this project?

Perhaps this was contemplated, and the Senator, hearing of it, "nipped it in the bud," fearing that perhaps that would be going too far.

Revival in Western Kansas. Twenty-five years ago thousands of farmers settled in Western Kansas, attracted by the fact that for two or three years the rainfall had been sufficient to grow crops. They were ruined by successive droughts, for they discovered that a good crop year came only once in four or five seasons. They pulled up stakes and went back East.

These farmers little dreamed that there was an unlimited quantity of water within easy reach, which could be lifted by windmills into irrigation ditches. A few years ago our Geological Survey discovered that a large part of the high plain of western Kansas is underlaid with an abundance of water of the purest description. It is from one hundred to two hundred feet below the surface. It is believed that it may come all the way from the Rocky Mountains along the impermeable cretaceous rocks that keep it up within reach and seem to slope ever eastward in that region. We know that the Arkansas draws the water in its channel from those same mountains. At any rate, the new farmers in the extreme western counties feel the stimulus of enthusiasm and confidence and believe they are going to keep Kansas in the van of the wheat States, a proud position she has occupied several times of late years.

Irrigation has of late made great progress in the heretofore arid countries in the northwestern portion of the State. Here settlers have been flocking with money to buy land, and real estate is having a boom. Tracts of 160 acres that went begging at $100 a few years ago are now selling at $1,600. Many little reservoirs have been sunk on the tops of the prairie undulations, and windmills are everywhere pumping from the wells into the reservoirs which feed the irrigation ditches. Many newcomers are living in sod houses, others are putting up substantial cottages and market towns are rising. This spring 13,000 fruit trees have been delivered at the towns of Colby and Goodman to be planted on the prairies of the northwest tier of counties. The intensive farming that irrigation always brings is supplanting the meager stock raising that followed the bitter failure of twenty-five years ago.

Lute Wilcox. In connection with the good words quoted from "Polly Pry" about Lute Wilcox, editor of *The Field and Farm,* in this issue is brought to mind a happening in the early history of the National Irrigation Congress which it will do no harm to repeat.

The executive committee of the —— Congress, which was to be held in Phoenix in the fall of 1893 met at Denver in the summer of that year to arrange a program, and Lute Wilcox, as well as the writer, was in attendance. During the work incident to the preparation of the program, the writer suggested the name of Dr. Clarke Gapen, at that time superintendent of the Eastern Hospital for the Insane at Kankakee, Ill., as a good man to have on, as he had been experimenting along the line of supplemental irrigation at the hospital farm and would be able to give a valuable and interesting report on his experience.

For some unknown reason, all the members of the committee excepting Lute Wilcox opposed the suggestion, evidently thinking that a man from Illinois could give very little information to a Westerner. After threshing over the subject for some time, and when it was about decided to turn the proposition down, Wilcox came over to where the writer was sitting and suggested going downstairs "to see a man." When he had gotten out of earshot of the balance of the committee he said, "Say, ————, you stop here a little while and I will go back and tell those fellows something. They think that because your man Gapen and yourself are from east of the Missouri that you can't tell them anything."

Wilcox came back in about five minutes, smiling, and said it was all right—Gapen would go on.

As a result of that work the Congress at Phoenix heard the best talk that has ever been delivered on supplemental irrigation, and Dr. Gapen's talk has appeared in print and been read by one hundred people to every one who has ever read any of the other talks at that meeting.

In connection with this story it occurs to the writer that this same Congress at Phoenix was the first time George H. Maxwell came upon the scene. This is the same "Ozone George" who now poses as the father of all irrigation movements in this country. "Ah Lack-a-day."

Self Exploitation. In conversation recently with a well known irrigation man from a Western State, some queer information was secured about the methods of F. H. Newell, of the Reclamation Bureau and his systematic method of exploiting his personality during the years when he filled the position of hydrographer for the United States Geological Survey.

The gentleman informed us that on one of his trips through the West he met Mr. Newell in a Pullman car on his way to Denver. As they were nearing the city he noted that the genial "Doctor" opened a suit-case, which was filled with half-tone portraits of "the gentleman himself," to each one of which was attached by a rubber band a typewritten biographical sketch, in some cases accompanied by a written-in-advance interview on some subject germane to a particular district. On arriving at the station, our informant states that Mr. Newell explained that he would visit several of the newspaper offices and leave cuts and data before going to the hotel. On the following morning the papers appeared with splendidly written interviews with Mr. Newell, accompanied by his photo in half-tone.

Thus it will be seen that glory may be gathered abroad by direct application to work during harvest time.

IRRIGATION BOOKLETS FREE.

In order to increase the circulation of The Irrigation Age, it will be necessary for the publishers to secure the names of all interested so that sample copies may be forwarded, with a view to having this class of people become interested in the publication. With this end in view, we will ask our readers to send on a list of names of those in their county or State who would be interested enough in irrigation to examine a sample copy of this journal.

If you send us a list of ten names we will forward to you, postage paid, our booklet No. 1, on "Laying Out Land for Irrigation." If twenty names are sent, we will forward booklets No. 1 and No. 2, the latter entitled, "The Science and Art of Irrigation."

If thirty names are sent in we will send full set of booklets, Nos. 1, 2 and 3, which treats of "The Irrigation of Profitable Crops."

Remember, these booklets will be sent to you absolutely free of charge, the only expense to you being one or two cents, one cent if names are sent on postal card and two cents if sent in a letter.

Kindly write your name and address plainly, also observe the same rule in preparing the list sent in.

Address The Irrigation Age, 112 Dearborn street, Chicago, Ill.

EXPERT IN FARM MECHANICS.

Prof C J Zintheo, Formerly Professor in Farm Mechanics of the Iowa State College, has been Appointed as Expert in Farm Mechanics in the Office of Experiment Stations, Department of Agriculture.

In his last report to Congress, Secretary Wilson called attention to the valuable results which had come from including irrigation and drainage in the work of the Department of Agriculture, and recommended that this be extended to include two other branches of agricultural engineering with which this work has a close relation, these being farm buildings and farm machinery. In speaking of the need of the department of an expert to deal with these questions the secretary said:

"The requests of the colleges and stations for aid in carrying out these investigations and in planning courses of instruction have been supplemented by

PROF. C. J. ZINTHEO.

numerous similar requests from farmers for advice and assistance about the selection and operation of different kinds of farm motors and other farm machinery. In the absence of any special arrangement for dealing with these problems they have been referred to the office of experiment stations and dealt with by the irrigation and drainage division of that office; but there are at present no funds which can be utilized for systematic work along these lines. I am of the opinion that results of great value, alike to the farmers and the manufacturers of agricultural machinery, will come from the extension of the department's work in agricultural engineering to include studies of this character in coöperation with the agricultural colleges and experiment stations. I have, therefore, asked Congress for an appropriation which will enable us to employ an expert in farm buildings and farm machinery in connection with the irrigation and drainage investigations."

The agricultural appropriation bill passed by the last Congress made the study of the use of different kinds of power and appliances for agricultural purposes a part of the work of the irrigation and drainage division of the office of experiment stations. In urging this extension of the department's work the secretary was following the lead of many European governments. Sweden and Denmark have for a number of years maintained experiment stations for the investigation of the merits of various farm implements. The Agricultural Society of Germany has been conducting field trials with both domestic and foreign agricultural implements and has distributed the information obtained among the farmers in the form of bulletins. Belgium and Italy are carrying on farm machinery investigations and instructing their agricultural students in the proper use of farm implements. An agricultural experiment station has recently been established in Spain for testing agricultural implements. At the Agricultural College of Russia the students are judging the merits of farm machinery very much after the plan in vogue in our American agricultural colleges of judging cattle.

In Moscow and St. Petersburg are established permanent expositions, where all styles of ancient as well as modern farm implements are on exhibition and where buyers come to study the various implements and to learn which will best meet their needs.

Prof. C. J. Zintheo, professor of farm mechanics in the Iowa State College at Ames, Iowa, has just been appointed as expert in charge of this work and will remove to Washington, July 1st. Professor Zintheo is well fitted by education and practical training to take charge of this position. He began his mechanical training by learning the blacksmith's trade and by being employed in the railroad shops of the Northern Pacific Railway as a machinist and locomotive repair man. He graduated from the University of Minnesota in 1897, having studied in the scientific and electrical engineering courses. During vacations he worked for the McCormick and Deering harvester companies as field expert on their machines. After graduation he took a course of practical training in the Deering Harvester Company's factory in Chicago, and was afterward sent by them to all parts of the United States where special difficulties existed with the company's machines.

In 1900 he went to Paris, France, to put up the Deering Company's extensive exhibit at the exposition. From there he was sent to Siberia to introduce the Deering machines in that far-off country. He spent two summers in Siberia, traveling constantly along the Trans-Siberian Railroad, by steamers on the large rivers and by wagon for thousands of miles from the railroad, introducing the Deering goods to the Siberian natives, convicts and Russian peasants, where now the sales exceed 10,000 machines annually. During the intervening winters Professor Zintheo went to South America, visiting Brazil, Uruguay and Argentine Republic, the Deering Company doing a large business in the latter country. During his two years' trip abroad he visited thirteen countries, and his ability to speak the language of most of these countries gave him an excellent opportunity to inform himself on the agricultural conditions and requirements of these countries.

On his return to the United States he accepted a position at the North Dakota Agricultural College, where he organized the first farm mechanics department in any agricultural college of this country. In

1903 he was elected to be the head of the farm mechanics department that had just been organized at the Iowa State College at Ames. A new farm mechanics building, costing, with the equipment, $70,000, was erected, and it devolved upon Professor Zintheo to outline and organize the new courses of teaching farm mechanics. There were no precedents to follow and no sources of information for the various subjects to be taught in the course, and a great deal of work had to be done to organize the courses. The farm mechanics department at the Iowa State College is now giving very comprehensive courses in field engineering, such as farm drainage and road construction; farm machinery, consisting of a study of farm implements and farm motors; also farm implement design and farm architecture.

Among the lines of experiments which the department will take up will be experiments with farm motors to determine the cheapest motive power for farm purposes. Tests will be made with the new gas producer gas engines to determine how cheaply power may be produced from lignite coal in the extensive lignite fields of North Dakota, and thus obtain a substitute for the expensive gasoline.

Experiments will also be conducted with "denaturized" alcohol produced from potatoes and waste products of the Western farms to be used as a fuel for farm motors in Colorado and elsewhere.

Cement and concrete for farm building purposes will be experimented with to determine their efficiency and cost as compared with lumber, which is constantly increasing in price.

A bulletin on corn harvesting machinery will be issued in the near future.

It will be seen that a very extensive field of investigation and information will be established and a great deal of benefit will be derived both by the implement manufacturers and by the farmers.

A half-tone photograph of Professor Zintheo is shown herewith.

"LUTE" WILCOX.

Polly Pry, a well-known magazine of Denver, has the following to say about our friend, Lucius M. Wilcox, editor and proprietor of the *Field and Farm:*

Somewhere between forty and fifty years ago, more or less, there or thereabouts, one Lucius M. Wilcox made his advent upon this vale of tears. Early in life he was called "Lute," and as he never lost his boy-heart he never lost his boy-name, and everybody either knows "Lute" Wilcox or knows of him.

A few years ago he established *Field and Farm,* a journal devoted to farming in this region, once known as "the Great American Desert." He wrote all the farmers he could learn of postal cards of the return variety and asked them if they were subscribers for the paper and wound up with the pertinent question: "If you are not a subscriber, why don't you subscribe?" Then he asked if they had any suggestions to make, and as anybody can tell an editor how to run a paper hundreds of thousands of ranchers subscribed for the pleasure of giving him good advice.

He must have carefully avoided taking it, for he has made a tremendous success of his paper, built it up until it has a splendid circulation, and made it the most quoted agricultural paper in the West; in fact, it is The only agricultural paper in the West that anybody hears of right straight along. "Lute" is making money, and everybody is glad of it, whether they know him or not. If they know him personally it is almost as if good fortune had overtaken one of the family. If they know him by hearsay they are glad of any pleasant thing that comes his way, because he has done much to build up this State and because a few years ago he had lost his sight.

Ordinarily it is not good manners to speak of any personal affliction, but sometimes there comes with such a loss a spiritual gain, such a growth of the finer attributes of the mind and soul that the loss may be accounted gain.

"Lute" didn't give up or moan and bewail his lot. He thanked God for the bravest, truest wife a man could hope for, gave the general supervision of things into her strong and capable hands, and began to adjust himself to the new, untried life he must lead in a continual valley of shadow.

You will find the best literature of the day and of other days on Lute's table; the May *Century* and the *Autocrat* elbow each other. The newest novel, the last

LUCIUS M. WILCOX
Editor Field and Farm, Denver, Colo.

scientific treatise, the agricultural papers and the Government irrigation reports all have a place in his scheme of existence. It would be hard to find a better posted man or a better read man than he. Not only that, but it is as if, having lost the outward sight, he had gained inner light that clears up the dark and puzzling points and renders luminous the most obscure and difficult problems. He really thinks; most of us only think we think.

He is a man worth cultivating, worth making much of; we do not find his brave, cheerful spirit every day. Whenever I think of him I think of these lines, which somehow seem to suggest his experience:

"I could not see till I was blind,
Then color, music, light,
Came floating down on every wind,
And noonday was at night.

"I could not feel till I was dead,
Then through the mold and wet
A rose breathed softly overhead;
I heard a violet."

MEASURING THE FLOW IN UNDERGROUND STREAMS.

In mountain regions, and especially in California, rivers often rise among the mountains, flow for a distance upon the surface, and then suddenly disappear.

In an interesting paper read before the Western Society of Electrical Engineers, Professor Slichter discussed the flow of water through the ground, and the apparatus used for measuring the rate of flow. Measurements was made, among others, upon the Rio Hondu and the San Gabriel rivers east of Los Angeles, Cal. Rising in a canon they flow above the ground to its mouth, and then disappear for ten miles. Rates

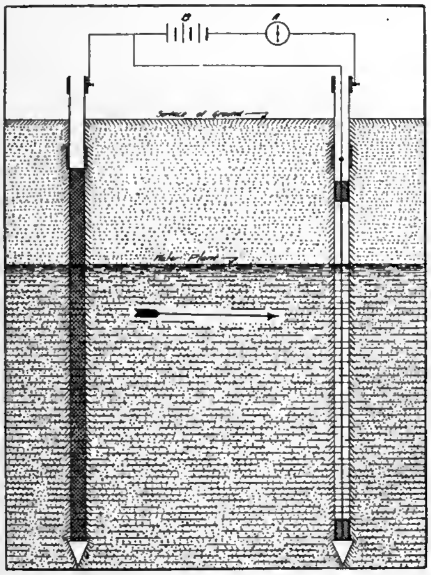


FIG. 1.

of underflow of from 3.8 feet to 48 feet per day were found, says *Popular Mechanics.*

The measurements were made between drive wells sunk for the purpose. Common 1½-inch or 2-inch drive well pipe is used, having on the end an ordinary 1½-inch brass jacket well point from forty-two inches to forty-eight inches in length, with a brass gauze strainer. The pipe is cut in lengths of six or seven feet, threaded 1½-inch at each end, wrought iron recessed couplings being used to fasten the lengths together for different depths. Rolled steel shafting four inches long with a hole for the escape of air is screwed on the upper end of the pipe for a driving head, and a heavy cylinder 5½ feet long by 5½ inches in diameter with iron rings shrunk on the ends is used to drive the pipes down.

Fig. 1 shows the way the drive wells are located, AC being the probable direction of the flow as determined by the slope of the land. For deep work the wells are put farther apart to throw out any mistakes due to driving the wells not plumb.

In Fig. 2 two wells, say A and D, are electrically connected as follows: On the pipe D is a binding post from which a wire runs to an ammeter, A, for measuring the current; then the current runs through a battery of five or six dry cells and to the binding post on the case of well A. Inside the well D is a ⅜-inch nickled brass rod, four feet long, kept from touching the well case by wooden spools. From the upper end of this rod a rubber covered wire connects with the wire from the casing on well A as shown. In every group each of the down stream wells is connected, as just described, to the upstream well A.

To find how fast water is traveling through the soil from A to B, C and D, a pail of water into which

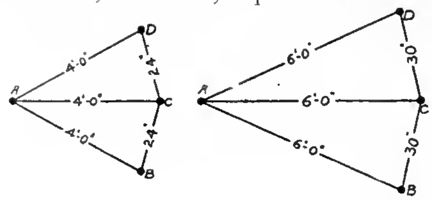


FIG. 2.

all the sal ammoniac it will dissolve has been placed is poured into the well A. It will flow toward the B, C and D and being a conductor of electricity, when it reaches any one of the three wells it will form a circuit between the casing and the nickle bar, and a current from the battery will at once swing the ammeter needle well up on the scale. The distance from A to each down stream well being known, this divided by the time elapsing between putting sal ammoniac in well A, and the swing of the ammeter needle, will give the rate of underflow.

Finely powdered sal ammoniac may be used in well A, lowering it as in Fig. 2 by a wire screen bucket holding about two pounds. The method succeeds using only common pipe and wiring between the casing of up-stream and down-stream wells, leaving out the nickled rod.

Special clock work and self recording instruments have been made which measure the slowest and fastest flows yet found, so that after the wells are driven, wired, and salted, the observer need not be always present. A No. 2 cast iron pipe puller and five-ton railroad jacks will serve to pull the well casings when through.

A publication, interesting alike to the engineer and layman, is the new catalogue on Hydraulic Rams, recently issued by the Columbia Engineering Works of Portland, Ore. It is replete with facts and figures which demonstrate the superiority of this device over the old fashioned ram; a superiority imparted to it by a very ingenious valve mechanism fully described in the catalogue. The most interesting feature of the latter is the disclosure that by virtue of the peculiar construction of the waste valve the shock so pronounced in old style rams is completely subdued, making it possible to increase the size and capacity of single units to mammoth proportions. This feat, formerly considered impracticable, raises the Phillip's Hydraulic Ram from the level of what might be termed a cut and dry mechanism to that of a highly scientific hydraulic engine, which, owing to its great efficiency, inexpensive operation and comparative simplicity, will fill a long felt want in hydraulic engineering.

The catalogue contains fifty-four pages, each of which is covered with interesting reading matter. It can be had for the asking.

RECLAIMING OF THE ARID LANDS OF THE NORTHWESTERN STATES.

BY THOMAS COOPER, LAND COMMISSIONER NORTHERN PACIFIC RAILWAY.

No single feature of the development of the Great Northwest—the States of North Dakota, Montana, Idaho, Washington and Oregon—is more significant of future greatness than the work done during the last decade in bringing the semi-arid land under cultivation and in developing methods by which great areas are made immensely productive.

Irrigated land produce never failing crops. The land and the water, primary elements in crop production, are known quantities and can be depended upon. Adjacent to the principal areas of the Northwest in which irrigation development is now in progress are splendid home markets waiting to take all that the land will produce.

The land to be brought under cultivation through the work of the United States Reclamation Service, the organization through which the Federal Government is carrying out the largest scheme of irrigation development and irrigating work yet attempted, will be thrown open to settlement as fast as the water is supplied, under terms which from the standpoint of the settler will be very reasonable.

Land irrigated by the United States Government will be subject to entry under the Homestead act, as modified by the Reclamation act. The cost of irrigation works and the expense of furnishing water to a given district will be apportioned pro rata to the acreage benefited and the cost per acre, thus obtained, is what the settler pays for the land and the water rights, in ten annual payments without interest.

The cost per acre varies with the cost of the project, the term used by the Government engineers to designate irrigation plans and work in a given district. On projects so far undertaken the cost runs from \$15 to \$30 an acre. The reclamation service carefully considers the character of the land, its proximity to markets and transportation facilities before undertaking any improvements, in order to make sure that there will be left an ample margin of value above the cost of the work when completed.

The purchase money received by the Government goes back again into the reclamation fund to be used over again in building other canals and in supplying water to new districts.

Scene near Head of Mink Creek Canal, Oneida Irrigation District, Oneida County, Idaho.

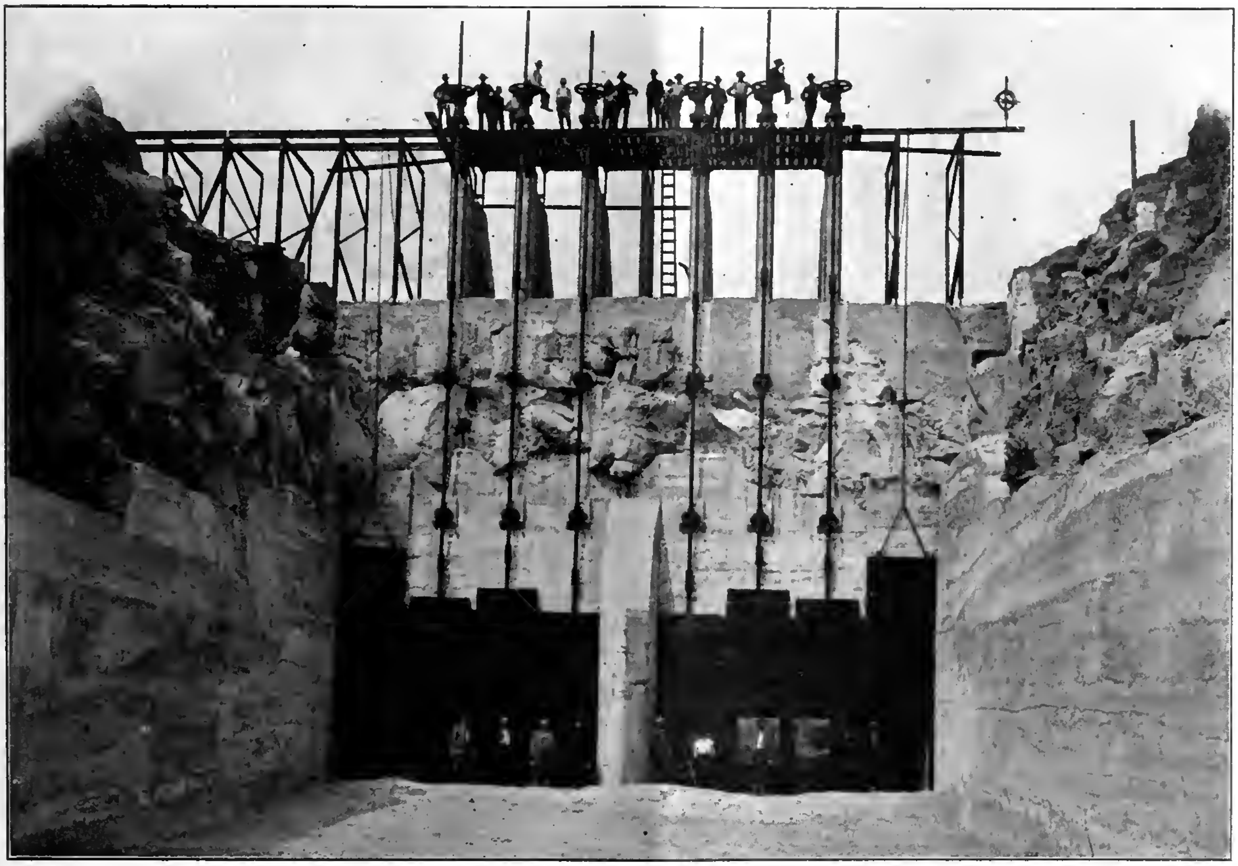
The irrigation projects along the line of the Northern Pacific Railway on which work will probably be inaugurated during the present year by the Government Reclamation Service, are the Lower Yellowstone canal, which will irrigate 40,000 acres in Montana and 20,000 acres in North Dakota, and several others of importance. The Yellowstone canal will take water from the Yellowstone River at a point about thirteen miles below Glendive, Mont. An association of the land owners under the canal has been formed as required by the Reclamation Service and is called the Lower Yellowstone Water Users' Association. It is expected that all of the necessary preliminary work will be completed within sixty days, after which contracts for the construction of the canal will be awarded.

On the Crow Reservation several canals are contemplated by the Reclamation Service, one of which, known as the Huntley Project, will irrigate 30,000 acres and will be put under contract within a few weeks, it is expected. The lands irrigated by this canal are in the vicinity of Huntley Station on the line of the Northern Pacific, a short distance east of Billings, Mont. It is expected that at least two other good irrigation projects will be developed on the Crow Reservation, as surveys already made indicate that they are feasible and that their cost will be low.

In Washington the Reclamation Service is endeavoring to remove the obstacles in the way of the Washtucna Coulee Project, which is to irrigate 100,000 acres of land in the vicinity of Pasco. This is one of the largest projects so far undertaken by the Government and involves the construction of a large dam across the mouth of the Washtucna Coulee, for the purpose of creating a reservoir in which to store the waters of the Palouse River. The principal obstacle lies in the fact that the coulee is now occupied by the tracks of the Oregon Railway & Navigation Company, a branch line connecting with the Northern Pacific at Cannell. This branch must be moved to higher land if the Government engineers go forward with their plans. It is understood that good progress is being made in the negotiations between the Reclamation Service and the Oregon Railway & Navigation Company for the removal of the branch. In all likelihood the work of constructing this irrigation project will be commenced this year.

Surveys have been made for a large number of other projects along the lines of the Northern Pacific Railway, some of which have been found impracticable under present conditions and others possible. Among the latter are two projects for pumping from the Missouri River in North Dakota, one in the vicinity of Fort Buford and the other in the vicinity of Bismarck. The engineers are working out the details of these two projects.

In addition to the projects of the Reclamation Service there are a number of irrigation canals under construction by private capital at different Northern Pacific points. At Forsyth, Mont., the canal of the Rosebud Land & Improvement Company, irrigating 12,000 acres, will be completed and in operation this year. The Billings Land & Irrigation Company will also complete a large canal irrigating 40,000 acres near Billings, Mont. This company is now placing its lands upon the market. The construction of a large sugar beet factory is now assured and a large irrigated area has been proven to be splendidly adapted to the growing of sugar beets.



Tunnel Gates, Twin Falls Land & Water Co.'s Dam at Milner, Cassia County, Idaho.

On the table lands immediately east of Spokane several canals have been and are now being constructed, utilizing the numerous lakes in that district for storage purposes. Under these canals irrigated lands can be purchased at very reasonable terms.

There is still a large area of irrigated land under the constructed canals in the famous Yakima Valley in Washington. An extension of the Sunnyside canal, now one of the largest in the United States, is contemplated this year. This will water 200,000 acres additional.

The Northern Pacific Railway has made arrangements with the United States Department of Agriculture and the State Experiment Station of Montana for conducting a number of experiments in dry-land farming this year in Eastern Montana. These experiments will be started within a short time and it is confidently expected that the results will show that millions of acres of Montana lands heretofore assumed to be valuable for grazing only are adapted to agriculture. This is predicated upon the fact that the minimum rainfall in eastern Montana is about fourteen inches, that the soil is generally good, and that this method of farming is being profitably conducted in eastern Washington, California, Western Kansas, Nebraska and Colorado in districts where the annual rainfall is from nine to ten inches. It is also known that in that portion of North Dakota west of the Missouri River where the rainfall is from fourteen to sixteen inches the farmers are doing well and although last year was unusually dry there was a large increase in the products shipped from the different stations in North Dakota and west of the Missouri. This country is being rapidly settled up by a good class of settlers attracted by the large areas of unoccupied Government lands and the low prices at which lands are being sold by the land companies operating there.

It is a constant source of surprise to all who are familiar with the conditions that the settlement of northern Minnesota does not proceed more rapidly. There are millions of acres of excellent lands in northern Minnesota where the timber has been cut off which are waiting for settlers and which are obtainable at very low prices. There appears to have been no systematic effort toward securing immigration in Minnesota and the result is that settlers have gone and are going further north into Canada trying to make homes on lands not nearly as well adapted to their purposes as those they are passing by in Minnesota. An excellent move to cure this condition of affairs would be the establishment of a State Immigration Bureau. The ownership of northern Minnesota lands is so diverse that it would be difficult if not impossible to secure unity of action by the land owners, and as every settler adds to the wealth of the State it is entirely proper that the work of securing them should be borne by the State as a whole.

H. G. LEAVITT VS. THE SECRETARY OF THE INTERIOR AND THE NEBRASKA STATE BOARD OF IRRIGATION.

In our issue for March mention was made of a decision by the Nebraska State Board of Irrigation against Heyward G. Leavitt, who had completed plans for an extensive irrigation project and wherefore he had filed with the secretary of the State Board a petition for leave to appropriate from the North Platte River in Nebraska, some one thousand eight hundred cubic feet of water per second to be used for irrigation and domestic purposes.

The claim of Mr. Leavitt and his associates was ignored by the State Land Board and an adverse decision rendered.

Action was subsequently taken in the form of an appeal from the decision of the Nebraska Board of Irrigation to the courts and we herewith publish a copy of the petition served on E. A. Hitchcock, Secretary of the Interior, John H. Mickey, Governor of Nebraska, Norris Brown, attorney general, and H. M. Eaton, commissioner of public lands and buildings of Nebraska. The last three named constitute the State Board of Irrigation of that State.

IN THE DISTRICT COURT OF SCOTTS BLUFF COUNTY, NEBRASKA.

Heyward G. Leavitt, Appellant, vs. Ethan Allen Hitchcock, as Secretary of the Interior of the United States, and John H. Mickey, as Governor of the State of Nebraska, Norris Brown, as Attorney-General of Nebraska, and H. M. Eaton, as Commissioner of Public Lands and Buildings of Nebraska, Constituting the State Board of Irrigation of Nebraska, Appellees.	Petition of Appellant on Appeal.

TO THE HONORABLE DISTRICT COURT OF SCOTTS BLUFF COUNTY, NEBRASKA:

Heyward G. Leavitt, the appellant in the action above entitled, respectfully states and shows to the Court:

1st.—That heretofore, to-wit: on the 19th day of September, 1904, the Honorable Secretary of the Interior of the United States, acting in that behalf by and through John E. Field, the district engineer of the United States Geological Reclamation Service, transmitted to the secretary of the State Board of Irrigation of the State of Nebraska, an application, Number 768, and entitled, "Application for a permit to construct the Pathfinder Reservoir, and to store the unappropriated waters of the North Platte River, in the State of Wyoming." A copy of said application is found in the transcript filed herewith, in the appeal entitled herein, which transcript is duly certified by Adna R. Dobson, secretary of the State Board of Irrigation of Nebraska, and reference thereto is hereby had, and said application made a part of this petition, to the same effect, and with the like intent as though the same was incorporated herein at length.

Said application was made in reference to and in compliance with the provisions of Senate File No. 45, of the State of Wyoming, in Chapter 69, pages 74, 75 and 76, of the Session Laws of 1903, of the State of Wyoming, approved February 21st, 1903, entitled: "An Act to encourage the storage, for a beneficial use, of the unappropriated waters of the State of Wyoming, and defining the authority of the State Engineer, and the duties of the Water Commissioner thereunder."

Said Act of the Legislature of Wyoming was in full force and effect, when, and at the time, said application was, as aforesaid, transmitted to the Secretary of the Board of Irrigation of the State of Nebraska, and is still in full force and effect herein. A true and correct copy of said Act of the Legislature of the State of Wyoming is hereto annexed, marked "Exhibit A," and made a part of this petition.

2d.—Appellant further shows that no action was taken by the secretary of the State Board of Irrigation of Nebraska, or by the State Board of Irrigation itself, save and except that said application was, as aforesaid, transmitted to and received by the secretary of the State Board of Irrigation, until the 14th day of February, 1905, and long subsequent to the application to appropriate waters from the North Platte River, made by the appellant herein, and hereinafter more particularly referred to.

3d.—That on the 8th day of October, 1904, the appellant, Heyward G. Leavitt, filed with the secretary of the State Board of Irrigation of Nebraska his application. Number 769, for leave to appropriate from the North Platte River, within the State of Nebraska, one thousand, eight hundred and four sevenths (1,800 4/7) cubic feet of water per second of time, to be used for irrigation and domestic purposes.

That said appellant stated in his said application his purpose to construct an irrigating ditch or canal, under and by the name of the "Union Canal."

Sand Springs Falls (in Winter) near Thousand Springs, 180 feet high, near Hagerman, Lincoln County, Idaho.

That said application was made upon one of the blanks furnished to said appellant by the State Board of Irrigation for such purpose, and there was attached thereto all the information required by the State Board of Irrigation, and fully and correctly all matters required by the Statutes of the State of Nebraska, relating to such applications, as may be seen by referring to the certified copy thereof, contained in the transcript filed herewith, in the case entitled herein.

Said application, plate and schedule accompanying the same, being hereby referred to, are made a part of this petition, to the same effect, and with the like intent as though incorporated at length herein.

4th.—That the secretary of the State Board of Irrigation of Nebraska, and the Board of Irrigation of Nebraska itself, failed to act on the said application of this appellant further than to file and number the same, until the 14th day of February, 1905.

5th.—That on the 25th day of November, 1904, the Secretary of the Interior of the United States, through and by the above named John E. Field, filed a so-called amended application with the secretary of the State Board of Irrigation of Nebraska, for permission to store all unappropriated waters of the North Platte River in the Pathfinder Reservoir, proposed to be constructed by the Government of the United States in Central Wyoming, and for water rights for ditches connected therewith, which ditches are designated in said application as follows: "Caspar Canal," "Douglas Canal," "Goshen Hole Canal," "Fort Laramie Canal," "Interstate Canal," and other canals constructed or to be extended and enlarged.

6th.—That said so-called amended application was filed in the office of the secretary of the State Board of Irrigation of Nebraska, together with the accompanying maps, plats and descriptions of land, but no further, or any action was taken thereon until the 14th day of February, 1905.

7th.—That on the 14th day of February, 1905, the matter of the original application, and the so-called amended application of the Secretary of the Interior, and the said application of this appellant, were taken up and considered by the State Board of Irrigation of the State of Nebraska, who, thereupon, made the order, duly certified copy of which is contained in the transcript filed herewith, in the case entitled herein, under date of February 14th, 1905, and by which order, the application Number 768, filed by the Secretary of the Interior, and as attempted to be amended, was allowed, and the date of priority thereof fixed as of September 19, 1904, and the appellant's application, Number 769, was dismissed.

The lands to be irrigated under the said so-called amended application of the Secretary of the Interior were lands lying partly within the State of Nebraska, and included all the lands described in appellant's said application.

Said order of the State Board of Irrigation is hereby referred to and made a part of this petition, to the same extent, and with the like effect as though incorporated at length.

8th.—Appellant says that the State Board of Irrigation of Nebraska erred in making said order to the prejudice of said appellant in the several particulars as follows:

9th.—The State Board erred in receiving the original application of the Secretary of the Interior, Number 768, erred in giving it said number, or any number, and in taking any action thereon, save and except to reject the same, for the reason that said application was and is absolutely void, being an application to impound the water of the North Platte River in the State of Wyoming, in the reservoir to be constructed in the interior of the State of Wyoming, and having no reference whatever to any lands in the State of Nebraska, or to the appropriation of any water from the North Platte River in the State of Nebraska.

10th.—The Board erred in allowing the Secretary of the Interior to amend his application, Number 768, filed September 19, 1904, and to incorporate therein the matters contained in his application of November 25, 1904, for the reason that said original application was a nullity and not entitled to be filed or acted on in any manner, and could not serve as a basis for any amendment, and for the further reason, that the Statutes of the State of Nebraska, relating to irrigation, do not provide for the amendment of applications made to appropriate water from the streams of the State of Nebraska, but only provide and contemplate corrections in such applications where errors or omissions in drafting the same have occurred, and do not provide and contemplate any changes or corrections which will have the effect of enlarging the scope, purpose or purview of the original application.

11th.—The amendment allowed to be made to the application, Number 768, of the Secretary of the Interior, is not within the purview of or germane to that application, the original being for leave to impound and store waters of the North Platte River in the State of Wyoming in the Reservoir to be constructed in the State of Wyoming, and having no reference to the construction of any irrigating ditch or canal in the State of Nebraska, or the irrigating of lands lying within the State of Nebraska.

12th.—The State Board erred in considering the original application, Number 768, of the Secretary of the Interior, it being shown in and by said application, and the so-called amended application that the Secretary of the Interior was proceeding in that behalf under the provisions of the Reclamation Act so-called, passed by the Congress of the United States, entitled: "An Act appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands." Approved June 17, 1902.

Which said Act provides, in the 5th section thereof, that "No right to the use of water for land in private ownership shall be sold for a tract exceeding one hundred and sixty (160) acres to any one land owner, and no such sale shall be made to any land owner unless he be an actual bona fide resident on such land, or occupant thereof, residing in the neighborhood of said land."

The appellant herein says in that behalf that unless the quoted provision of Section 5, of said entitled Act, is modified or controlled by the provisions of Section 8 thereof, there is a conflict between the provisions of said Act of Congress and the provisions of the irrigation laws of the State of Nebraska, inasmuch as under the laws of the State of Nebraska the owner of lands to any amount, whether residing thereon, or otherwise, or occupying the same and residing in the neighborhood thereof, or whether a resident or nonresident, is entitled to have all his lands lying under a ditch irrigated therefrom; and a large percentage of the land covered by the so-called amended application of the Secretary of the Interior are lands held in private ownership by appellant and other parties, appellant and many other owners, each holding title to more than one hundred and sixty (160) acres of land embraced within and covered by said so-called amended application of the Secretary of the Interior; and the State Board of Irrigation of Nebraska had no authority or jurisdiction to grant a water right to any government, person, persons or corporation, unable, for any reason, to comply with the laws of the State of Nebraska, in the use and distribution of the water appropriated, or to deny to the citizen or land owner of the State the use of water to irrigate his own and other private lands covered by the so-called amended application of the Secretary of the Interior, which lands the Secretary of the Interior was prohibited from furnishing water for irrigation or other purposes by the provisions of the fifth section of the Act of Congress, above referred to, unless the ownership of such lands should be confined to one hundred and sixty (160) acres to each person, actually residing thereon.

13th. The Board erred in dismissing appellant's application, No. 769, and in giving the so-called application of the Secretary of the Interior priority over the application of appellant, for the reason that the application of the Secretary of the Interior for leave to construct irrigating ditches and to irrigate lands in the State of Nebraska was not filed until November 25, 1904, while the application of appellant was filed October 8, 1904, and no showing was made to said State Board of Irrigation that the application of appellant was not made in good faith and that he was not able to construct the canal and maintain the same, nor was any claim made that said application was for speculative or for any purpose except the single honest one of constructing and completing the canal within the time designated in his application, and in all respects in accordance with the laws of the State of Nebraska.

14th. The Board erred in not giving priority to the application of the appellant over that of the Secretary of the Interior, appellant's application to appropriate water to irrigate lands in the State of Nebraska being dated more than thirty (30) days prior to any application for that purpose filed by the Secretary of the Interior.

15th. Appellant further says that the powers of the Secretary of the Interior relating to constructing canals and irrigation enterprises, and permitting and operating irrigation projects, are limited by the Act of Congress aforesaid, and the provisions of the fifth section of said Act conflict in many material respects with the provisions of the Statutes of the State of Nebraska relating to irrigation, and denies to citizens of and owners of land situated in Nebraska many privileges awarded them by the laws of said State, unless the provisions of Section 5 of said Act of Congress are governed and controlled by the provisions of Section 8 of said Act.

16th. The Board erred in allowing a water right to the Secretary of the Interior, whose right to build and operate a canal, and to water lands under such canal, in full accordance with the laws of Nebraska, is doubtful, for the reason that the Secretary of the Interior is limited in any authority he may possess by the Act of Congress aforesaid. And whatever interpretation or construction may be given the provisions of said Act of Congress, the said State Board erred in giving to the so-called amended application of the Secretary of the Interior priority preceding the date of its filing, and in dismissing the application of appellant herein.

Wherefore appellant prays that the application made by him to the Board of Irrigation be allowed, and that the application made by the Secretary of the Interior be disallowed.

(Signed) Heyward G. Leavitt,
By Isaac E. Congdon,
His Attorney.

State of Nebraska, }
} ss.
County of Douglas. }

I, Heyward G. Leavitt, having been first duly sworn, on my oath say that I am the appellant in the above entitled appeal; that I have read the foregoing petition for appeal, know the contents thereof, and believe the allegations and averments therein contained to be true. (Signed) Heyward G. Leavitt.

Subscribed in my presence by the said Heyward G. Leavitt, and by him sworn to before me this 26th day of April, A. D. 1905. (Signed) C. H. Marley,
[seal.] *Notary Public.*

THE WASHINGTON IRRIGATION AND COLONIZATION COMPANY OF IDAHO.

This Company Will Bring Suit for Damages Sustained by their Project Being Killed Through Action of the Reclamation Bureau.

The Washington Irrigation and Colonization Company, of Boise, Idaho, has placed before the secretary of the Interior a statement covering the history of its application for the segregation of 92,593 acres of public lands which would have been served by a contemplated canal system adjacent to the town of Minidoka on the Snake River, Idaho.

The organizers of this company, recognizing the value of this land for irrigation purposes, and the feasibility of the enterprise for private capital, were the first in the field to form a company for its reclamation and claim that they were the first to make surveys under the Carey Act and the State laws of Idaho. The company also claims that it was the first to file applications for water right and plans for the construction of the necessary dam and system of canals, and that these filings were made fully one year before the Government representative made his recommendation that the Government undertake the construction of the same system upon an enlarged plan.

It is furthermore stated that there being no doubt as to the commercial value of the enterprise, there must then arise the contention whether this is a proper case under the Reclamation Act for the employment of Government aid, when private capital was and is now prepared to undertake it.

The Secretary of the Interior is furthermore asked if it is the purpose of the Reclamation Act for the Government to intervene in any irrigation enterprise where private capital is prepared to go ahead under the Carey Act after having complied with the requirements of State and Federal enactments.

The original plans of the Government engineer contemplated the reclamation of double the amount of land specified in the documents filed by the Washington Irrigation and Colonization Company. This was to be accomplished by raising the dam to a greater height than proposed by the company and adding pumps to raise the water required for the irrigation of an additional 100,000 acres which lie upon a level much higher and not generally considered good land.

In view of the fact that this company had expended a considerable amount of money in surveys and for other purposes it is proposed to bring action in the courts which will fully expose the methods of Reclamation Service officials and secure such redress as the court may decide is its due.

As this is one of many cases wherein the Government has stepped in to hamper development under private money, the outcome of such action as the company may decide to take will be watched with interest.

TO LOOK OVER RECLAMATION PROJECTS.

A committee composed of members of the United States Senate and House of Representatives and a limited number of guests start June 1st from Kansas City on a tour of investigation covering nearly all of the projects under course of construction. This trip was planned by members of the legislative bodies and was subsequently taken hold of by representatives of the Geological Survey, who will pilot the party, and it is reasonable to suppose these gentlemen will at least show up all the good points possible. Fortunately, a number of members of the House and Senate are acquainted with some of the facts connected with the selection of certain sites and a thorough investigation may result in bringing to light some of the conditions surrounding the "Reclamation throne."

Below is given an itinerary of the circuit to be made. This is published so that those along the line of route who have grievances may have an opportunity to present them.

The editor of THE IRRIGATION AGE intends spending some considerable time during the coming summer where Government work is in progress, and reports of conditions as found will appear in future issues of this journal.

ITINERARY.

June 1.—Kansas City, Mo. Leave on Golden State Limited at 10:40 a. m.

June 2.—Arrive at El Paso, Tex., 3:45 p. m.

June 3-4.—El Paso, Tex. Visit Engle dam, Mesilla Valley, New Mexico, Jaurez, Old Mexico.

June 5.—Leave El Paso, 7:15 a. m.

June 6.—Arrive Maricopa, Ariz., 4:57 p. m. By special to Phoenix.

June 7.—Leave Phoenix early morning, drive to Roosevelt, arriving evening.

June 8.—Back to Phoenix, leaving 7:30 p. m.

June 9.—Arrive Yuma, Ariz., 3:35 a. m., drive to Laguna dam site in morning. Afternoon trip down river on steamer.

June 10.—Leave Yuma, 3:35 a. m., arrive Old Beach 5:32, special to Calexico, arriving at 9:15 a. m., leave 2:20 p. m.

June 11.—Special to Riverside and Redlands. Leave Riverside at 4:51 p. m., arrive at Los Angeles 6:51 p. m.

June 12.—Leave Los Angeles, arrive San Francisco 9:10 a. m., June 13.

June 14.—San Francisco.

June 15-16.—Sacramento Valley.

June 16.—Leave Sacramento 10:20 p. m. on No. 14, arrive at Sparks, Nev., 8:00 a. m., June 17.

June 17.—Special to Hazen, Nev.

June 18.—Hazen, Nev.

June 19.—Leave Hazen 1:00 a. m. for Salt Lake City on No. 4. arrive Ogden 6:10 p. m., Salt Lake City 7:10 p. m., June 19.

June 20.—Salt Lake City.

June 20.—Leave Salt Lake City 11:45 p. m., arrive Minidoka, Idaho, 8:31 a. m., June 21, No. 5.

June 21.—Leave Minidoka 6:59 p. m. on No. 1, reaching Nampa 12:35 a. m. Boise, 1:25 a. m., June 22.

June 22.—Leave Boise 1:00 p. m., arrive Portland, Ore., 7:15 a. m., June 23.

June 23.—Portland, Ore.

June 24.—Leave Portland 11:45 p. m., arrive Seattle 7:05 a. m., June 25.

June 25.—Leave Seattle 4:00 p. m. on No. 2, arrive Billings, Mont., 9:05 a. m., Cody, Wyo., 11:20 a. m., June 27.

June 27.—Special, leave Cody via Wheatland to Denver.

June 29.—Leave Denver on D. & R. G. 9:30 p. m., reach Montrose, Colo., 2:56 p. m., June 30.

July 1.—Leave Montrose 1:50 p. m., arrive Denver 7:20 a. m., July 2.

IRRIGATION BY GASOLINE POWER.

A great deal has been written on the subject of irrigation, usually referring only to the large and extensive plants; but to the average stockman or ranchman, the isolated irrigation power plant is an absolute necessity. The requirements in the way of power and equipments vary according to the conditions. For deep wells, force pumps and special geared pumping engines having the entire engine equipment connected on skids in as convenient and simple a manner as possible, will give better results. Particularly where the walking beam style engine is preferred.

Where the water is to be forced considerable distance to a tank or reservoir, then the force pump operated by a special semi-portable gasoline engine arranged for moving around, is used.

Where the water is to be raised from ten to thirty feet and very large quantities are required, the centrifugal pump operated by a stationary or semi-portable gasoline engine, if properly constructed, will raise a large amount of water at small cost; for this requires usually several essential features absolutely necessary on the engine, such as wipe feed oilers which will permit constant operation. The engine should have electric ignition of the self-cleaning type to avoid shutting down. The bearings should be of phosphor bronze, owing to the long and strenuous periods of operation for this class of work.

The Witte Iron Works Company, of Kansas City, Mo., manufacturers of the Witte gas and gasoline engines have for years been securing a foothold among the large irrigation improvements of the West and South, and the popularity of their engines has resulted principally from the fitness of the Witte engine for irrigating work. The manufacturers guarantee the engines for five years and for each class of irrigating work they furnish a separate style engine. The perfect operation of plants which they installed over fourteen years ago illustrates the value of a well built and simple engine and that it pays to purchase irrigating machinery from people who have made that line a study and success.

CENTRIFUGAL PUMPS FOR IRRIGATION.

We reproduce below a letter received recently from Mr. Carl Lager, superintendent of the Morris Machine Works, Baldwinsville, N. Y. This letter is in reply to a request for data concerning pumps of this character and we reproduce several illustrations mentioned.

IRRIGATION AGE, Chicago, Ill.

Dear Sir—We are sending you today under separate cover copy of our pump catalogue, and we further enclosed herein beg to hand you blue prints from the following drawings: No. 4359-M, No. 4603-M; No. 4856-M; No. 4577-M; No. 4367-M.

With reference to pumps for irrigation it will, of course, depend upon the quantity desired as to what size of pump is needed, to the height to which the water is to be elevated for the type of pump, and the quantity and elevation together as to the amount of power the pump would take. If the water for irrigation can be obtained from a stream or lake in which the rise and fall of the water does not amount to much, the proposition is very simple; especially if the elevation under which the pump must work, that is, the height to which the water must be elevated from surface of supply water up to point of delivery, is not high. A plain Standard horizontal centrifugal pump, as shown by Fig. 16, page 16, of catalogue, will be the simplest pump to use, and this pump driven from a separate engine by means of belting. The driving engine must be either steam or gasoline. A gasoline engine for small irrigation pumping plant is sometimes quite desirable owing to that the motive power is all in a self-contained unit, and as wood or coal is not always readily obtained for a steam engine, gasoline in barrels can be handled so much easier for a gasoline engine.

If large quantities of water, that is, capacities above 10,000 gallons per minute, are to be handled, especially if the elevation does not exceed twenty feet or twenty-five feet, an engine directly connected to the pump shaft is to be preferred owing to its greater economy, and also to that the outfit is self-contained and takes up very little room. Where capacities as large as 10,000 gallons per minute are to be handled it is very seldom desirable to drive the pump by means of a gasoline engine.

Examples of a pumping plant driven by belting are given by blue print No. 4367-M, which quite plainly shows the arrangements of pumps, boilers and engines. The print shows a pumping plant consisting of two 24-inch Morris pumps with

Improved Horizontal Right Hand Pump, Morris Machine Works, Baldwinsville, N. Y.

a capacity for the two pumps of about 34,000 gallons of water per minute. The pumps were built for an elevation of twelve feet, and each one of the engines delivers to the pump shaft from 90 to 100 horse-power.

Drawing No. 4577-M shows a pumping plant for the same purpose, but in which the engines are directly connected to the pump shafts. This plant consists of two 30-inch pumps having a combined capacity of 50,000 gallons of water per minute. The engines are compound in order to secure highest results in fuel economy.

Where there is a very great rise and fall in the supply water, as, for instance, in some rivers where the water may rise and fall as much as thirty feet or more, it is not possible to place the pumps on the bank, as then when the water went down there would be too great distance down to the water line, and the pumps would not be capable of lifting the water by suction. The only things to do then is to place the pumps in a pit or excavation, some distance from the

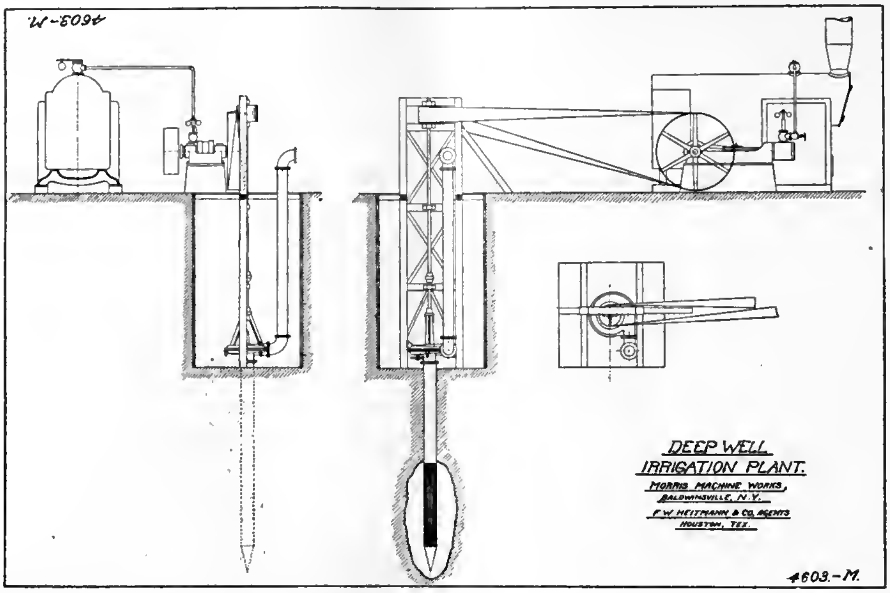
Vertical Pump for Irrigation, Morris Machine Works, Baldwinsville, N.Y.

water line, making this pit sufficiently deep so that the pump can be placed with the suction pipe not to exceed twenty feet above the lowest water line. An arrangement of this kind is shown by blue print No. 4359-M, in which the pump is driven from an engine arranged on the ground above, by means of belt leading down to the pulley on the pump shaft.

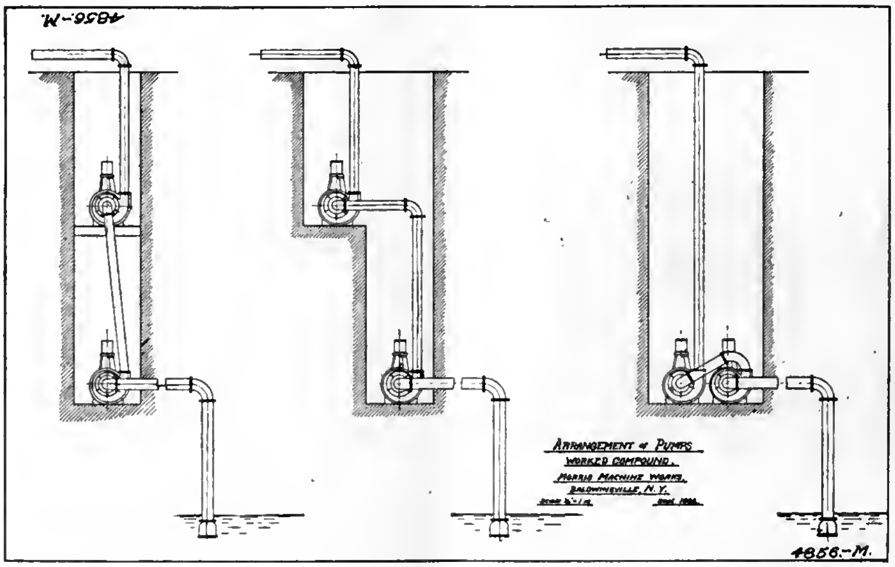
Another arrangement for small pumping plants is shown by drawing No. 4856-M, giving examples of arrangement of small pumps, say with 6-inch or 8-inch discharge, directly connected to engines, and for elevations up to about fifty feet. Owing to the high elevation compound pumps are used, that is, two pumps are working together, one pump taking the water from the supply and delivering into the suction of the second pump, which pump in turn delivers up to the full elevation.

Where water is obtained from driven wells a special type of vertical centrifugal pump is frequently used, and the arrangements of such a pumping plant is shown by drawing No. 4603-M. It depends entirely upon how high the water will rise in the well pipe as to the location of the pump. If the water rises very nearly up to the surface of the water, and if the well pipes are of sufficient number and size so that the proper amount of water can be obtained without drawing down the water level more than about twenty feet, then the pump can be placed directly on the ground, in which case it is best to use not the vertical pump, but the horizontal shaft centrifugal pump. However, when the water stands at some distance below the ground line, then a pit must be dug to begin with, and the pump placed in this pit, which is the arrangement shown on the print referred to. In this case the pump is simply attached by means of its suction flange directly to the well pipe. A wooden frame is built up from the pump which carries the driving shaft, and the pump is driven from an engine by means of quarter twist belt. This arrangement is quite plainly shown by the drawing.

A centrifugal pump is undoubtedly the cheapest and most economical pump that can be used for raising water. The general impression is, or has been, that a centrifugal pump is only capable of handling large capacities under low elevations, and that the pump is somewhat wasteful of steam. This is not so. A centrifugal pump can be built to elevate water several hundred feet high, although, of course, a somewhat special construction must then be used.



As regards the amount of power it takes, the efficiency of the pump is from 60 to 70 per cent, according to size, although very much also depends upon the care in the design of the pump and how well it is built. There are many centrifugal pumps that only have an efficiency of 40 per cent or less. As compared with an ordinary direct-acting reciprocating steam pump a centrifugal pump can at any time be depended upon to deliver the same quantity of water to the same elevation with less than half the amount of fuel required by the direct-acting pump.



The weight of a centrifugal pump in proportion to its capacity is exceedingly small. The working parts of it are few, practically only a revolving shaft with its runner. Therefore, the pump is balanced, there is no vibration, no expensive foundation required, and the repairs are a minimum.

As regards pumping from deep or driven wells, there is no pump that is as satisfactory as a centrifugal pump. A well always delivers a certain amount of sand with the water, especially to begin with, with a newly-driven well, and a centrifugal pump will handle the sand and water without appreciable wear, while a direct-acting steam pump with its tight fitting plungers, valves, etc., would very quickly wear out, or at least wear so that there would be an enormous slippage.

We suggest that the tables given on pages 15 and 17 of our catalogue should be printed, as they give the amount of water the different sizes of pumps deliver, together with power required per foot of lift, and general dimensions of the pumps. A cut of Fig. 36, page 14, and Fig. 16, page 16, would show what the regular type of vertical and horizontal pumps are like, and a cut of, for instance, the large pump with directly connected engine, shown on page 29, would give somewhat of an idea of what the large irrigation pumping engines would look like.

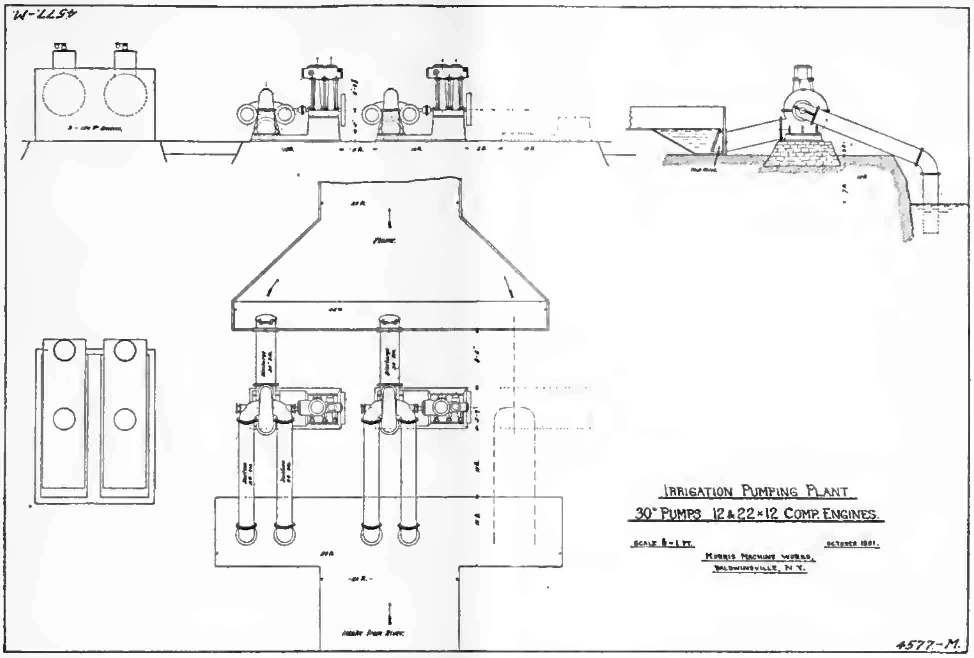
We also believe it might be of advantage to publish the direction for erecting and running centrifugal pumps given on pages 31 and 33, as this information would enable users of pumps for irrigation work to fully understand the principle of the working of a pump, and in case of trouble they would refer to this chapter.

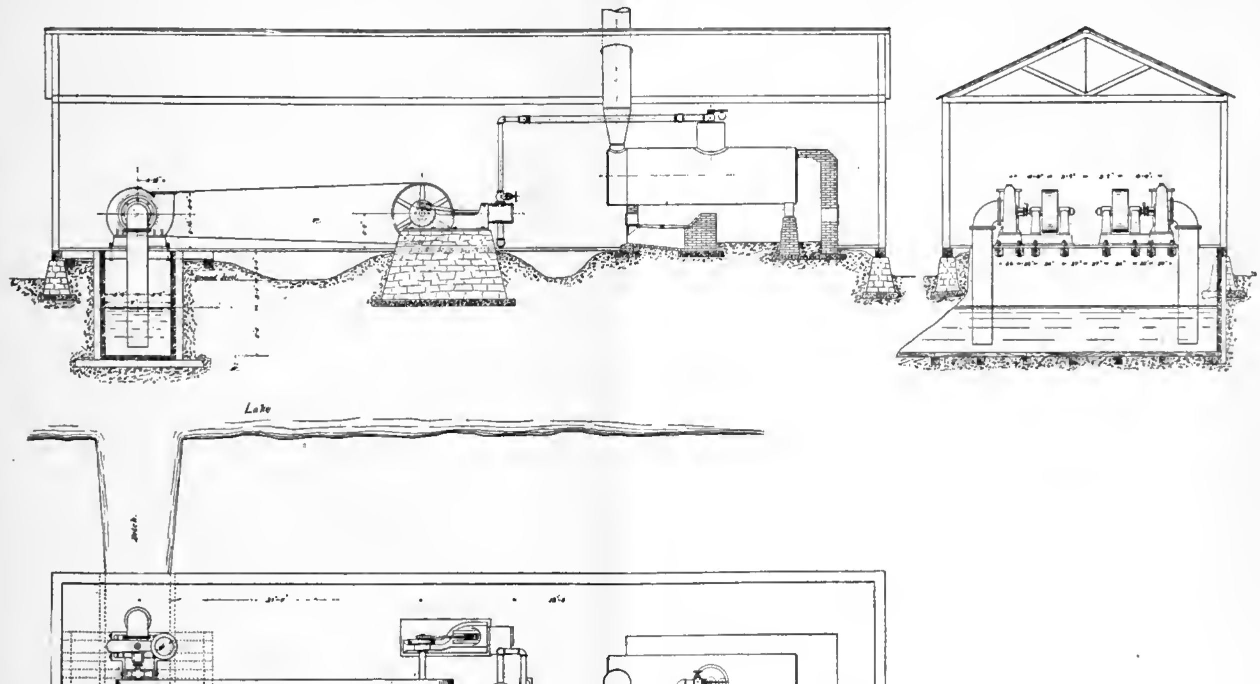
Any further information you may require on the subject we will cheerfully give, and we have written to our Texas representative to see if we can obtain from him any photographs showing plants in service. Yours truly,

Carl Lager,
Supt. Morris Machine Works,
Baldwinsville, N. Y.

DISCREDITING CLEAN ENTERPRISE.

A subscriber writes from Payette, Idaho, as follows: A number of our most substantial promoters of irrigation projects are interested in the construction of canals in Malheur County, Ore., just across the Snake River from Payette. This canal system has been in course of construction for over two years and will ultimately water some 50,000 acres of choice land, unless Mr. Newell succeeds in discrediting the enterprise to such an extent that it becomes impossible to carry out our plans. He has already placed several Government solicitors in the field to misinform the settlers under this system to such an extent that they would be willing to sign contracts to be furnished by a Government proposition which will, if completed, water a portion of the land covered by our canal system and, while we would be glad to have the Government assist in the development of this country, we shall protest vigorously against any direct interference of this kind with private industries, now in the hands of capable irrigation and colonization men who have been very successful indeed in the development of this country, and we are heartily in sympathy with the Governor of Wyoming in his protest against the "imperialism" of Mr. Newell.





DRAINAGE

LAND DRAINAGE.

Nothing more important, nothing more neglected among the most essential lines of agriculture, says Dr. Knapp in *The Rice Journal.* Soil is composed of a great number of exceedingly fine particles of irregular form, having small spaces between them, as in piles of cobble stones. In moist soil these earth particles are covered with a thin film of water, which is ample for vegetation. When the soil is saturated the spaces between the particles are filled with water. Complete saturation excludes air, prevents the formation of plant food and tends to acidity of soil. This standing water in the soil must be removed or profitable crops of other than water plants can not be produced. Without drainage the roots of our cereals are prevented by the standing water from penetrating the soil deep enough to withstand drouth. By capillary attraction the surplus water is brought to the surface and it evaporates, leaving a slight film of alkali, which in time becomes a menace to plant life, the mechanical condition of the soil is injured and the particles are left in an adhesive state, breaking into clods when plowed.

The coast country of Texas and Louisiana, for fifty miles inland is mainly underlaid with a stiff and semi-impervious subsoil. The soil is a rich clay loam or a good sandy loam, and would be very fertile if it were it not for the surplus water in the soil. It is idle to recommend the general prairie farmer in this coast belt to plant fruit trees or corn or potatoes and general farm crops. He can raise rice and some grasses, and on selected spots a variety of crops. Here is a genial climate, a superb soil, an abundant rainfall, and all the conditions, except one, essential to the most luxuriant plant growth. That one exception is standing water in the soil. Whenever a post hole twenty inches deep shows water in the bottom, there is too much water in the soil. The problem before our people is to remove this water. With drainage, farms now considered of little value, will sell quickly at a good price, because of intrinsic merit. It is not meant by drainage to construct a few surface drains—this may be of some service—for this simply removes the surface water, when a removal of soil water to the depth of three feet is required. Where there is sufficient outlet, tile drains do this work perfectly, but the expense is prohibitive to the average farmer. Open ditching is the only practical plan, and for this purpose the main ditches should not be less than four feet deep and the laterals at least three feet, and these ditches should be of ample width to carry the water rapidly away. One serious difficulty arises from natural conditions. The country is so generally level that the creeks and gullies at times are full, preventing any flow from drainage ditches. The creeks, and at times the rivers, are insufficient, by reason of their slight fall, to remove the water in the time required. Again, many small farms have no practical outlet deep enough for drainage, but there is generally some lowest part on such farms which provides surface drainage. It is entirely feasible to construct the drainage ditches to the lowest point, and throw the water out by means of a wind mill. The use of a wind mill for such purposes is practical and economic; the cost of the mill in many cases would be less than the cost of a main drainage ditch to provide outlet.

Our American people have given little attention to questions of the use of economic power. We practically limit the use of the windmill to elevating water from a well; the economic Hollanders use it for drainage and irrigation. A windmill tower and pump of sufficient capacity to remove all the water from a farm of 160 acres can be bought for $150 or less.

With a complete system of drainage, general farming can be undertaken with success along the gulf coast and it never can be a complete success without it. The use of steam or gasoline engines for mere drainage will be found in general too expensive.

DRAINING IRRIGATED FIELDS.

C. G. ELLIOTT, DEPARTMENT OF AGRICULTURE.

A good system of drainage must be developed along with the distributing system if irrigation is to succeed. A few examples will be helpful. Albert Igo, near Greeley, Colo., has used a series of small wells located at points where water appeared, sinking them into the gravel which lies beneath the saturated soil. The wells consist of curb boxes twelve inches in diameter, made with eight sides from board one inch thick. They are sunk from eight to twelve feet deep, the excavations being made with a large auger.

The wells have underdrain outlets about three feet deep, leading to a surface ditch. The water rises at once in these wells to the height of the outlet provided and flows away. The soil, which is about five feet deep, is underlaid with gravel, which through the process of seepage from higher lands has become surcharged with water, which by reason of constant pressure and continual supply from land occupying a higher level, saturates the soil above the gravel. These wells, put in at various points where water appeared, reclaimed at small cost a field which had been given over to grazing land on account of the saturation and alkali.

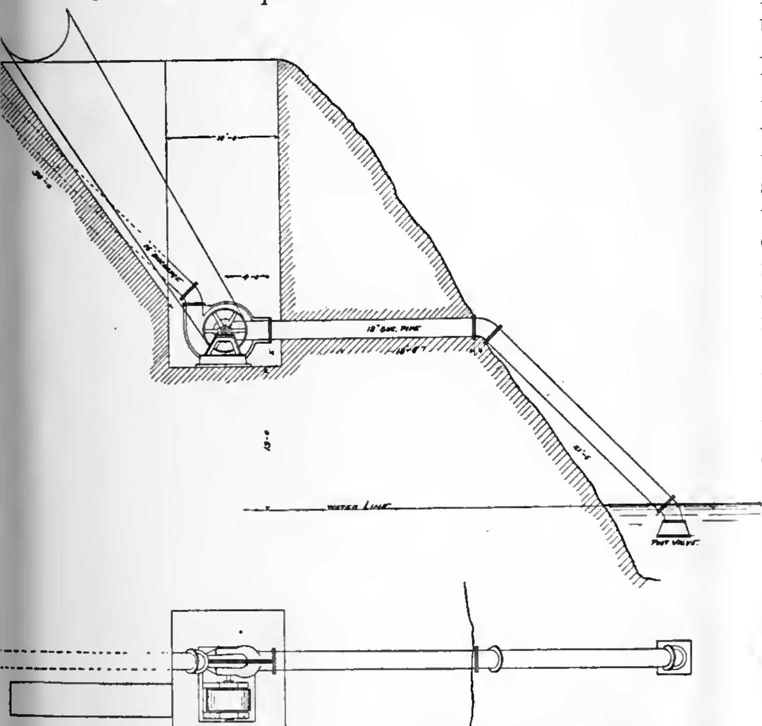
This method of draining is regarded as highly successful by the farmers of the vicinity who have witnessed the reclamation of the land so treated. The method is simple. Its efficiency consists in relieving the pressure of the underground water at such a depth that it will not continue to force itself upward against the soil, and also in removing such a quantity that the gravel stratum underlying the tract will provide for the remainder.

Drains upon another plan have been used by J. Hetzel and others in the vicinity of Longmont, Colo. A continuous line of underdrains is laid crosswise of the slope along the upper border of the lands showing seepage. These drains are laid five feet deep, which is regarded as necessary to their success. The subsoil is adobe clay, in which pockets of sand are encountered, which interfere with the laying of the drains. The drains are made of 1-inch boards in the form of a continuous box, 6x6 inches in the inside, with no bottom. These drains, complete, cost about $1 per rod.

The experience of R. P. Tjossem, of Washington, in reclaiming alkali land proves that it can be done by underdrainage and subsequent irrigation. He has tried mole drains and box drains two to two and a half feet deep, also box drains four and a half feet deep. His draining was not done systematically, but experimentally, and was continued over a field of seventy-two acres in a random way. He discarded the shallow system of draining early in the work and adopted four and a half feet as the minimum depth at which drains should be placed. He is now of the opinion that five feet is preferable.

He irrigated liberally, and by subsoiling, turned the surface soil down as deeply as possible and irrigated again. The land was seeded as rapidly as possible, the completeness of the reclamation being indicated by the growth of the crops planted. Some parts of the field were soon producing a paying crop, while other portions were more stubborn and required further irrigation and cultivation. At the end of five years the entire tract produced a profitable crop of alfalfa and timothy. In the sixth year only small spots remained which failed to produce a good average crop of grass. This field at the beginning was badly affected with alkali, and is described as absolutely barren, black alkali being prominent among the salts. The drainage was meager and experimental. The field is now pointed to by neighboring farmers as an example of the successful reclamation of alkali land by underdrainage. The cheapest and most effective methods and the details which practical farmers desire to know are not as fully demonstrated as they will undoubtedly be later on.

The filling of ditches in fields to be irrigated should be done carefully, and every precaution should be taken to make the earth solid over the drains. There will be difficulty in passing irrigation water over a field containing underdrains until the earth over them has become well compacted.



ARRANGEMENT of 15" D.S. PUMP.

SCALE ½"=1 FT. JAN 1901.

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PREPARING LANDS FOR IRRIGATION AND METHODS OF APPLYING WATER.

From Bulletin 145, courtesy United States Department of Agriculture.

(Continued.)

GRAIN.

There seems to be the same excessive use of water in the growing of grain as with alfalfa. The most common practice in the Truckee Valley seems to be to irrigate grain from six to eight times, some men using ten, fifteen, and even twenty irrigations.

It is easy to over irrigate grain when it is young. The results upon the station farm the past season were fairly satisfactory from three and four irrigations. Wheat yielded forty-six and forty-eight bushels per acre and oats from sixty-five to seventy-five bushels per acre—yields above the average results of common practice. The first irrigation was May 27, before which many fields in the valley had been watered two or three times.

The furrow method is used almost exclusively in the irrigation of grain. Here it is more essential that the space between the furrows should not be flooded than in the case of alfalfa, because the young grain does not always make sufficient growth to shade the ground before the first irrigation. Last spring the grain upon the station farm practically covered the ground when first watered. After the grain is sufficiently grown to be in danger of lodging, it should not be irrigated when the wind blows.

To facilitate handling the water it is best to run a smaller ditch or furrow parallel with the head ditch, into which water is turned at convenient intervals from the head ditch, these intervals to be determined by the number of furrows that can be filled by the head of water in use. For instance, referring to Figure 31, if the head of water is about what can be carried by ten furrows, put a tappoon across the ditch between A and B, open the ditch at A, and fill the space between the ditch bank and the land at X. The water is thus turned into the first ten furrows. When this part of the field is sufficiently wet, first put in another obstruction at Y, put in a tappoon between B and C, make an opening at B, and close up A. The water is thus turned off from the first ten furrows and into the second ten. In some cases it is better to have water run from two or more openings in the head ditch at once, depending upon the amount of water used and the fall of the head ditch.

Making and breaking dams in the head ditch and making and closing breaks in its bank are not in keeping with the best irrigation practice. In permanently laid out fields the ditches should be provided with boxes or with "back flows" for the control of the water. When water is first turned onto the land the flow from the first box should be so regulated by raising or lowering the gate that the flow will fill the desired furrows, and so on down the ditch until the water is all in use.

The furrow method of irrigation is especially adapted to crops planted in rows, such as corn, potatoes, roots, and other vegetables. Here the ground may and should be stirred by the use of a cultivator of some sort as soon as it is dry enough after every irrigation, and new furrows should be made for subsequent irrigations.

The cost of fitting land for the first application of water can not be stated in a general way. Some men, after clearing land of sagebrush at a cost of $1.50 per acre, have paid as much as $30 an acre for hauling off stones. In furrowing a grain field or refurrowing alfalfa, ten acres is a fair day's work for a man and team.

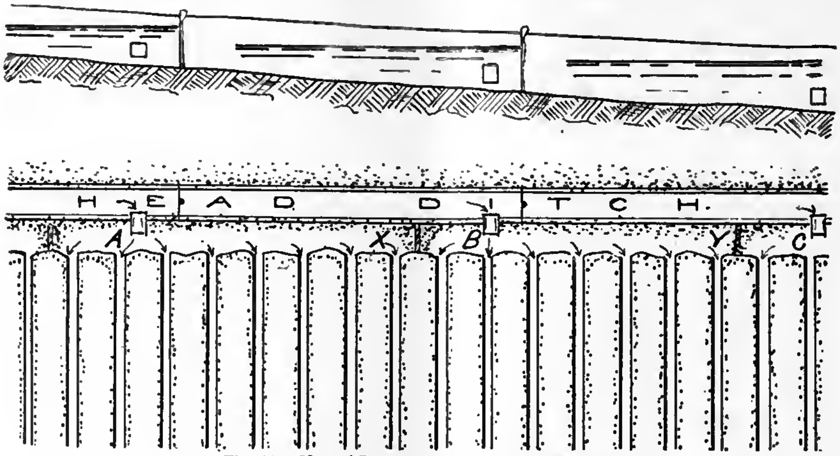


Fig. 31. Use of Tappoons in furrow irrigation.

METHODS IN USE IN SALT LAKE BASIN.

On account of the system of colonization which has for years been in vogue, agricultural practice varies but little throughout the irrigated portions of Utah. The farmer along the Virgin River, in the extreme southern part of the State, irrigates his grain in much the same manner as does the farmer living in Cache Valley, in the northern part of the State. The methods they employ were developed in the parent colony in Salt Lake Valley and have been adopted with but slight variations in other sections of the State, as well as in some of the Mormon colonies in neighboring States. What will be said, therefore, in regard to irrigation practice may be taken as typical of the State as a whole.

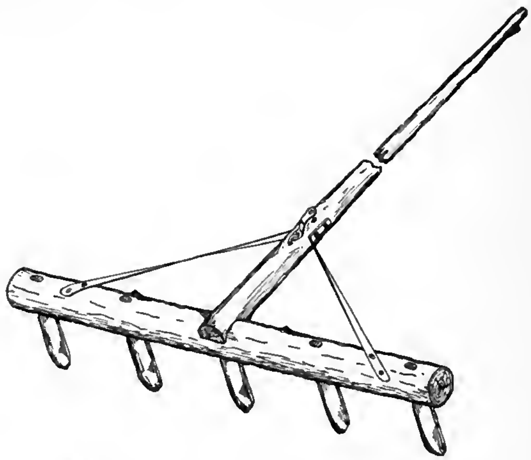


Fig. 32. Home-made marker for furrow irrigation.

Fall-sown grain, or "dry grain," as it is commonly termed, requires, as a rule, no irrigation. It is sown during the fall months, is brought up by the rains and during winter is protected by snow. When the snow goes off in the spring it grows rapidly, and the rains received in the early spring are in average years sufficient to bring it to maturity. Spring-sown grain, however, is dependent upon irrigation for its full development. The land on which spring grain is to be grown may either be plowed in the fall, in which case it will be in splendid tilth for sowing, or it may be plowed in the spring as soon as the frost is out of the ground. The grain is drilled in at any time from the latter part of March to the last weeks in April, depending upon the locality and the weather conditions.

After sowing time the farmer's next duty is the preparation of his land for the first irrigation. The tract of land is, as a rule, supplied by a main lateral or ditch, which is located along the highest side. If the tract be large, this main ditch is supplemented by others paralleling it at intervals of fifteen rods or more, which cut the field in strips, each having a supply lateral along its upper side, which, in addition to supplying the tract below it, serves to catch the surplus from the strip next above.

The planted area is then gone over with what is called a "marker" (Fig. 32). It consists usually of an eight-inch log eight or ten feet long, to which is attached a tongue and doubletrees. Wooden blades or teeth, two or three inches wide and from twelve to sixteen inches long, are inserted in the log, and the whole forms a comb-like implement, which when drawn over a field makes furrows two or three inches deep.

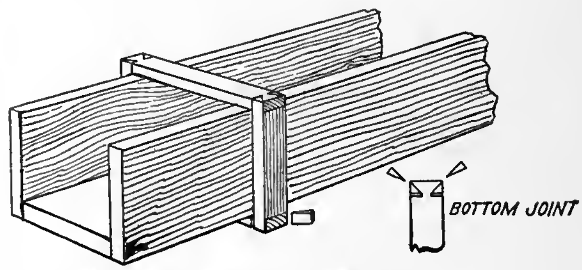


Fig. 33. Wooden Flume, used by Mr. Warner, Scott County, Kans.

The usual spacing of the teeth in the log is from eighteen to twenty-four inches.

Many prefer to mark the fields immediately after the sowing, while others wait until the grain is up. The direction in which the furrows are run depends on the slope. After a field has been marked the water is admitted into the laterals, and at intervals of two or three rods is turned from the laterals onto the fields by temporary earthen dams or the more effective canvas dams, cuts being made in the banks of the laterals.

The water, after it leaves the lateral, is directed into the small channels made by the marker and flows rapidly over the surface. However, the water is not entirely confined to the furrows, but is allowed to overflow. They simply serve as guides to carry the water to all parts of the field, thus insuring a thorough wetting of the surface. Where the small furrows are made across the slope they aid in distributing the water transversely, and a larger stream may be taken from the main lateral. Where the marks run with the slope, more attention is required of the irrigator to prevent them washing into large channels and becoming collectors rather than distributers of the water. In some instances the marker is handled so as to place the channels on a slight grade. This method gives perhaps the best results. During the first irrigation close attention must be given to the distribution, and dirt must be put here and there in the small channels to make sure that the water spreads evenly. Each time the field is irrigated the small channels become more fixed, and toward the end of the season but little attention is required to thoroughly irrigate the tract.

The main distributary laterals in the field should be placed from five to eight rods apart, depending upon the slope of the land and the nature of the soil, and may be given grades of from one-half inch to an inch per rod. Each lateral should carry from two to three cubic feet of water per second, as one man can usually handle this volume with ease after getting his stream set.

Alfalfa is irrigated in much the same manner as that just described. It is usually sown with a nurse crop, either wheat or oats, which protects the young alfalfa and is ready for harvest before the alfalfa gets to such height as to interfere with its growth.

Such crops as potatoes, sugar beets, and other vegetables which are grown in rows are irrigated by the furrow method. These furrows are made with ordinary walking plows after the crop has come up, and the water reaches the roots from the furrows. During the early period of growth water is turned into each furrow. When the crop is approaching maturity, or when the water supply becomes short, water is turned into alternate furrows only.

METHODS IN USE IN COLORADO AND WYOMING.

A mistake often made by the inexperienced irrigator when laying out his field laterals is in placing them too far apart. In old-established colonies, like Greeley and vicinity, in irrigating alfalfa, oats, wheat, and other grains by the flooding system the distance between laterals varies from twenty-five to thirty steps —seventy-five to ninety feet. In the grain and alfalfa fields with varying slopes, in the vicinity of Greeley, the field laterals were rarely found to be under seventy-five feet to over 100 feet apart. Old irrigators have learned from experience how unwise it is to attempt to force a sheet of water over an intervening space of 200 or 300 feet, especially where the head of water is small and the slope of the ground moderate. The essential thing in applying water to crops by the flooding system is to advance the sheet of water uniformly over the area irrigated so that all parts of that section of the field to which water is being applied may receive, as nearly as possible, the same amount of water. Near Greeley one of the most economically managed farms, as far as water is concerned, comprising 160 acres, is entitled to a head of water consisting of two ditch rights and two reservoir rights. A ditch right, as mentioned here, entitles the possessor to fifty-two Colorado miner's inches for a period extending from May 1 to August 1. A reservoir right entitles the owner to thirty-two Colorado miner's inches for a period of ten days. Converting these figures into cubic feet per second, from May 1 to August 1 the farm receives 2,708 cubic feet per second from the two ditch rights and for ten days after August 1—not necessarily consecutive—the farm receives 1.67 cubic feet per second from the two reservoir rights.

The main lateral on this farm has a top width of three feet, a bottom width of two feet, and side slopes of one to one. The field laterals are placed from seventy-five to ninety feet apart in the grain and alfalfa fields. Canvas dams are placed in the laterals so as to back up the water for a distance of seventy-five feet, when it is allowed to flow either over the lower bank or through cuts made in the bank at intervals of ten or fifteen feet. The owner of this farm, with a head of one and one-half ditch rights, 2.03 cubic feet per second, can spread water over the surface of his fields between laterals placed at thirty steps apart with ease and effectiveness.

The furrow system of irrigation is practiced on this farm for root crops, such as sugar beets and potatoes, which are planted in long rows, the beets about three feet apart and the potatoes about five feet. The soil is a sandy loam and the slopes are such that the irrigator can flow water down the furrows for a distance of 800 feet from the main lateral. The distance which a stream of water can be successfully run in furrows depends upon the texture of the soil through which they extend. Where the soil is coarse and absorbs water quickly the distance for the same head of water must be shorter than where the texture of the soil is finer and absorbs water more slowly. The stream in the furrows must be made to flow with a velocity sufficient to carry it to the lowest extremity of the field or the next lateral below, but at the same time must not flow with such swiftness as to cause scouring of the banks of the furrow or cutting deep into the furrow. The implement most generally used for ditching potatoes and sugar beets is the wood-beam wing-shovel plow.

One of the best examples of high-class irrigation which has been observed is the watering of a field of potatoes on a hillside. It cost the owner and irrigator of this piece of ground three years of hard labor and bitter experience to learn to run his furrows between rows in such a way as to prevent scouring. At first he attempted to run his furrows diagonally across the hillside, but the grade was too steep and the water scoured the furrows, while his crop of potatoes was a failure owing to the lack of water at the head of his rows and the over-abundance at the lower ends. The next year he ran his furrows around the hill, but they did not conform to the contour of the ground sufficiently to altogether prevent scouring, and his crop was poor. Finally, he has fitted the curve of his furrows to the contour of the hill in such a way as to prevent all scouring, and now his crop of potatoes from this hillside is as good as any crop he raises on comparatively level ground.

CARE OF LATERALS.

Laterals, like machinery, need more or less constant attention when in use. If they are neglected, breaks, leaks, and blocking of the channel may occur, and probably at a time when water is most needed. A heavy storm may cause the washing out of a portion of the lower bank in the lateral, especially on a hillside. Such a break must be speedily repaired. Unceasing annoyance and trouble in the operation of laterals is caused by gophers, or prairie squirrels, which burrow holes on hillside slopes and will burrow from the bed or side of a canal or lateral down through the lower bank, coming to the surface again, perhaps ten or more feet below their starting point. When water is first turned into a canal in the spring the water finds its way through these holes. These leaks may be hardly perceptible at first, but very soon attain such proportions as to endanger the lateral banks. Any method used to exterminate these pests like gophers and prairie dogs is a tedious one. A method frequently adopted is to drown them out, but this is not always successful. Before the water is turned into the canal, a ditch rider goes down the line of ditch blocking all the lower holes or exits from from the burrows that may be discovered. After the lower holes are blocked the water is turned into the canal filling the burrows and drowning the gophers. Of course many holes may escape attention and careful supervision of the canal and its banks must be exercised whenever gophers are numerous. Many formulas for poison have been compounded and successfully used for exterminating prairie dogs and pocket gophers. The Kansas Experiment Station has recently published a valuable bulletin* on the subject of "Destroying Prairie Dogs and Pocket Gophers."

Laterals become blocked by the caving of the upper banks or the trampling of loose stock or by the deposit of refuse from the main canal, which may connect in one spot and form an imperfect dam. The laterals must be kept clear of débris and an uninterrupted flow maintained.

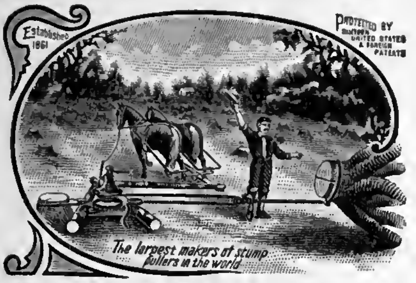
*Bulletin No. 116, January, 1903.

(To be Continued.)

NOTICE TO CONTRACTORS.

Notice is hereby given that the Boards of Supervisors of Monona and Harrison Counties, Iowa, will meet at Onawa, Iowa, June 8th, 1905, for the purpose of opening bids and letting the contract for the construction of a drainage ditch through the above named counties a distance of 23 miles. The excavation will be approximately 3,250,000 cubic yards. For specifications address the County Auditor at Logan, Iowa or Onawa, Iowa. Payment to be made by Drainage Bonds or Certificates according to drainage laws of Iowa.

Onawa, Iowa, May 13th, 1905.



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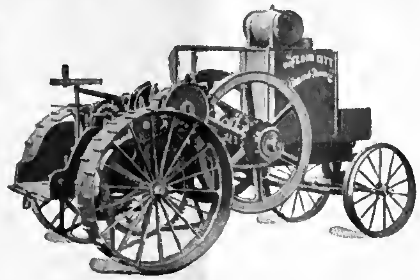

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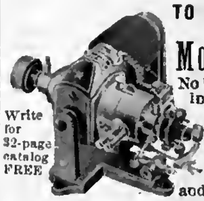

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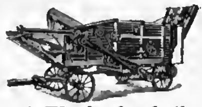

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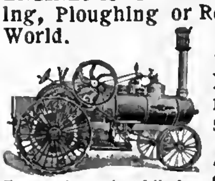

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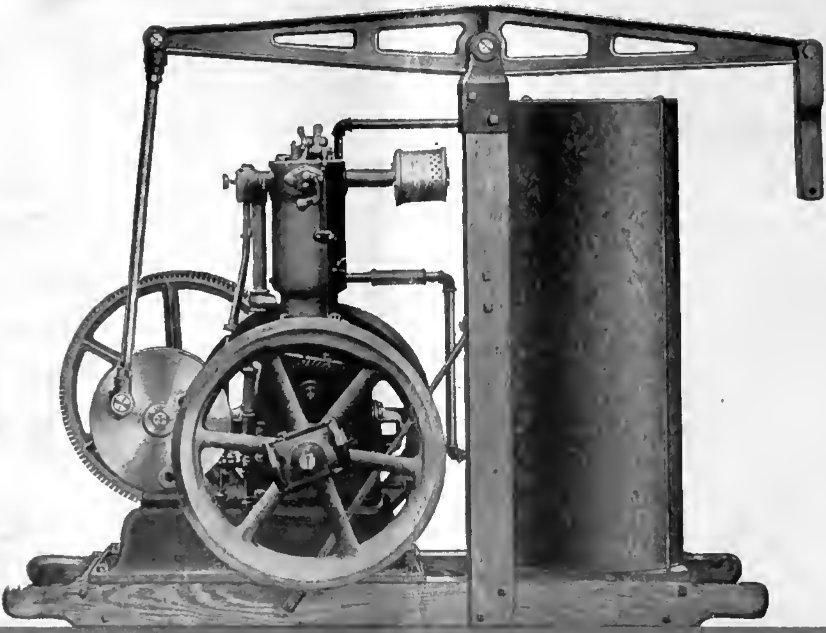

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THE IRRIGATION AGE

PUBLISHED IN THE INTEREST OF IRRIGATION AND DRAINAGE

JULY, 1905.

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WITH WHICH IS MERGED
THE DRAINAGE JOURNAL
ESTABLISHED 1879

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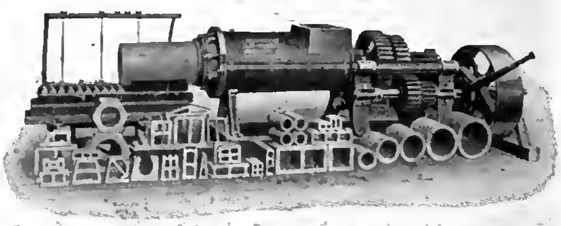
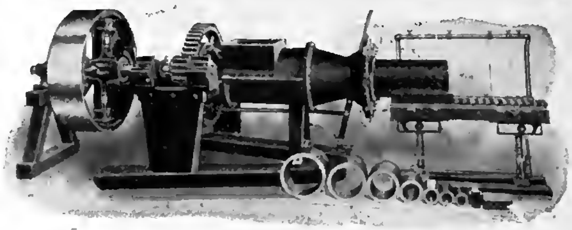


Centennial Auger Machine



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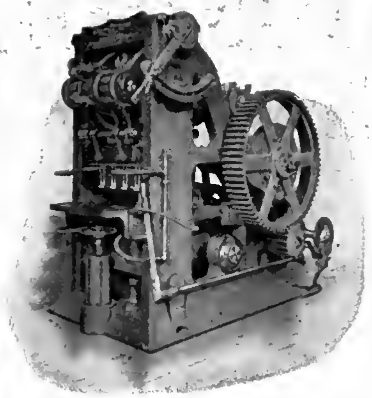

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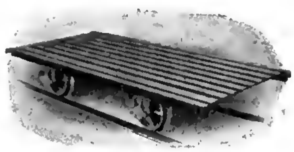

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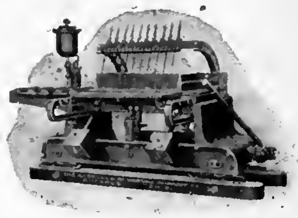

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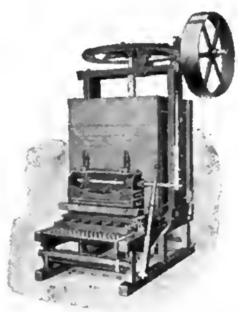

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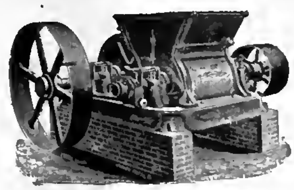
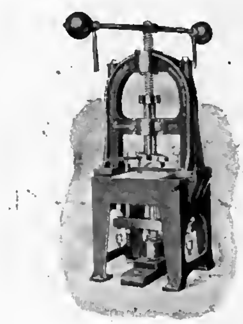


Disintegrators



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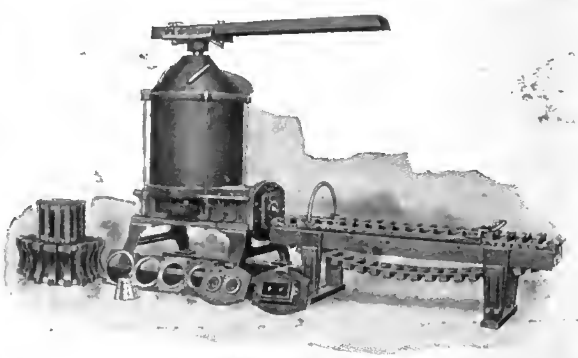
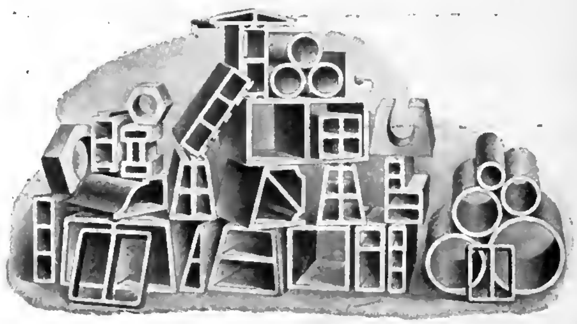


Horse Power Plunger Machine



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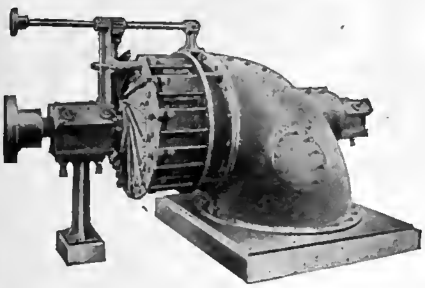

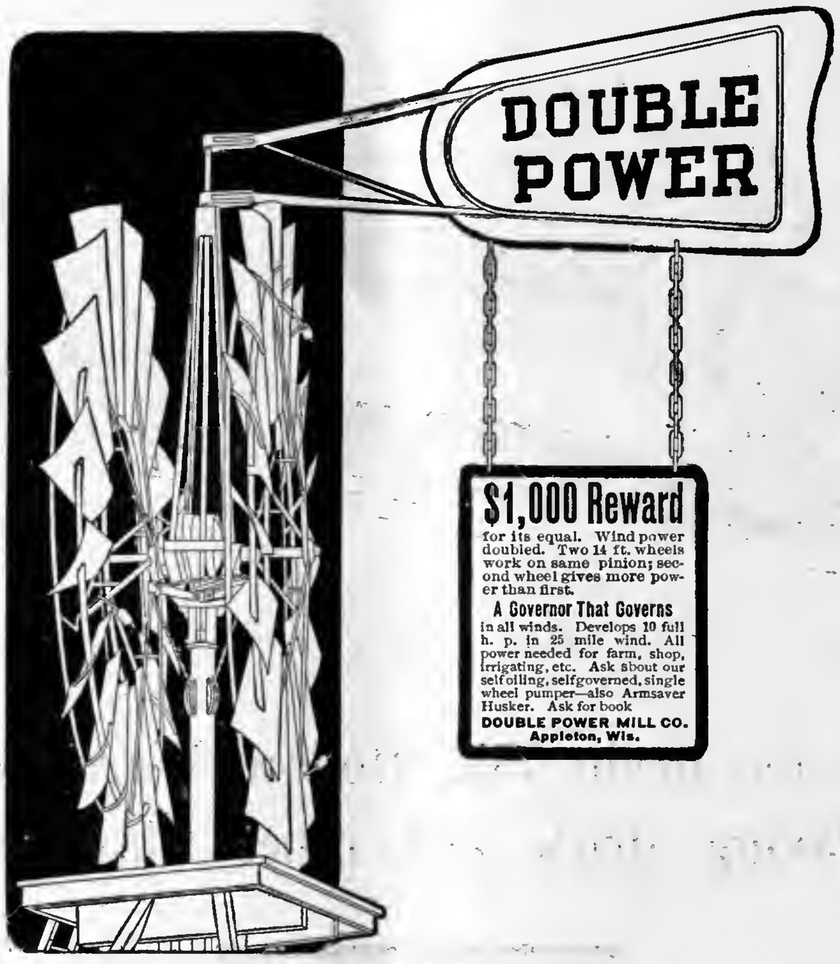
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THE IRRIGATION AGE

VOL. XX — CHICAGO, JULY, 1905. — NO. 9

THE IRRIGATION AGE

With which is Merged

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THE IRRIGATION ERA — MID-WEST
ARID AMERICA — THE FARM HERALD

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

Thirteenth National Irrigation Congress. The thirteenth annual convention of the National Irrigation Congress will convene at Portland, Oregon, August 21, 22, 23, and 24. Owing to the fact that this congress is to be held in Portland, a large attendance is expected, as many will improve the opportunity of attending the congress and at the same time visit the Lewis and Clark Exposition. The editor spent a few days in Portland in June and can speak a good word for the Lewis and Clark show. The grounds are delightfully planned and the surrounding fir-covered mountains give additional charm which will draw out kindly comments from all who attend.

Opportunity to Secure Homes. Beginning with this number, and continuing during the next twelve months, will appear a series of articles covering information valuable to those seeking homes in the newly developing irrigated sections of the West. All of these articles will be profusely illustrated from photographs taken by the editor in his travels throughout that country and our readers are requested to make inquiries concerning any point not made clear. A great deal of valuable information will be brought out which will enable prospective purchasers of irrigated farms to go about the matter intelligently and so shape their plans that the possibility of failure will be minimized. As stated above, all questions addressed to the editor of IRRIGATION AGE will be gladly and fully answered.

Maxwell and Boothe. There is a strong likelihood that George H. Maxwell and his small but misguided band of followers will attempt to run the Thirteenth National Irrigation Congress to be held in Portland this year. Through the manipulations of this crowd at El Paso in 1904, C. B. Boothe, who helped Maxwell spend part of the money—that "easy" individuals throughout the country have been induced to contribute to the one-man-organization known as the National Irrigation Association—was made executive chairman of the thirteenth congress. Perhaps these gentlemen may be asked something about the expenditure of this money by members of sections or branches of their organization. Their representatives have been at work throughout the Northwest during the past year securing members at $10 per head, and these gentlemen have led new members and different commercial bodies to believe that by joining and paying the annual fee they were becoming allied with the combination that controls the location of all irrigation projects through contact with the Department of the Interior and the Reclamation Bureau under it. It is fairly possible that these gentlemen have some influence with the Reclamation Bureau; they certainly have none in the Department of the Interior as the Secretary of the Interior is well acquainted with their motives and would not be likely to lend aid to their plans. Of one thing this crowd may be sure, that the delegates to the thirteeth congress will look into the record of the National Irrigation Association.

Reclamation a Reality.

A writer in a Colorado paper recently gave a good description of the beginning of reclamation work by the Government and concluded by saying: "The artist who can create upon his canvas, the writer who can portray in words, or the dreamer who can imagine the result of the transformation of the vast mountain and plain section of the United States as it will come to pass during the next half century, does not live.

"Fifteen miles east of Reno, Nevada, with the noonday sun beating back upon a little company of men from an expanse of silica as boundless as it is barren, the floodgates of the Truckee-Carson irrigation canal were opened on Saturday for the first time. The work of watering the arid West was begun. Though merely informal ceremonies marked the event, the day opened an era of progress and development for the sixteen States included in the reclamation district, that will bring a greater change during the life of men now living than ever has been created in an equal district in an equal period of time by the hand of man. The reclamation act, which now bears its first fruit, unquestionably means more development of American agricultural resources than has been brought about by any other legislative enactment in the country's history with the exception of the homestead law.

"Engineers estimate that by this act it will be possible and practicable to reclaim one hundred millions of acres of land now useless. The completion of this work will increase the crop belt of the country by twenty-five per cent. It will make two and one-half millions of forty-acre farms, and offer a good living for twenty millions of persons.

"The Truckee canal project, put into use recently, is thirty-one miles in length, running from Derby, Nevada, on the Truckee river, to Leetville, Nevada, on the Carson river. The construction of this canal will result in the reclamation of fifty thousand acres of land immediately. During the next two years the extension of the system will take in two hundred and fifty thousand acres more and the Truckee-Carson system will then include twelve hundred miles of ditch. Later on, in the course of the next ten years, further extensions will be made until the whole area of the valleys of the Truckee and Carson rivers shall have been converted into fertile land.

"The value of the reclamation project to the country lies in the practicability of the scheme. The lands are open to settlement under the homestead law exactly as are Government lands where irrigation is unnecessary. For the title to the water right the Government charges $26 per acre, or $1,040 for a forty-acre tract. The payments extend over ten years and, as title will not lapse until two payments have been passed, the homesteader will have a chance to tide over a hard year. No interest will be charged on deferred payments but it is likely that inducements will be offered for early settlements. When the ten years have elapsed the irrigation system will be turned over to a water users' association to be organized under the direction of the Secretary of the Interior. Perpetual government regulation of the system is secured by the retention of the title to the sources of supply in the Government.

"Speculation as to the possibilities that lie in this work of reclamation might be carried on indefinitely. It is wihin the range of reason, however, to say that it offers more for the solution of the tenement house problem, other phases of the slums problem, the public health problem, the immigration problem and of sociological problems in general than is to be expected from any other source now in sight.

Railways Assist.

Between the Government and the Harriman lines, the Union and Southern Pacific, and the Oregon Short Line, the great arid plains west of the Missouri River are rapidly being reclaimed by irrigation. Congress has appropriated millions, which is being spent upon the river beds and ditches which are to carry water to the dry districts, and to this the Harriman roads have added almost $1,000,000 more. When this work is all completed, this whole vast area, which always has been unproductive, will be turned into a fertile field, capable of producing grains or other food products, sufficient to sustain millions.

It will be of the greatest benefit to the Harriman lines to have this waste land made fertile, as they are the only roads which enter the territory, and therefore will get the full benefit of the immense tonnage which will be developed. The money appropriated by the railway company is being spent only on that land which is contiguous to the Harriman lines.

In one district of Southern California the Southern Pacific has loaned $300,000 to the corporation formed for the purpose of building irrigation ditches to develop the plant.

Officers of the interested railroads are accompanying the congressional committees which are now on a tour of that region, and every district, whether it be little or big, is being thoroughly inspected.

The committees are made up largely of western members of congress, who are interested in the development of the country. It is believed that this money, which is being spent will result in transforming these vast plains, which have never yielded a dollar's worth of produce, into a garden spot, where cereals and fruits will grow in abundance. Already in places where irrigation has been secured good results have been achieved. The plan to reclaim the country is one upon which E. H. Harriman has worked for many years, and he is taking the greatest interest in the work, realizing that the life of the West means life to the Harriman lines.

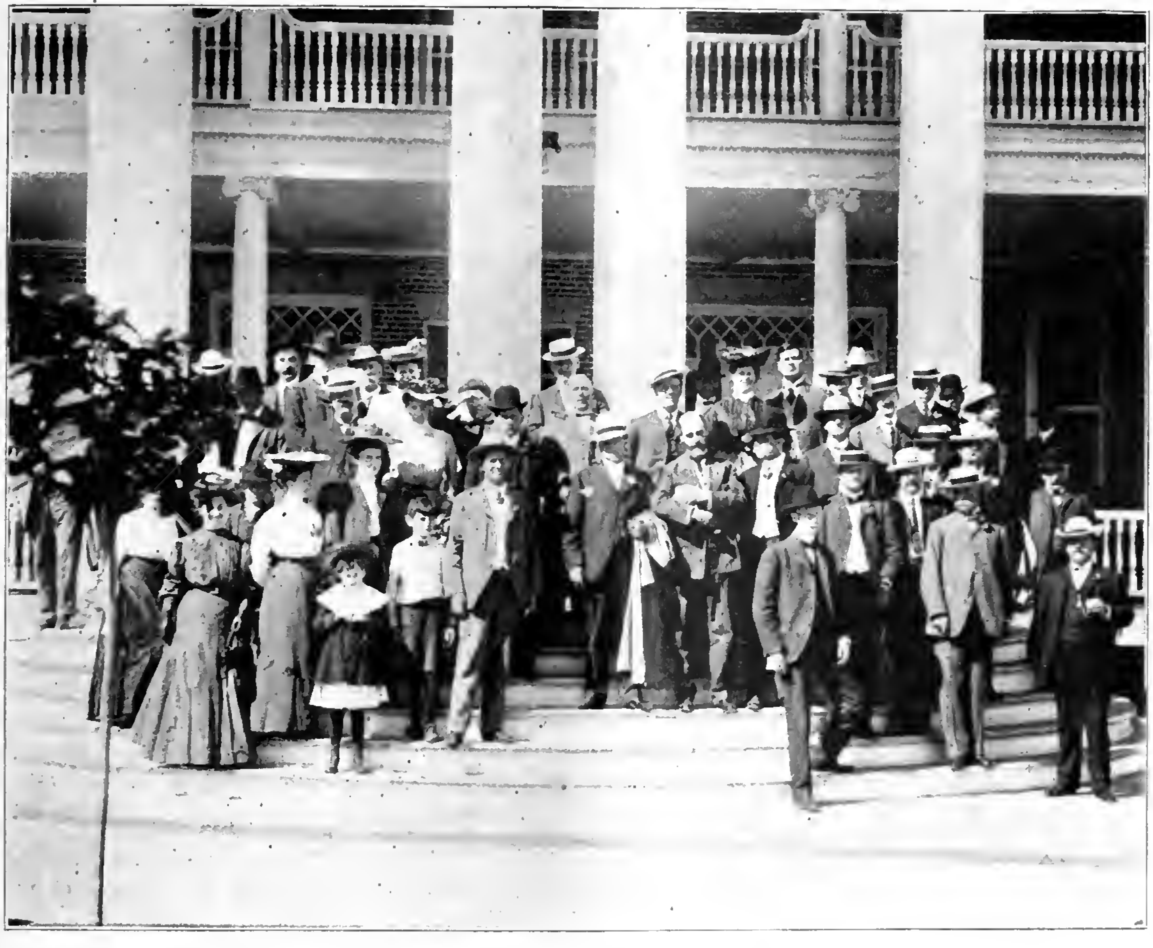
COMMITTEE ON IRRIGATION AND RECLAMATION OF ARID LANDS.

The Committee of United States Senators and Congressmen, with several invited guests, have just completed their tour of inspection of the work in progress under the reclamation law in the western States. This party was made up mainly of members of the House committee on irrigation of arid lands, several United States Senators, members of the reclamation service, including F. H. Newell, chief engineer; Elwood Mead, chief of irrigation investigations office of experiment stations, United States Department of Agriculture. Mr. C. G. Rowley, who was with the party, is chairman of the committee on irrigation and arid lands of the National Association of Manufacturers of Agricultural Implements and Vehicles. Mr. Rowley has no doubt learned much of the conditions in the West and is now in a position to furnish a report to his association which will give that body a much better idea of the possibilities for the development of trade in their lines in the great western country about which manufacturers, generally, know so little about.

Our readers can see Mr. Rowley in the group photo reproduced herewith—if they will pick out the bald-headed man near the center of the picture. From his attitude one would think he was offering up a prayer but the writer is inclined to doubt that.

Following is a list of members of the party as it appeared on the register of the Dewey-Palace Hotel, Nampa, Idaho, June 22d:

U. S. Senator F. T. Dubois, Idaho.
Hon. F. W. Mondell, Wyoming.
Hon. W. A. Reeder and wife, Kansas
Hon. E. W. Casper and wife, Pennsylvania.
Hon. J. I. Parker and wife, Washington, D. C.
H. J. Brown and wife, Washington, D. C.
C. J. Blanchard and wife, Washington, D. C.
I. T. Whistler, U. S. G. S., Washington, D. C.
D. W. Ross, U. S. G. S., Washington, D. C.
John Hoyt, Washington, D. C.
F. H. Newell, Washington, D C.
Gov. Frank Gooding, Idaho.
Dr. Elwood Mead, Washington, D. C.
Hon. Arthur Ruhl, New York.
—— Cunningham, New York.
C. G. Rowley, Jackson, Michigan.
Hon. W. L. Jones and wife, Washington, D. C.
Hon. B. S. French, Idaho.



Committee on Irrigation and Reclamation of Arid Lands. Photo taken expressly for THE IRRIGATION AGE in front of Dewey-Palace Hotel, Nampa, Idaho, June 22, 1905.

Current Wheels. Owing to the press of general illustrated matter for our July issue it has been found necessary to cut down the article on Current Wheels, so that only about one-half of it will appear in this number. The balance, with a large number of interesting and valuable illustrations, will appear in the August issue.

LOOK TO THE WEST FOR HOMES.

Great Opportunities for the Weary Wage Earner on Irrigated Tracts in the West.

There are many questions relating to this great subject of irrigation that address themselves as worthy of the most intelligent consideration on the part of, not only irrigators, but those who contemplate investing in farm lands in the section commonly known as "The Arid West." It has been the intention of the writer for some years past to begin a series of articles covering all questions which would naturally come to the mind of a prospective irrigation farmer, and with that end in view the editor of THE IRRIGATION AGE will spend the greater part of the present summer visiting different irrigated sections throughout the West. It is his intention to become personally acquainted with small irrigation farmers and learn from them their individual experiences in developing small tracts of land, the original cost of this land, the expense attached to moving on to it from their present homes and explain in detail the difficulties encountered, if any, and the success attained under varying conditions both as to soil, locality, methods of securing water for lands, and care will be given to securing data as to what a given amount of money will accomplish under different conditions.

Inverted Syphon, Condon Irrigating Ditch, three miles from North Yakima, Wash., on Northern Pacific Railway.

This line of work has been brought to the writer's attention more directly in the last few months by the receipt of numerous inquiries from people throughout the eastern and central States by which they seek to learn what given sums of money will permit them to accomplish in the way of purchasing a tract of land, either improved or otherwise.

It was this thought that induced the writer to make an initial trip over part of the Northwest recently The people interviewed on this visit were mainly men who have established irrigation projects of greater or less magnitude, projects developed for the purpose of supplying water to land subdivided into tracts of from ten to one hundred acres or more secured by settlers either from private owners, the State in which the system is in operation, or under what is known as the Carey act, whereby the settler is enabled to secure land from the State at the rate of fifty cents per acre provided he contracts to purchase a perpetual water right from the corporation which constructs the system.
It is not our intention to advertise in any way these corporations furnishing water, further than is necessary in explaining the general scheme.

What is irrigation? If this question had been asked of every individual in the United States twenty-five years ago, a very large proportion of them, perhaps 95 per cent of the total number, could not have answered it intelligently, nor would they, in all probability, have had any correct conception of its relation to the welfare and progress of mankind; yet so rapidly and universally has the "irrigation idea" spread, that it is today a household theme throughout the land.

It originated, so far as this country is concerned, as a concomitant necessity to existence, in the settlement of that great estate of public domain known as the "Arid West." At first it was considered as an onerous condition to the prosecution of agriculture, to be palliated and excused by those resorting to it, and commiserated by the humid Pharisee from the East. Happily we have now passed beyond that phase of the question, for irrigation has not only rendered it possible to live in the so-called desert, but it has made it so profitable and delightful to live there that this same desert has become a veritable mecca for Utopian seekers. From being a problem concerning only the misguided homeseeker, begotten of sinister necessity, it has become one of the living, potent factors of human progress, and it is making for itself a large place in national policy. It has disclosed a vista of corollated propositions and questions, political, social, industrial and scientific, pertaining to rural life, and engaging its fundamental surroundings and conditions to that extent that its entire aspect is being changed. That irrigation conduces to the betterment and promotion of the ruralist, goes without the saying and nothing better can be said of its usefulness than the promise it affords as the greatest influence in arresting the decay of farm life.

Like all other great questions and causes it has its zealots on one hand and its critics on the other, and it is difficult to tell from the hands of which it suffers the most. Taking all that can be truthfully and conservatively claimed for the future of irrigation, there is enough to commend it to the sober and thoughtful consideration of the people and to demand for it a dignified place in the economy and policy of the Government, but to heed all of the vagaries and concede all of the absurd claims of its over-zealous friends will only serve to bring it into disrepute and disappointment to its interests.

With each change of the moon there is heralded some new disciple of the propaganda of irrigation, and he brings to his consideration his contribution to the literature of the subject, generally brilliant in theory and beaming with zeal. Under these circumstances it is not at all surprising that much that finds its way into print, and is accepted on that account with a greater or less degree of faith, is, as a matter of fact, entirely outside of the realm of reality, and does not at all coincide with the literal truth and the actual facts as they are dug from the earth by the real toilers. It is not a case of infrequent occurrence that a flying visit to the headworks of some irrigating canal, followed by an even more hasty visit to the fields of some successful farmer living under it, suffices to furnish material for a learned and elaborate disputation upon the scientific principles and proper methods of canal construction and distribution and application of water, or a verbose declaration of the benefits and advantages of certain lines of practice in the art of irrigation. It is hardly charitable to presume that among the many bright and shining lights in the field of irrigation today, any should thus have acquired reputations as expert irrigationists, and yet it is altogether possible that this may be the case. After all is said, and all due credit given to the learned treatises and the literary efforts, we sometimes think that the most effective as well as the most eloquent tributes that can be paid to the cause of irrigation, is a properly designed and well executed system of canals, adequate to the requirements of the case, and not a burden of expense to the owners. Surely the expert knowledge and experience required in such a case can not be supplied by the library, nor do they emanate from the literary sanctum. They must be acquired by familiar association with hobnail shoes, the irrigating shovel and mud. The field of literature and theory is so distinct and apart from that of practical operation that one can hardly hope to occupy both successfully at the same time.

Whether irrigation may be defined as a science, an art, or a practice, depends upon the standpoint from which the subject is considered. However it may be regarded it is no longer a theory or a circumstance, but a condition of such importance that it has not only established itself between the covers of the statute book but molded about itself the very politics of many of the States. In some respects it has laid the lines of a new jurisprudence and innovating the ancient and time honored common law traditions and precedents, it has achieved its own processes of adjudication.

Distinctively a western idea and of western origin, it is astonishing its most sanguine advocates by invading the dense prejudice of the extreme East and we read of irrigation undertakings in New England, New York and Florida. These efforts, though they may be upon a small scale, signify an implied recognition of irrigation as a valuable aid to agriculture even in humid quarters.

The Annual Irrigation Congress which will convene at Portland, Ore., August 20 to 24 of this year, is in a measure indicative of the prominence of this subject in the public mind. The purpose of these meetings appears to be partly to arouse popular interest, but chiefly through public discussion to gather as much light and information upon the various questions relating to this subject as is possible. It is light upon the manifold complications and perplexities arising out of the readjustment of new social and industrial conditions to old ideas that statesmen and thinkers are searching for, and it is light on the manner of harmonizing new principles and doctrines to old laws and precedents that the lawyers most desire. Philanthropists are interested in the relation these questions sustain to social economics. Financiers and capitalists are eager for information on the questions of security and profit as afforded by this new field of investment. Engineers are seeking for light and information on these subjects as they relate to largest utilization of the natural resources and questions of applied sciences and skill in matters of construction and practice. So we see this many sided question serves a diversity of interests and the plan of convening these interests and the gathering of representative men for the interchange of ideas and opinions appears to be wise and commendable and it is to be hoped that it will result in much good to the cause of irrigation.

Irrigated Potato Field Two Miles from North Yakima, Wash., on Northern Pacific Railway.

Irrigation evolved along the lines of individual and co-operative effort. In all its succeding stages it fell into the hands of corporations, those vicarious institutions that are resorted to in this glorious land of ours, in lieu of paternalism. In other countries the governments are the patrons of irrigation development. It remains to be seen whether the future of irrigation can be successfully met by the corporation or by the Government acting through the Reclamation Bureau. One potent fact comes now before us, that the Reclamation Bureau is trying to absorb and pass off as its own handiwork several successful enterprises which, merged with additional water supply, made possible by vast expenditure of money secured from the reclamation fund, will lead the uninformed to believe that the whole scheme developed in the brain of certain officials, while in point of fact, the ground plan, the part of the work where men of large brains and grasp was necessary, has all been developed by private individuals, who in all likelihood, will get little or no credit in the final round up. (This, however, is a diversion, and it will be our aim to hold that class of matter separate from this series of articles.)

While an irrigation enterprise may be either a success or a failure financially, it is nearly always a source of gain to the commonwealth. The benefit accrues to the community rather than to the investor,

Great Irrigation Syphon one-half mile in length. The wa er falls 1C0 feet from the mountain side in distance and runs up the mountain side in immediate foreground emptying into the flume shown in another il ustration, Near North Yakima, Wash., on Northern Pacific Railway.

whatever the investor's profit may be, as increased population and some increment to the general wealth is bound to follow every effort of reclamation. The fact is so obvious that irrigation development has been recognized in other countries as the peculiar charge and province of the Government, and it is a sentiment that irrigation works and projects would be committed directly to the trust and responsibility of the benefited communities, that has found expression in many ways in our own country. Much is to be expected in the way of assistance to the development of the West by the management of the different railway lines traversing the West, and prospective settlers should communicate with the land departments of these different lines where reliable information may be secured. In arranging to prepare this series of articles the writer came in contact with Mr. Thomas Cooper, land commissioner of the Northern Pacific Railway, St. Paul, Minn., from whom many valuable pointers were obtained and a number of illustrations used in these articles were made from photographs of scenes along the line of that railway.

As an illustration of what can be accomplished by the cultivation of a small tract of land properly irrigated, we will call the attention of our readers to a crop produced during the season of 1904 by a Mrs. Snively on four acres of land near North Yakima, Wash. On this small tract of land were produced forty boxes of apples, five tons of prunes, one ton of tomatoes, 1½ ton of grapes, four barrels of cider, $15 worth of vinegar, $60 worth of cherries, $75 worth of pears, $20 worth of asparagus.

In harvesting this crop Mrs. Snively employed one man continually and an extra man for two months.

Without definite knowledge of the value of the different items, it would be difficult to give the exact value of the combined crop, but from $1,200 to $1,600 would not be far out of the way; thus it will be seen that, deducting wages and water fees, a handsome profit was obtained. It is safe to say that the original investment in land, a home, farming utensils, etc., could not have exceeded $2,000, possibly not over $1,000, hence it is evident that an income sufficient to support a family of four or more was produced from only four acres.

Many of the illustrations shown herewith were made from photographs taken especially for IRRIGATION AGE by Mr. Harmer, who is connected with the Northern Pacific Railway at North Yakima, Wash.

The Yakima Valley stands pre-eminent in the arid West for the plentitude of its water supply. This valley has the reputation and shows by results that it is as well, or better adapted, for the successful culture of deciduous fruits than any other part of the West. It is now the largest producer of such fruits on the Pacific Coast and each year Yakima farmers are planting additional trees, it being estimated that fully 100,000 new trees have been set out during the past twelve months.

The next article in this series will tell about other points in Washington and data will be given based on

The Flume into which the great syphon empties and runs around the mountain 85 feet above the country road.

the experiences of people operating small irrigated fruit and truck farms.

With the opening of the Truckee-Carson canal below Reno recently the first irrigation system constructed by the Government under the Reclamation Act, a new era was opened for Nevada and the entire West.

The main canal runs from Donby, fifteen miles east of Reno on the Truckee River, to a point ten miles above Leetville on the Carson River, a distance of thirty-one miles.

The entire system as projected will not be completed for nine or ten years and will cost about $9,000,000.

IRRIGATION IN WASHINGTON, PRESENT AND PROSPECTIVE.

BY WALTER N. GRANGER.

INTRODUCTORY.

Writers upon the subject of irrigation generally preface their remarks with statements to the effect that irrigation is older than history, as old as husbandry itself. One says, upon unquestioned authority, that the original habitat of man was an oasis in the desert and that as the race multiplied and "outgrew nature's fertile spots, there being no rain, but springs and streams, he led these from their channels to the surrounding waste and caused it to produce abundant harvests." Another says that "under the ruins of the tower of Babel, in the ancient city of Babylon, have been found still more ancient ruins, evidences of civilization that had lived and gone to ruin and been buried by the ruins of succeeding civilizations, which in their turn had lived and died and that among these most ancient ruins have been found tablets of stone on which are written laws governing the use and distribution of water for irrigation purposes."

Other antique writings are referred to, as well as the ruins of important irrigation works, some of them evidently on a scale far more colossal than any of present times, in Egypt, India, South America and within our own country in southwestern Colorado, New Mexico and Arizona, as going to establish beyond a doubt the great antiquity, importance and value of irrigation.

It is further pointed out in this connection that these remains of former greatness all attest that wherever irrigation was practiced, "wealth accumulated, opulence held sway and large cities flourished rich in their homes and public places."

This practice upon the part of irrigation writers may be due in part to the scientific spirit, which seeks to trace things to their origin, but more largely perhaps to the consciousness that to their readers, who are inhabitants of the humid regions, the term irrigation is but a name, suggestive perhaps of some new-fangled experiment or of hardships and privations for which it is but an amelioration.

A Highly Improved District Near North Yakima, Wash.

BEGINNINGS OF RECLAMATION.

Unquestionably, through the aid of irrigation literature much has been done to dispel the ignorance and prejudice of the people of the humid States upon the subject. Much has been done by personal missionary effort and by the display of irrigation products in exhibit cars and at fairs and expositions. But the most effective factor in the settlement of the reclaimed lands of the arid West has been the willing testimony of the older settlers and the evidences of thrift and prosperity which their farms afford to the homeseeker. Heretofore the conquest of the arid West has been an individual fight and the points of attack have been many, throughout the valleys of the entire Pacific coast and

Rocky Mountain States. The struggle has been long and fierce. Many have fallen by the wayside. More than two hundred millions of capital have been invested. Much of it has been hopelessly lost to the investors and but comparatively few enterprises have proved directly profitable. The indirect returns, however, have been surprising and far-reaching. More than eighteen million acres of the arid West have been reclaimed. Taxable wealth has been created to the amount of many times the investment. Hundreds of thousands of happy homes exist, and flourishing villages, towns and cities where formerly there was naught to sustain human life. At last the public conscience and intelligence of the entire country have been aroused and the pioneers in the struggle are to have national aid in the great work of reclaiming the arid West.

RECLAMATION ACT.

June 17, 1902, President Roosevelt approved an act which provides (Sec. 1) that all moneys received from sale of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming, excepting allowances to registers and receivers and five per centum of the proceeds of the sales of public lands in the above States set aside by law for educational and other purposes, shall be set aside as a fund, to be known as the "Reclamation Fund," to be used in the examination and survey and for the construction and maintenance of irrigation works for the reclamation of arid lands in said States and territories.

Section 2 provides that the Secretary of the Interior is directed to make examinations and surveys for and to locate and construct irrigation works for the storage, diversion and development of waters for irrigation purposes.

Section 3 provides for the withdrawal of public lands under any irrigation project from entry except under the homestead law, which entries shall be subject to the limitations, charges, terms and conditions of the act and that the commutation provisions of the homestead law shall not apply to such entries.

Section 4 provides that if the Secretary of the Interior shall find that any irrigation project is practicable, he may cause to be let a contract for construction; that he shall give public notice of the lands irrigable under such project and limit the area per entry to such acreage as in his opinion may be reasonably required for the support of the family upon the lands in question and shall designate the charges which shall be made per acre upon the said entries and upon lands in private ownership, payable in not exceeding ten annual installments, with a view of returning to the reclamation fund the estimated cost of construction.

Section 5 provides that the entryman upon the lands to be irrigated shall, in addition to compliance with the homestead laws, reclaim at least one-half of the total irrigable area for agricultural purposes and before receiving patent shall pay to the Government the charges apportioned against such tract; that no right to the use of water for land in private ownership shall be sold for a tract exceeding 160 acres to any one land owner and not then unless he be an actual resident on such land; and for forfeiture in case of default in payments.

Section 6 provides that when payments are made for a major portion of the lands irrigated, then the management and ownership of such works shall pass to the owners of lands irrigated, thereafter to be maintained at their expense under such form of organization and under such rules and regulations as may be acceptable to the Secretary of the Interior.

A Farm Near Kennewick, Wash., Only Two Years Old.

Section 7 provides for the purchase or condemnation of property necessary for carrying out the provisions of the act.

Section 8 provides: "That nothing in this act shall be construed as affecting, or intended to affect, or to in any way interfere with the laws of any State or territory relating to the control, appropriation, use or distribution of water used in irrgation or any vested right acquired thereunder, and the Secretary of the Interior in carrying out the provisions of this act shall proceed in conformity with such laws, and nothing herein shall in any way affect any right of any State or of the federal Government, or of any landowner, appropriator, or user of water in, to or from any interstate stream or the waters thereof: Provided, that the right to the use of water acquired under the provisions of this act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure and the limit of the right."

Section 9 provides that it is the duty of the secretary so far as the same may be practicable and subject to the existence of feasible irrigation projects to

800 Crates of Strawberries, Part of One Day's Shipment—19,200 Boxes Shipped from North Yakima, Washington, via Northern Pacific Express.

expend the major portion of the funds arising from the sale of public lands within each State for the benefit of the arid lands within the limits of such State; that he may temporarily use such portion of said fund for the benefit of lands in any State that he may deem advisable, but when so used the excess shall be restored to the fund as soon as practicable.

In the administration of the act the organization of the engineering force was placed with the director of the United States geological survey, Mr. F. H. Newell, chief engineer. In each State a district engineer has been appointed to make the necessary surveys and look after the interests of the Government in carrying out the provisions of this act.

The fund now amounts to about thirty million dollars, of which Dakota, Washington and Oregon have contributed the larger share, Washington's contribution thereto now amounting to over three and one-half million dollars.

THE ARID WEST.

It has been well said that the arid West is the nation's farm. It comprises nearly one-third of the whole United States, exclusive of Alaska and insular possessions and extends from about the middle of the continent west nearly to the Pacific ocean. Practically all the vacant public lands, comprising over five hundred million acres, are within its borders. The significance of its reclamation was strikingly shown by President Roosevelt in his first message to congress in which he said, "The western half of the United States would sustain a population greater than that of our whole country today if the waters that now run to waste were saved and used for irrigation." The measures for its partial reclamation have now been inaugurated by the enactment of the legislation above referred to. Of course topographical features and lack of available water supply forbid that all of its vast area shall be reclaimed. It is variously estimated that from fifty to one hundred million acres of the entire arid West are susceptible to reclamation by means of irrigation.

ARID WASHINGTON.

The arid lands of Washington are located in the central and eastern portion of the State and comprise a part of the counties of Chelan, Kittitas, Yakima, Franklin, Douglas, Adams, Walla Walla and Asotin. Geologists tell us that the country was once the bed of a great inland sea, or lake, now drained by the Columbia river and its tributaries. In large terms, the great basin of which it forms a part is bounded on the north by the Okanogan highlands, on the east by the Bitter Root mountains of Idaho, on the south by the Blue mountains of Oregon and on the west by the Cascade range. Pasco, which occupies about the center, has an elevation of 375 feet above sea level, and as you go east, north or west from this point, the elevation and consequent precipitation increase, until you find yourself among the famous wheat fields of the Walla Walla, Palouse and Big Bend districts or among the verdant foothills of the Cascade range, the boundary line between the sub-humid and arid portions being nowhere distinctly marked, but advancing, or receding according to the varying seasons.

The arid district proper comprises an area of between eight and nine million acres, probably, or about one-fifth of the total land area of Washington. It has an annual rainfall in the drier central portions of less than five inches. The vegetation is the ordinary sagebrush, greasewood, desert shrubs and scattering bunch grasses. It is estimated by the irrigation experts of the United States geological survey that of the entire area about three million acres can be reclaimed by irrigation from the available sources of water supply. The soil is generally fertile, being of volcanic origin and of great depth, while the climate favors the production, to a greater or less degree, according to elevation, of all the fruits, vegetables, grasses and cereals common to the temperate zone.

PRESENT IRRIGATED AREAS.

Snake River.—Snake river is a magnificent stream but flows through a deep canyon and is not available for the irrigation of the surface of the plateau through which it flows except possibly near its mouth. There are, however, some areas varying in size from a few acres to several hundred acres in the canyon itself, called "bars," which are irrigated either from small streams that come down the gulches in the canyon wall, or through water which is lifted from the river by undershot wheels placed in the current and ejuipped with buckets or pumps. In all there are perhaps between five hundred and one thousand acres which are irrigated from these various sources.

Where the Water Leaves the River.

Streams Heading in Blue Mountains.—About 3.500 acres of land in Asotin County are irrigated from the canal of the Lewiston-Clarkston Water & Power Company, which has its source of supply in Asotin creek. This is the famous Vineland district where irrigated lands have attained a value of from five hundred to one thousand dollars an acre.

There are probably from 10,000 to 15,000 acres of irrigated land in the vicinity of Walla Walla under various ditches receiving their supply from the Walla Walla and Touchet rivers.

Columbia River.—The magnificent Columbia river, like the Snake river, its principal tributary, runs in a deep canyon for the greater part of its course through eastern Washington. There are no canals having their source in the stream but along its banks are many wheels designed to lift water by buckets or pumps which make possible the cultivation of small fruit farms upon the "bars," islands and narrow strips of land between the river and its cliffs. There are also some irrigated areas along the stream that have their source of supply in springs and small streams, tributary to the river, the waters of which are often conducted by the individual farmer, in flumes, for miles along the almost perpendicular wall of the canyon to his small orchard or garden, forcibly illustrating the truth of the saying that in an arid country water is land. In the aggregate these various areas probably comprise several thousand acres.

Wenatchee River.—The Wenatchee valley, next to the Yakima valley, is the scene of the most important irrigation enterprises in the arid portion of the State. The larger canals are as follows:

	Length miles.	Area covered.
Wenatchee Water Power Company	6	1,500
Peshastin Ditch	8	2,000
Wenatchee Canal Company (high line)	18	7,000
Mission Canal Company		1,500
Total		12,000

Yakima River. The Yakima river canal system, with which the writer is most familiar, will be hereafter more fully treated. There are under ditches already constructed or in process of construction about 200,000 acres, of which about 95,000 acres are now in cultivation.

To summarize, the present irrigated areas in the arid district are approximately as follows:

	Acres.
Snake river canyon	1,000
Blue mountains	18,500
Columbia river	3,000
Wenatchee river	12,000
Yakima river	200,000
Total	234,500

These various undertakings probably represent a capital expenditure in their construction between four and five million dollars and are the aggregate result of reclamation work extending over a quarter of a century.

In addition to the irrigation enterprises referred to, which are confined to the arid district proper, it should be mentioned that in the humid and sub-humid portions of the State irrigation has been resorted to in many instances for the purpose of supplementing the natural moisture during the drier portions of the year. Throughout the wheat districts of eastern Washington it is not an uncommon thing to see where some small stream has been diverted from its course to irrigate the farmer's garden or orchard. Even in western Washington, where the annual rainfall exceeds fifty inches, some of the market gardens resort to irrigation in periods of summer heat and drouth.

However, the most notable instances of irrigation in a sub-humid climate are to be found in the vicinity of Spokane, where several thousand acres have been brought under ditches having their source in the mountain lakes of Idaho and northeastern Washington. By these means lands which were formerly held for $10 to $20 per acre have been advanced in value to $100 per acre and more. It is believed that the water supply is sufficient to irrigate the entire basin, comprising perhaps 50,000 acres of arable lands and that companies now organized will consummate the work.

The Desert before the ditches are dug.

GOVERNMENT IRRIGATION PROJECTS.

The great bulk of the arid lands of Washington susceptible to reclamation lie in the western and southern part of that broad plateau which has the Columbia river for a boundary on the north and west and the Snake river on the south. By reason of the fact heretofore mentioned that said streams have cut their channels far below the surface of the adjacent country they are not available on any large scale for the reclamation of the lands referred to. The sources of water supply must be sought therefore at long distances from the point of desired distribution involving expenditures which are at present and probably will be for a long time to come beyond the resources of private capital seeking such investment. Therefore the irrigation investigations of the Government have been in the main wisely devoted to this field.

Big Bend Project.—This is the largest irrigation project which has so far received the attention of the Government in the entire arid West and in magnitude will range among the greatest irrigation projects of modern times. The work has not yet advanced beyond the preliminary stages of investigation but it is estimated will cost $20,000,000 and reclaim perhaps 1,500,000 acres of arable lands. It is proposed to use the great Coeur d'Alene lake in Idaho as a storage reservoir and to divert the water from the Spokane river.

Okanogan Project.—The Okanogan project contemplates the irrigation of about 35,000 acres of lands on the benches of the Okanogan river in Okanogan County, which is outside the arid district proper. The estimated cost of construction would make the cost of water about $35 per acre, which is probably higher than the value of the lands will warrant at the present time.

Yakima River Storage Reservoirs.—The Government lands surrounding lakes Katches, Kitchelos and Cle Ellum, at the head of the Yakima river, have been withdrawn from public entry and preliminary investigations made with a view to Government use of these lakes for storage reservoir sites. This is a desideratum among all interested in the water supply of the Yakima river and with the practice of proper economy in the use of water by the irrigators would render possible the reclamation of every acre of land in that valley which it is practicable to supply from that stream.

PRIVATE IRRIGATION PROJECTS.

Klikitat River.—Within the past year or two surveys have been made with a view to diverting the waters of the Klikitat river and conducting them by a canal about one hundred miles in length to the Horse Heaven plateau in the eastern part of Yakima and Klikitat Counties. So far as the writer is informed it has not been determined as yet whether or not this project would be practicable from an economic standpoint.

Snake River Project.—A canal is now under consideration having in view the irrigation of several thousand acres of land in the western part of Walla Walla County in the vicinity of Wallula. The source of supply will be the Snake river, from which it is proposed to raise the water by pumps from the ditch itself.

Sunnyside Canal Extension.—This project will be hereinafter referred to. It may be stated here in brief that the consummation of the project will about double the irrigated area of the State.

YAKIMA VALLEY.

This valley comprises approximately nine-tenths of the present irrigated area of the State as heretofore shown. The Yakima river, one of the largest in Washington, rises in the Cascade mountains near the center of the State and flows in a southeasterly direction to its junction with the Columbia fifteen miles above the forty-sixth parallel which separates this State from Oregon. During the last eight miles of its course it flows in a wide valley which was once a part of the great lake which the Columbia drained when it broke through the Cascades and out to the ocean and the beds of the valley being silt the silts remained in place when the lake receded and the present water courses were established.

The cultivated valleys of the Yakima consists of ancient lake beds. Ellensburg is near the center of the upper one. The second includes the Natchez, Wenas and Selah valleys. The next one includes the Cowiche, Ahtanum and Moxee valleys, the present thriving city of North Yakima being about the geographical center. The fourth comprises the Sunnyside, Reservation and Prosser districts. The lower valley comprises a part of the older Columbia lake bed. The elevation at the mouth of the river near Kennewick is about 350 feet above sea level; at Prosser 674 feet; the Sunnyside district from 700 to 900 feet; North Yakima 1,078 feet; the Ellensburg district from 1,500 to 2,000 feet.

Areas.—The Yakima valley forms a part of the two counties of Yakima and Kittitas. The former county contains an area of 5,784 square miles and the latter of 2,414 square miles. Comparatively, the area of Yakima County is larger than Connecticut, nearly twice that of Rhode Island and Delaware and nearly two-thirds that of Massachusetts. Professor Waller, of the State Agricultural College, estimates on the basis of very careful investigations that 660,000 acres can be reclaimed by irrigation, assuming a sufficient water supply. This is equivalent to about 18 per cent of the entire area of Yakima County in which the great bulk of the irrigable lands lie.

Soils.—An analysis of the soils of the Yakima valley made by the department of chemistry of the State Agricultural College shows that they are especially rich in lime, potash and phosphoric acid, the three constituents most essential to plant life. The soil deposit being of disintegrated basaltic rock is of great fertility. It is sufficiently porous to readily absorb the water and allow a free penetration of plant roots. At Zillah, in the Sunnyside district, where the river has cut down its banks, the soil is eighty feet deep and where wells have been sunk it has been found to be from sixty to two hundred feet in depth, which would seem to be sufficient assurance of its permanent fertility. In this it is in no way exceptional to other basaltic soils, notably those of Italy, southern France, Arizona and Mexico, where lands which have been under cultivation for centuries still maintain their marvellous fertility.

Climate.—The climate varies of course with the altitude and as there is a difference of some 1,500 feet between the elevation of the lower and upper portions of the valley it will be interesting to note the differences of climate as measured by the temperature and rainfall. The following is taken from a meteorological tabulation covering a period of twelve years:

	Altitude.	Annual mean.	Jan'y mean.	July mean.	Seasonal range.	Precipitation.
Kennewick	350	54.1	29.7	76.5	46.8	6.64
Sunnyside	750	54.1	29.4	73.1	43.7	6.36
North Yakima . . .	1,078	5.3	29.2	71.7	42.5	8.55
Ellensburg	1,500	46.2	23.8	65.6	41.8	9.05

In general, however, it may be said that the summer climate of the Yakima valley resembles that of the California valleys in the length of the growing season, the number of sunny days, the absence of late spring and early fall frosts and the immunity from destructive storms. The winters are short and mild.

Water Supply for Irrigation.—Prof. O. L. Waller, agent and expert of the State Experiment Station and the United States department of agriculture for irrigation investigations, says upon this subject:

"The situation of Yakima County so near the slopes of the Cascade range possibly provides a more abundant supply of water than is enjoyed by any other irrigated section in the West. The enormous rain and snow fall upon the mountains gives rise to a large number of small streams which course down the watershed with rapid fall to join the swift currents of the Yakima and Natches, which in turn descend at the rate of thirty to forty feet to the mile. By reason of this step grade of the natural water courses the irrigating canals draw rapidly away from the streams, and with a minimum of length and expense, reclaim a maximum of land. The slope of the bluffs inclosing the valleys being for the most part gradual the difficulties of construction are correspondingly decreased. These conditions of an abundant water supply and its economical development have promoted irrigation enterprises and hastened the settlement of the country. The pioneers, attracted by the ease of the undertaking and the promise of rich results, dug small ditches and reclaimed small tracts along the rivers. For many miles the results of their labors may be seen in beautiful fields and orchards. Following them came the canal companies with ample means, and the work which was accomplished by the pioneers on a limited plan has been advanced on a broad scale by the latter, and there now exists a continuous line of irrigation systems from Kennewick to the Selah valley."

Maj. J W. Powell, director of the geological survey, said some years ago in an address at North Yakima:

"There is more than water enough, flowing through Yakima County, to irrigate every acre of arable land; and in this respect the Yakima valley is especially and exceptionally favored, as its water supply is superior to that of any other region in the West, with but one exception, that of Boise, Idaho."

It is only during the latter part of July and the month of August, a period of about six weeks, that the demands upon the river in future may possibly exceed the present minimum run-off. Before September 1 the hay and vegetable crops of the country are made, so far as irrigation is concerned, and the demand for water after that date is for the comparatively small area of orchards, and for new seeding, which also represents but a small percentage of the area to which water is supplied during the season. During the first half of the irrigation season the normal flow of the river is more than sufficient for any possible future requirements. It will be apparent therefore that by utilizing the natural reservoir sites at the heads of the Yakima, Natches and Tietan Rivers for storage, as now contemplated by the national Government, to be drawn upon only during the period of minimum flow of the river, the supply of water, which is now, without storage, ample for existing requirements, will be sufficient for any possible demands of the future.

Irrigated Areas.—The following table shows the locations, names of the principal canals of the valley, when constructed, the length of main canal, the acres covered thereby and the areas now under cultivation:

Location and name	When con-str'ct'd.	Length miles.	Acres covered.	Acres in cultivation.
Kittitas County—				
"Cascade Canal"	1903	42	15,800	
"Town Ditch"	1887	30	10,000	7,000
"Olson" Ditch	1892	6	1,300	1,200
"West Side" Ditch	1889	15	6,784	5,356
"Bull" Ditch		6	2,200	2,200
"Tanum" Ditch		6	5,000	5,000
Yakima County—				
"Selah Valley" Ditch . . .	1892	21	9,000	5,500
"Wapatox" Ditch	1884	9	2,850	1,180
"Congdon" Ditch	1894	25	4,200	3,500
"Gleed" Ditch		14	2,000	1,850
"Natchez & Cowyche" Ditch	1881	12	1,500	1,400
"Union" Ditch	1884	6	2,700	2,300
"Schanno" Ditch		. . . .	1,600	1,000
"Selah Koxee" Ditch	1900	26	6,000	55,000
"Taylor" Ditch	1880	4	1,400	1,000
"Fowler" Ditch	1885	12	3,000	2,750
"Hubbard" Ditch	1880	10	. . . . . .	. . . . . .
"Moxee" Ditch	1880	10	5,000	4,000
"New" Reservation Canal	1903	4	24,000	. . . . . .
"Old" Reservation Canal .	1898	12½	700	700
"Sunnyside Canal"	1891	57	64,000	30,000
"Gilbert" Ditch	1900	7	2,500	2,500
"Toppenish" Ditch	1897	4	500	500
"Prosser Falls" Ditch . . .	1894	10	3,500	1,502
"Kiona" Ditch		. . . .	3,000	300
"Kennewick" Canal	1902	35	14,000	1,000
"Grosscup" Ditch		6	3,000	. . . . . .

Towns.—The towns of the valley starting from the lower end and following up and enumerating only such places as are almost entirely dependent upon the irrigated areas for their support, are as follows: Kennewick, Kiona, Prosser, Mabton, Sunnyside, Alfalfa, Toppenish, Zillah, Wapato, Yakima City, North Yakima, Ellensburg and Thorpe. The aggregate urban population will approximate 12,000 persons and many of the places named are important distributing and shipping centers.

[In our August issue will appear an article by Mr. Granger on the Sunnyside Irrigation District.—Editor.]

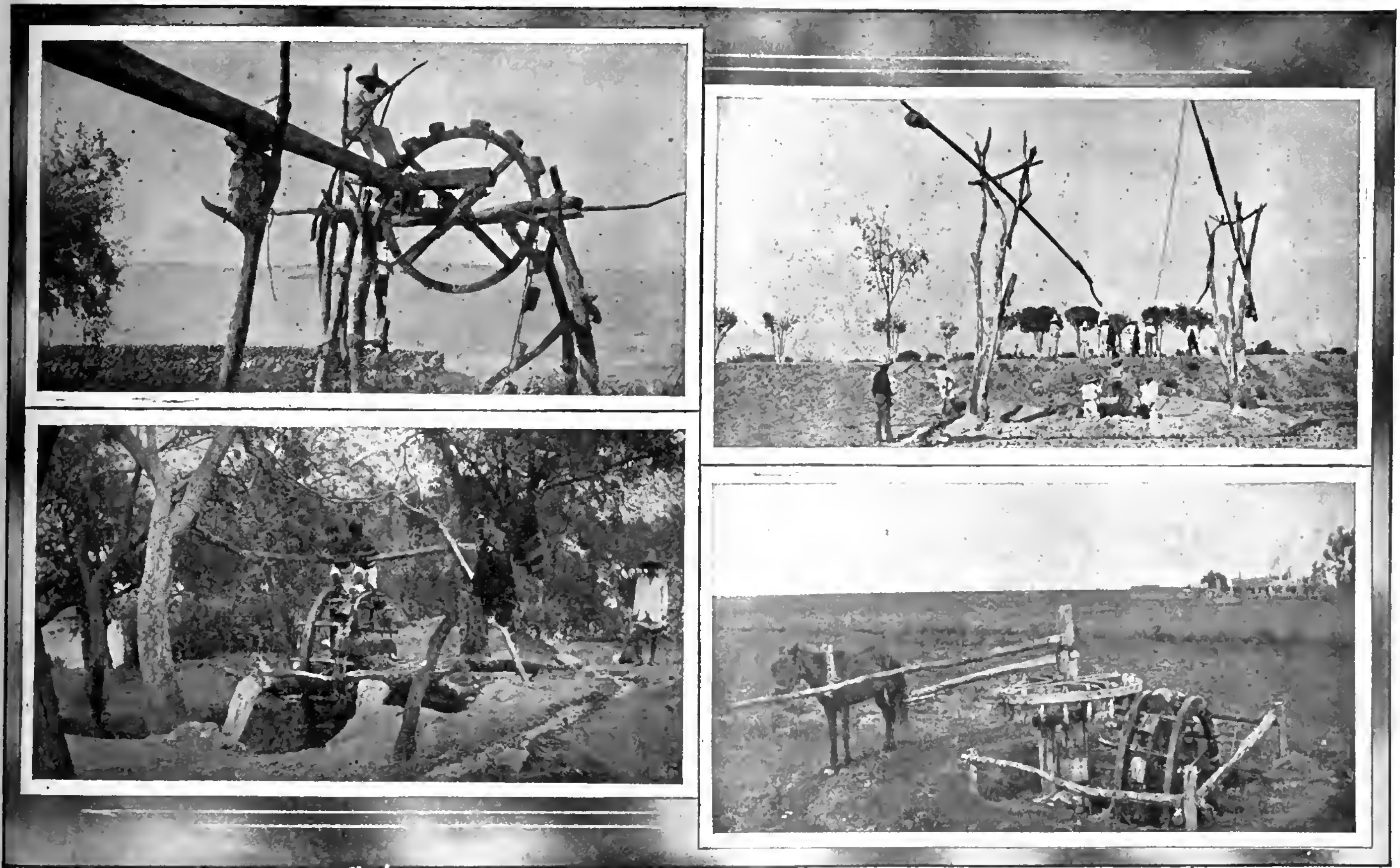
PUMPING WATER IN MEXICO.

Primitive Devices That Have Remained in Use Even to the Twentieth Century.

Mexico, so near to and yet so far from the United States and our progressive cities and farmlands, only within recent years is beginning to feel the iron grip of progress struggling with her shackels and seeking to strike them away. Among the ancient and picturesque devices, says *Popular Mechanics,* still in general use in that country are the "pumping engines" for elevating water.

Some of these machines are shown in the accompanying illustrations. In the first one it will be noticed that but one man is required to keep the wheel with its continuous chain of buckets in motion, and the work is not so strenuous but that he can bear the warmth of full garb, while in another two men clinging to a sapling placed above the wheel are required to generate the power, and are working without shirts. The fact that one is subjected to the glare of the sun, while the others are protected from it by trees may account for this difference in the amount of clothing worn, however. The other devices are so familiar in one form or another to every one that a glance explains them.

Modern type irrigation pumps of the turbine pattern are now rapidly replacing these quaint devices. Power is cheaply developed by utilizing the many mountain streams for generating electric current, and then distributing it over the vast agricultural areas lying between the mountain chains.



HOW WATER IS PUMPED IN MEXICO. Courtesy Henry R. Worthington.

CURRENT WHEELS: THEIR USE IN LIFTING WATER FOR IRRIGATION.*

CONSTRUCTION OF CURRENT WHEELS.

The practical experience of many irrigators in the construction and use of current wheels has been collected and is here presented as an answer to inquiries regarding their cost and efficiency.

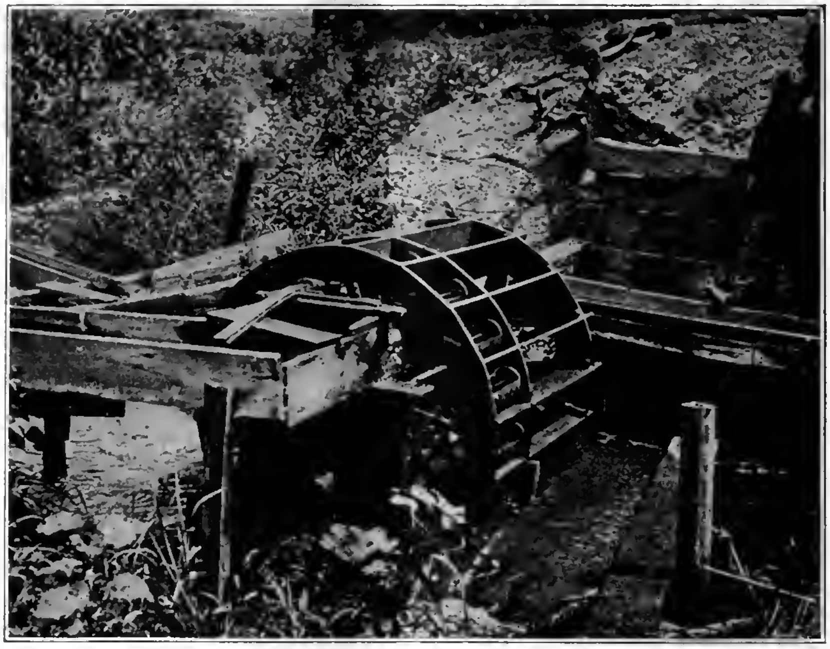
In its simplest form a current wheel consists of a large skeleton roller made of wood, with paddles projecting beyond its rim. It is hung on a shaft and supported at both ends by piers or posts, so as to allow the wheel to dip into the water to the width of the paddles. The simplest device for raising water with such a wheel is a row of buckets placed on the rim so as to fill at the bottom of the wheel and empty into a trough near the top. A more complicated way is to connect the wheel to chain and bucket gear, or to a pump of some sort. These more difficult methods of construction are necessary in all cases where it is desired to raise the water to a height greater than the diameter of the wheel used.

THEORY OF POWER IN CURRENT WHEELS.

While a home made undershot water wheel develops but little of the power in a running stream, still the action of the crudest wheel is governed by certain principles, an understanding of which will aid the builder in improving the design of his wheel, thereby increasing its efficiency.

* Courtesy U. S. Department of Agriculture.

Current wheels, unlike overshot wheels, do not act by the weight of the water, but by the impulse or dynamic pressure of moving water. The power contained in running water is expressed in terms of the distance through which the water would have to fall in order to attain the velocity observed. This distance is called the velocity head. A body falling freely four feet attains a velocity of sixteen feet per second. Hence water flowing sixteen feet per second has a velocity head of four feet. In other words, if an inclined plane were placed in such a stream, the water would run up it to the height of four feet before coming to rest. Thus the power contained in 1,000 pounds of water running sixteen feet per second is exactly sufficient to raise a weight of 1,000 pounds four feet. This weight may or may not consist of the moving water itself. The usual velocity in streams is from one to four feet per second, representing velocity heads of from one-fourth inch to three inches, so that some means other than an inclined plane must be used to raise water to a serviceable level. In any case work is performed only when the motion of the water is checked. The current wheel, by checking the motion of a large quantity of water to some degree, raises a very small quantity of water to a height ten or a hundred times as great as the velocity head in the stream.



Current Wheel, Farmers' and Gardeners' Ditch, Colorado.

THEORETICAL CALCULATION OF EFFICIENCY.

The speed at which a current wheel revolves may be regulated by increasing or decreasing the number and size of the buckets on the rim. When the load is so heavy that the wheel does not start, it is evident that although the water strikes the paddles with great pressure no work is done. Again, if the wheel is not loaded at all, and turns as fast as the water moves under it, speed is developed, but no appreciable pressure is exerted on the paddles. Half-way between those extremes lies the mean of greatest advantage; therefore the wheel should be so loaded as to move one-half as fast as the water. Given a wheel the rim of which moves one-half as fast as the water, its efficiency depends on the design of the paddles. For the amount of work imparted to the wheel by the water depends on the change in its absolute velocity in turning the wheel, which is largely governed by the angle at which the paddles are set. But dynamic pressure of water varies with the square of velocity, and the work imparted will vary as the square of the initial velocity minus the square of the final velocity. This relation is expressed by the formula[1] $k=(W\frac{v^2-v_1^2}{2g})$ in which k is the work imparted to the wheel, W is the weight of water that comes into action each second, v is the initial velocity of the water, v_1 is its final absolute velocity, and g is the force of gravity. In any given set of conditions W, v and g have constant values. The only way, then, to increase the amount of work done is by reducing v_1. In other words, if the water could be made to leave the vanes with an absolute velocity of zero, the power imparted to the wheel would equal the total dynamic energy of the stream, and the efficiency of the wheel would be 100 per cent. In figure 1[2] a series of wheels is shown with the paddles arranged at various angles. At (*a*) is shown the most common form, a wheel with plain radial paddles. Since the wheel moves one-half as fast as the water, the water will leave the paddle, in the direction of the small arrow, with a velocity one-half as great as that of the stream. Owing to the horizontal motion of the paddle the absolute discharge of the water will be in a diagonal direction, and its absolute velocity will be the initial velocity divided by $\sqrt{2}$. Since the energy in moving water varies with the square of the velocity, the water discharged has one-half of the energy of the water striking the paddles. Hence one-half of the energy is lost, and the efficiency of the wheel is 50 per cent.

Similar reasoning will show that in the wheel marked (*b*), the paddles of which slant upstream 30

[1] Merriman—Hydraulics, 8th edition, p. 406.

[2] All text figures referred to will be foand at the end of the bulletin.

degrees from vertical, the water is discharged with an absolute velocity one-half as great as the entering velocity, giving an efficiency of 75 per cent. At (*c*) the blades slant 45 degrees from vertical, giving an efficiency of 85 per cent. At (*d*) the paddles are set 60 degrees from vertical, giving an efficiency of 93 per cent. At (*e*) the paddles are supposed to discharge the water in a direction directly opposite to the wheel's motion, so that it leaves the wheel with no absolute velocity whatever. In that case the efficiency would be 100 per cent.

PRACTICAL OPERATIONS.

Certain practical considerations, however, of which no account is taken in the above theoretical discussion, prevent the adoption of several of the forms of wheel shown in Fig. 1. First, the loss by "impact," or the churning and eddying of water, is very great when the water strikes flat on a paddle, as at (*a*). At (*d*) the eddy formed in the sharp angle between the paddle and the rim is equally wasteful. It is impossible to avoid impact altogether in any water wheel, but it is least detrimental in a wheel like the one shown at (*f*) in which the paddles are curved. The intention is that the water shall strike the blades nearly at a tangent, and slide smoothly up them, coming to rest near the top. In sliding out the reaction is in line with the motion of the wheel, and the absolute velocity of the tail water is very low. A wheel of this design has reached a working efficiency of 68 to 75 per cent[3] which is about twice the efficiency usually obtainable in a wheel with straight paddles. Impact is seen to be a leading factor in reducing the efficiency of wheels.

In all carefully built wheels where the water is run under the wheel through a flume, it is necessary to provide ample waste way for the tail water. The fall in the tailrace below the wheel is, of course, light, so as to get the greatest possible fall above; but it must be great enough to make the tail water flow away without checking the wheel.

In order to avoid unnecessary churning of the water it is advisable to have not less than twelve paddles, in order that at least two may at all times be in the water. In the case of a large wheel set in a flume, more paddles should be provided to avoid the necessary loss between the flume and the paddles. They should dip into the water not more than one-tenth of the diameter of the wheel, for if they dip too deep, the pressure of the water is not applied tangent to the wheel, but at a less advantageous angle, and there is also a tendency to throw water on the lower side. When a wheel is placed in a flume, it is always well, where possible, to run the water under a gate, making the paddles somewhat wider than the depth of the water.

As a matter of practice the form of paddles shown in Fig. 1 (*e*) is entirely impracticable. The water discharged with no velocity would be in the way of the next paddle and the loss by impact and backwater would be so large as to make the wheel worthless. For wheels with straight paddles, the form shown in Fig. 1 (*b*) is found to be most satisfactory. In this case the paddles leave the water vertically with no tendency to splash water. Perhaps the most effective easy construction out of flat boards is the one shown in Fig. 11, page 30, where the paddle bends at an angle. In this case the usual stiff rim may be omitted.

Wheel near Morgan City, Utah.

EXAMPLES OF WHEELS IN ACTUAL USE.

The foregoing considerations apply in general to all current wheels. In the descriptions of wheels in actual use, attention will be given to many points in their design and to constructive details. In the estimates of the cost of materials, lumber is put in at $25 per thousand and hardware at about 100 per cent above wholesale prices. The weight of wheels is computed on the basis of four pounds per board foot for lumber and 450 pounds per cubic foot for iron work.

WHEELS ON THE SOUTH PLATTE AT DENVER.

In the Farmers and Gardeners' Ditch from the South Platte River at Denver, Colo., are four wheels

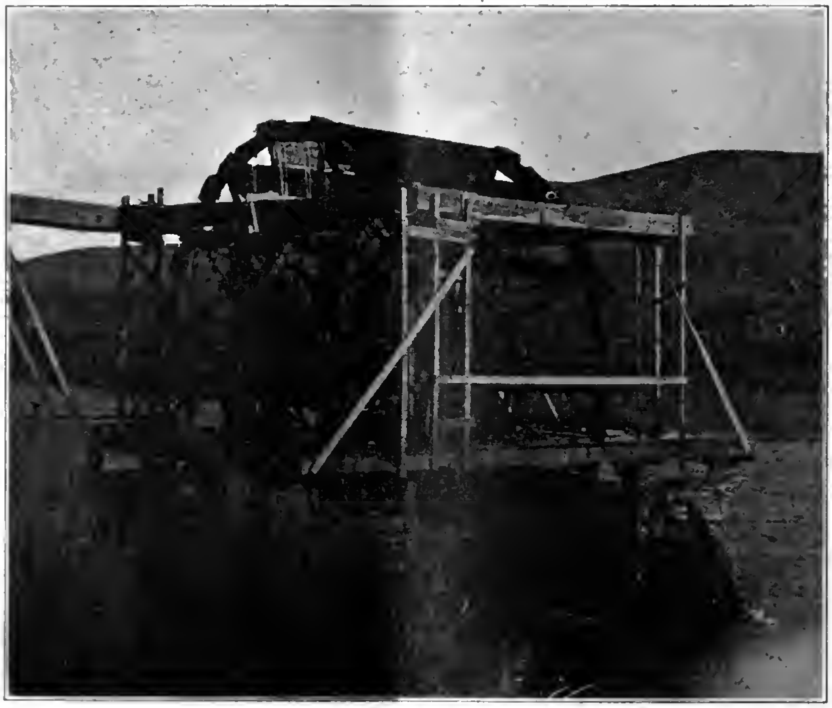
[3] Frizell—Water Power, 3d edition, p. 286.

of the design shown in Fig. 4, and in Plate 1, Fig. 1. Each is four feet in diameter and raises water three feet for the irrigation of five acres in vegetables. The shaft is of 1½-inch iron pipe and works in wooden bearings. Two rows of 1 by 2-inch wooden spokes are placed three feet apart on the shaft. Stiff circular rims of ½ by 6-inch material connect the ends of the spokes, forming a rigid wheel for the support of the paddles. There are eighteen paddles of ½-inch boards six inches wide and four feet in length. The paddles extend one foot beyond the row of spokes at one end, where the buckets are swung between them. These projecting ends are braced by a third stiff rim which furnishes a bearing for the buckets. These are half cylindrical in shape, being made of tin tacked onto round pieces of wood which form the ends. They are swung on pins of heavy wire run through the centers of the end pieces. Being free to turn on the pins, the buckets will always hang right side up unless forcibly turned over. In this case they are turned over when they reach the top of the wheel by a slender stick placed so as to strike each bucket in turn. A piece of rubber hose covers the end of the stick, which springs down enough to let the bucket roll over it without checking the motion of the wheel. Each of the eighteen buckets holds 0.04 cubic feet, so that at each revolution the wheel raises 0.72 cubic feet. Turning once in 3½ seconds, the wheel raises about 0.2 cubic feet per second. No attempt is made to confine the water of the ditch to a flume so as to bring it all into action on the wheel.

These wheels are well constructed and are said to have cost $27 each. Most of the expense appears to have been for labor, since the amount of material required is so small. The plan calls for forty-two board feet of lumber, five feet of pipe for the shaft, eight and a half pounds of tin (D C), and five pounds of No. 1 wire. At fair retail prices the cost for material is $3.15. This estimate is exclusive of the supporting posts and the flume for carrying away the water.

These wheels successfully water the gardens for which they were built and so entirely fulfill the purpose of the gardeners who put them in. With a little change in design, however, a wheel of this pattern could be made to raise twice as much water as these raise at present. In the first place, the wheel revolves almost as fast as the water that turns it, so that the water which strikes the paddles exerts about one-third of its power. The remedy is to increase the size of the buckets until the rim of the wheel moves about half as fast as the water. Another improvement which would increase the capacity of the wheel would be to slant the paddles about 30 degrees upstream, or, better still, a slanting board could be added to each paddle, so as to form an angle opening upstream.

Of the total available power in the stream, the wheel observed used 20 per cent in "useful work." By running all the water through a flume four and a half feet wide and changing the design as suggested the amount of water raised would be largely increased. For $10 a permanent flume of 2-inch material with a substantial apron and wings could be built.

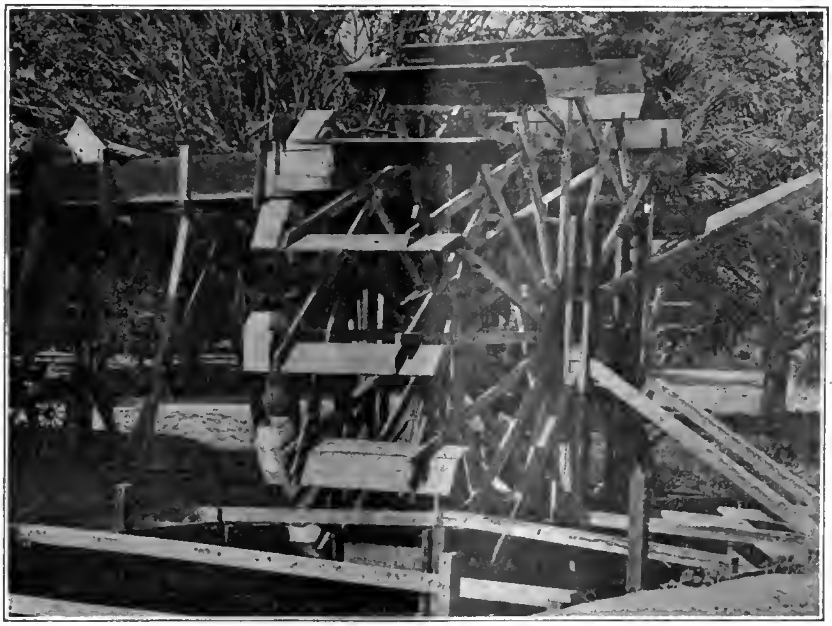


Wheel on Yakima River, Washington.

Another wheel in the same ditch is built on the same general plan, except the buckets are fixed rigidly in the rim. It is of less expensive construction, however, being framed from two buggy wheels with their rims removed and placed three feet apart on a shaft. The paddles of ½-inch boards, six inches wide, are nailed to the spokes. As before, rows of braces between the paddles form three stiff rims. The buckets are formed by nailing sheets of tin to the inside and outside edges of the paddles so that the two rims form the ends and the paddles form the bottoms. The sheet of tin on the inside is cut narrower than the one on the outside. But for the fact that when the wheel is in motion the water tends to fly away from the center, nearly all the water would spill from these buckets before reaching the flume. For this reason a rather high velocity is necessary to make this wheel work well.

The cost of the wheel was given as $1.85, which is probably the cost of the shaft, tin, and nails. It was built by the gardener who uses it. It contains almost exactly the same amount of material as the wheel first described, and, granted an indefinite supply of old buggy wheels, could be built for about half as much. But it can not be made to raise the water quite so high, and, on account of spilling the water, is much less efficient than the first type. Its efficiency could be increased by slanting the blades, but not by increasing the load; because a high velocity is essential.

Each of these five wheels irrigates five acres in market gardens, an annual tax of $5 being paid to the ditch company by each gardener. The ditch has a very constant flow, so that there is always water enough to run the wheels. Since the water level changes so little, no device for raising and lowering these wheels is used.



Wheel in Fancher Creek Nursery, Fresno, California.

A BIG WHEEL IN GRAND RIVER VALLEY, COLORADO.

A wheel in operation on the Grand Valley Canal, in Colorado, raises water thirty feet for the irrigation of forty acres of orchard. The wheel is thirty-four feet in diameter, the paddles being eight feet long and two feet eight inches wide. The spokes are secured at the center by means of castings and are set at such an angle to the shaft that they come to a point on the rim of the wheel (Fig. 2). To provide sufficient rigidity, a system of braces is adopted, making a very substantial construction. Braces are also run from paddle to paddle and between the arms of the wheel, so as to form a system of six or eight circular rims.

The buckets consist of long boxes made of 1-inch stuff, set at such an angle on the rim of the wheel that they will fill nearly full and raise the water within two feet of the top of the wheel.

One interesting feature of this wheel is the method tried for adjusting it to the stage of water. The plan was to counterpoise the weight of the wheel, balancing it on two heavy supporting timbers. The adjustment was to be accomplished by means of a windlass, but, owing to the unexpected increase of weight which occurred when the wheel became water soaked, the scheme was abandoned and the support was made rigid by additional braces.

The training flume for directing the flow of the canal against the paddles if the wheel is of somewhat unusual construction (Fig. 3). A flume with three channels was built in the canal, the wheel being set in the center; flashboards are inserted in the two side channels to control the flow. The effort to prevent the interference of floating matter with the action of the wheel, by means of a brush guard, as shown, is not altogether successful, owing to the fact that it checks the current to a considerable extent.

The quantity of water raised by the wheel was measured when all of the water was running through the center flume, and was found to be 0.36 cubic foot per second, which is the maximum capacity of the wheel. Under ordinary conditions, with the side channels open, it raised about 0.25. cubic foot per second. The wheel moved very unsteadily, being so heavily loaded that its motion was entirely checked each time a paddle entered the water, several seconds being required to back the water up to a sufficient extent to start the wheel. It turned over once in two minutes, having a rim velocity of about 25 per cent of the velocity of the water.

The cost of the wheel, which was built in 1895, was given as $400. It contains 1,750 feet of lumber and about 450 pounds of hardware, which together should cost not more than $90. The operating expenses are very low. The owner of the wheel is assessed by the ditch company at twice the usual rate charged the other users, with the stipulation that the water in the canal must not be appreciably checked. The assessment is usually about $2 per inch (38.4 Colorado inches equal one cubic foot per second).

CHEAP STRUCTURES IN WASHINGTON, UTAH, AND COLORADO.

NEED OF ADJUSTMENT TO STAGE OF WATER.

A 6-foot wheel located at North Yakima, Wash., is shown in Fig. 5. It is heavily framed of eight 2 by 4-inch arms radiating from a 6-foot shaft of 5 by 5-inch stuff. The paddles are 1 foot wide and 6 feet long, each carrying a 1-gallon tin can on either end. These cans are nailed to a beveled seat, which tips them enough so that they are full or nearly so when they leave the stream. But even allowing that the twelve cans discharge their full capacity, the efficiency of the wheel when observed was only 9 per cent. This low efficiency is due mainly to the faulty design of the paddles. They are so wide in proportion to the size of the wheel, and they dip so deep in the water that the wheel wastes its energy in churning the water, both as the paddles enter and as they leave the water. The advantage of balancing a wheel of this size by placing buckets at both ends is probably too small to pay for the extra fluming required.

This wheel is nearly twice as heavy as the one first described (page 10) and it requires three times as much water to run it, yet it raises less water. It is very substantial and requires little attention. It cost $18. As it contains only eighty feet of lumber, it could easily be reproduced for less money, as its simple construction would require no special skill. Not being adjustable for high and low water, it runs to great advantage just when there is the best supply of water to operate it.

CHEAP AND EFFICIENT.

Another wheel of the same design is small and well built, and, considering that it runs in a current moving only one foot per second, is remarkably efficient. It has a simple and effective device for raising and lowering the bearings, which is shown in Fig. 6. The buckets are all on one side and raise the water much higher than necessary to reach the flume. The wheel cost $13 and contains about seventy-five feet of lumber, including the supports but not the flume.

AN OLD WAGON HUB AS A BASIS.

An ingenious wheel installed in a ditch near Morgan City, Utah, is shown in Plate I, Fig. 2, and in Fig. 7. It is built by inserting spokes of 1-inch material three feet long in an old wagon hub. The spokes are made rigid by two sets of braces. The paddles are eighteen inches long and eight inches wide, and the twelve buckets hold nearly one gallon each, being tilted slightly by wedge-shaped blocks placed beneath them.

The shaft is supported on one side of the wheel only, being made fast to a tree at one end and resting on a post near the wheel. The wheel is but half the width of the ditch, a small gate closing the other half when the wheel is in use. This arrangement doubles the velocity of the water when the gate is closed and affords a means of regulating the amount of water raised. The wheel irrigates one-fourth acre of garden, and could be made to serve a much larger tract.

(To be Continued.)

THE VALUE OF THE WINDMILL ON THE FARM.

It is Adapted to most Purposes for which Power is Required—The Source of its Energy is Free and Exhaustless—Testimony of Users as to the Work Accomplished—Equipment Needed for Electric Lighting.

BY J. B. REYNOLDS, PROFESSOR OF PHYSICS, ONTARIO AGRICULTURAL COLLEGE.

Today in any good farming section of this continent, one of the most conspicuous features in the landscape is the windmill. Coming from Palmerston to Guelph last summer, the writer counted from the car window, as many as eight windmills in sight at once, and all along that road could be seen from three to eight mills in view at one time. The windmill, of course, is limited in its adaptability and steam and other forms of power have permanently displaced it for many purposes. But for certain specific purposes, and among them the pumping of water, the windmill is not only thoroughly reliable, but it is the most economical motor now in use.

The windmill requires to be controlled, and in modern machines is automatically controlled, in two particulars; it has to be thrown into the wind, and the speed has to be regulated so that steady work may be done in variable winds. The first control is effected by means of a vane on the same shaft as the wheel, with its plane at right angles to that of the wheel. The wind catching this vane throws it around until its plane is parallel to the direction of the wind, and hence the wheel pulled broadside to the wind. If, however, the wind should become too strong, either the mill has to be pulled partly out of the wind or else the different sections of the wheel are tipped, so that the wind is made to strike more obliquely and, therefore, with less effect, upon the surfaces of the vanes. The wheel itself is pulled bodily out of the wind by a side vane, with its plane parallel to that of the wheel, and on an arm that carries it out from the center bearings. When the wind becomes very strong, it forces its side vane around out of the wind, and with it the wheel. The individual sections of the wheel are controlled by a coil spring about the main shaft. A high speed of this shaft causes this spring to tighten, and by means of connecting rods to draw the individual vane somewhat out of the wind. By these means a fairly uniform speed is maintained in a variable wind.

USES TO WHICH THE WINDMILL MAY BE PUT.

Under this head windmills are classified as power and pumper. The power mill has on the end of the wheel shaft a beveled gear, which engages a similar beveled gear on a vertical shaft. This vertical shaft extends nearly to the barn floor, and here a similar beveled-gear arrangement runs a horizontal shaft, from which, by pulleys and belts power may be carried to machines on the barn floor. The pumper has on the end of the wheel shaft a solid wheel to which a rod is attached eccentrically, thus imparting an up and down motion to the rod—a motion necessary to pumping water.

The same wheel may be made to drive machinery or to pump water by fixing both of the above attachments to the wheel shaft.

The writer sent out recently some inquiries to owners of windmills, respecting the uses to which these machines are put, their efficiency, power, and cost of maintenance. Following are copies of some of the replies:

1. "The size of our wheel is 15 feet. The grinder is a 10-inch plate. The wheel is about 60 feet above the ground. We drive the grinder, pulper, and cutting box, but intend to run a circular saw and pump water with it. I think it has about 14 horse power in a good fair wind. We find it satisfactory in every respect for grinding, pulping, or cutting corn or straw. It has not cost anything yet, only for oil."

2. "Our wheel is 16 feet in diameter and 62 feet above the ground. The machines we drive with it are root cutter, emery wheel, pump, grinder, and straw cutter. In an average wind it gives a horse-power of 12. It has cost us 25 cents in three years for two bolts and $1.00 for oil and axle grease. I advise any farmer of 100 acres or over to secure a 15-foot or 16-foot mill when getting one, so that you can use the power if necessary. A small mill, 8 or 12 feet, will not give the satisfaction. We pulp from four to five thousand bushels of roots per year, which will pay for a mill. The mill is the most paying machine on the farm, and no particular cost.

PUMPING FOR IRRIGATION.

3. "The size of our mill is 6 feet in diameter and is fifty-five feet above the ground. The tank is thirty-five barrels, and is elevated twenty feet from the ground. The well is fifteen feet deep, and in an average wind it takes from three to four hours to fill the tank. The water is used for watering the lawn, house use, bathroom, etc., and is arranged to pump either hard or soft water from cistern or well. We use about fifteen to twenty barrels of water in summer, and in winter less. Our mill has been in use for about eight months, and has cost 25 cents for oil. I might add that were I an agriculturist I would consider the windmill indispensable to the farm, it being adaptable to so many ways as a labor-saving device, and adding greatly to home comforts."

4. "Our windmill is eight feet in diameter and is fifty feet to the tower. The water is used in large house (closet in house), and for twelve horses, twelve cattle, and sometimes forty hogs. We have not had much expense in maintaining the windmill, and could hardly do without it."

5. "The size of our windmill is 8 feet, and is 40 feet to the tower. The tank holds thirty-six barrels of water and is twenty-five feet from the ground. The well is about 55 feet deep, and in an average wind it takes about three hours to fill the tank. We use from 50 to 100 pails of water per day. The cost of maintaining the windmill is very little—I should think about $10 per year."

THE ELECTRIC GENERATOR.

The windmill power is well adapted to electric lighting for the farm. The plant necessary is rather expensive in first cost, but in maintenance it costs but little. There is required besides the windmill, an electric generator, and a number of storage batteries, in which the electric energy is stored while the windmill runs, this energy to be afterward used in lighting. Electric energy is measured by pressure, or voltage, and by volume of current or amperage. A single incandescent lamp requires 110 volts to light it to whiteness, and a current of about half an ampere. A storage cell, whether large or small, gives a pressure of about two volts, the different sizes of cells differing in the quantity of current they give. Then cells may be arranged in series, like horses, tandem, or in parallel, like horses abreast. In series, the current they give is equal to that of one cell only, while the voltage is proportional to the number of cells. In parallel, the current is proportional to the number of cells, while the voltage is that of one single cell. If both voltage and volume of current require to be increased, this may be done by a series parallel arrangement. For instance, suppose that the capacity of a single cell were 10 amperes of 2 volts pressure, then 100 cells in series would give a 10-ampere current of 200 volts pressure; a parallel arrangement would give a 1,000-ampere current of 2 volts pressure, and a series-parallel, with four rows of 25 in. series would give a 40-ampere current of 50 volts. It may thus be seen that to light even a limited number of lamps nothing less than 55 or 60 cells in series would do. Sixty-four small sized cells would light six 16 candle-power incandescent lamps for 8 hours, or twelve lamps for 3 hours, without recharging.

ECONOMY OF WINDMILL.

The windmill is ample for most power purposes on the farm. It is seldom that more than one machine is required to operate at once. It is not likely that a pump and a grinder or chopper could be run in a moderate wind at the same time. Where much or varied work is required of the mill, a larger one is more serviceable and economical.

In a comparison of the cost of windmill power with any other, not the total capital outlay should be considered, but the interest on the capital, a percentage for depreciation of capital, an annual outlay for oil, fuel, and attendance. The windmill may cost more in capital outlay than other forms of power, but while the interest on this may increase the charges against the windmill, it must be borne in mind that a considerable item of the cost in running other forms of power is in fuel. For the windmill fuel costs nothing, and thus the total charge against the windmill, as compared with other prime movers, has been found to be, per horse-power per hour, somewhat less; that is, the windmill as a means of developing power is one of the most economical, when the various factors of expense, as stated above, are taken into consideration. In this connection we may consider the economy of electric lighting by means of the windmill. The first cost, in addition to the windmill, would be quite considerable, probably, for electric generator and storage batteries enough to run eight or ten lights, about $400. The interest and depreciation of capital for this would amount to, say, 10 per cent, $40.00. While this costs a great deal more, no doubt, than the oil which is used for lighting on the farm, yet when we consider the greater efficiency and safety of the electric lighting, the greater protection that it guarantees against loss by fire in barn and house, this means of lighting may appeal to many as quite practicable and acceptable in point of cost. At any rate, for those who have thought of lighting by means of windmill power and electric generator, these figures are presented as a guide, so that persons who have the matter in mind may sit down and count the cost before embarking on the enterprise.

TREE PLANTING ON THE PRAIRIES.

Farmers Should Choose Trees For Their Timber as well as For Their Rapid Growth.

In the States of the middle West there is pressing need of more trees, both for wood and for windbreaks and shelter belts. This need has been felt since the prairies were first settled, but the attempts made to supply it have, as a rule, fallen short of the benefits which might have been secured. The early planting was done chiefly for the sake of ornament or shade; the usefulness of the species for wood was seldom considered. In many cases, also, trees were planted outside of the range to which they were adapted, and on soil and in locations unfavorable to them. On the other hand, many valuable species were neglected.

Experience has now furnished the basis for better practice. Various kinds of trees can be grown in these regions which will serve just as well for protection and ornament as those which have been most used, and which at the same time will furnish valuable wood. For several years the Bureau of Forestry has been investigating this subject, with results which are recognized throughout the prairie region as of great practical value. The work consists of field studies of the existing forest growth, both natural and planted, of its relation to soil and climatic conditions, and of the effect of various cultural methods.

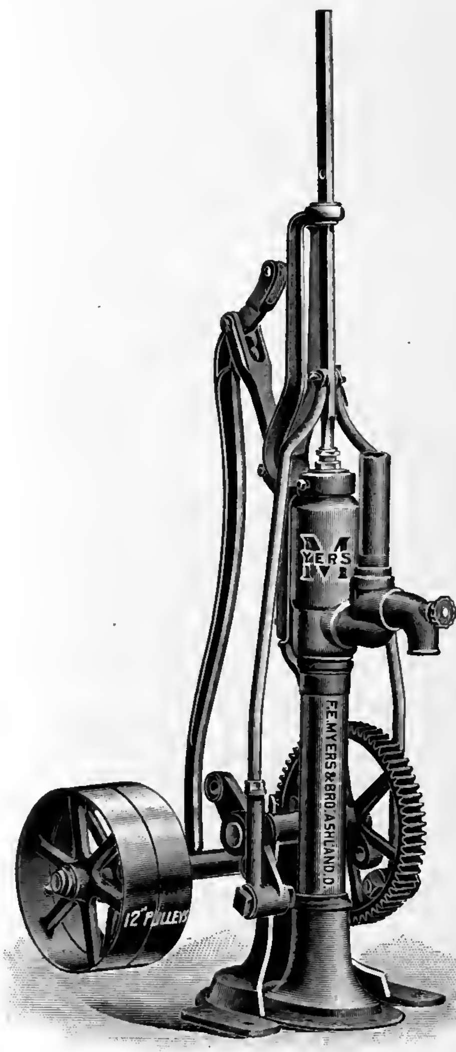
In carrying on the work bureau field parties examine and make measurements of representative groves. From these measurements volume and yield tables are made which show the returns in cordwood, posts, stakes, and lumber to be expected in a given time for each of the species studied. In addition to the measurements, the characteristics of growth and reproduction of the trees are noted, and valuable data on the natural distribution and advisable planting range obtained.

The work in the eastern part of the two Dakotas, western Minnesota, Illinois, eastern Nebraska, and western Kansas is already done. A bulletin based on the study in western Kansas has been published, giving information concerning the species most suitable to the locality, and telling how and where to plant them. Bulletins of the same character covering other States are in preparation. This summer Iowa will be studied, and later other States of the middle West, until the whole region is covered. Considerable tree planting has been done in some of these States, occasionally with complete success; but there have been many total failures, and many attempts successful only in part. As a rule the lack of success was due to lack of knowledge how and what to plant. But these plantations, whether successful or not, provide valuable object lessons in respect to future planting.

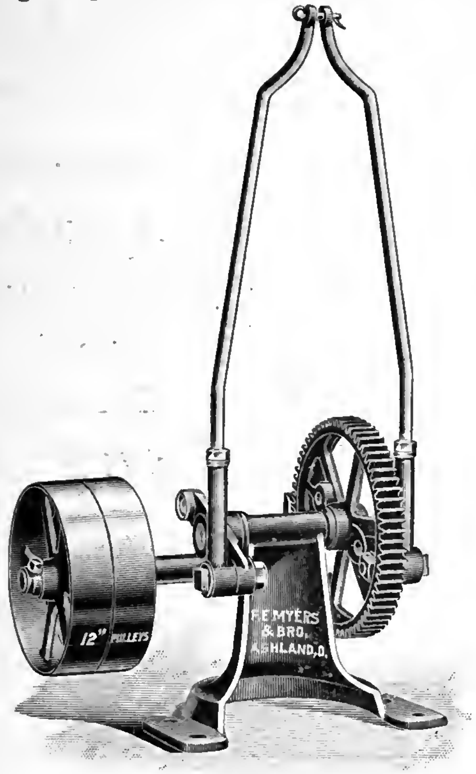
An important part of the study will be to determine to what extent the natural forest growth along streams and elsewhere is encroaching upon the drier upland in consequence of the protection from fire which settlement gives. Where this native growth can be utilized, it may be advisable to encourage it. Generally, however, the planting of species obtained from a distance will be necessary. The problem is to establish on the fertile prairies of the middle West the trees that will grow rapidly, and thus quickly furnish protection from the drying winds of summer and the bleak winds of winter, while at the same time yielding the timber most desirable for farm construction purposes, and possibly for lumber. It is the intention of the Bureau to determine exactly which are the most suitable species, and how they should be planted and cultivated to secure the best success.

MYERS UNIVERSAL PUMP JACK.

The demand for a pump jack that can be attached to any windmill pump has caused F. E. Myers & Bro., Ashland, Ohio, to bring out what is named the Myers' Universal Pump Jack, prints of which are shown herewith.



This pump jack has special merit and fills a particular want, owing to its favorable construction, having a half-circular base, which allows the frame of the jack to be placed so the crank shaft bearing comes right against the stand, and the jack can be located in a minute without in any way disturbing or disarranging the pump already set.



The jack is entirely self-contained, and it is only necessary to bolt it fast to the platform and connect the actuating rods to the pump rod, when it is ready for operation, not requiring fastening or attaching to the pump in any way, an advantage that will readily be appreciated. Application for patent on this device is on file at Washington.

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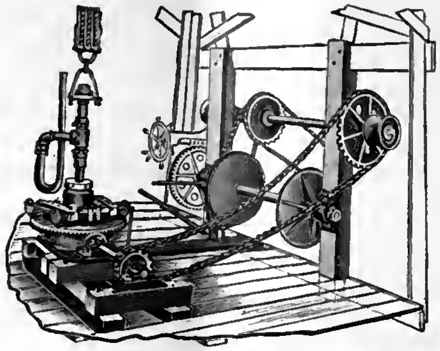

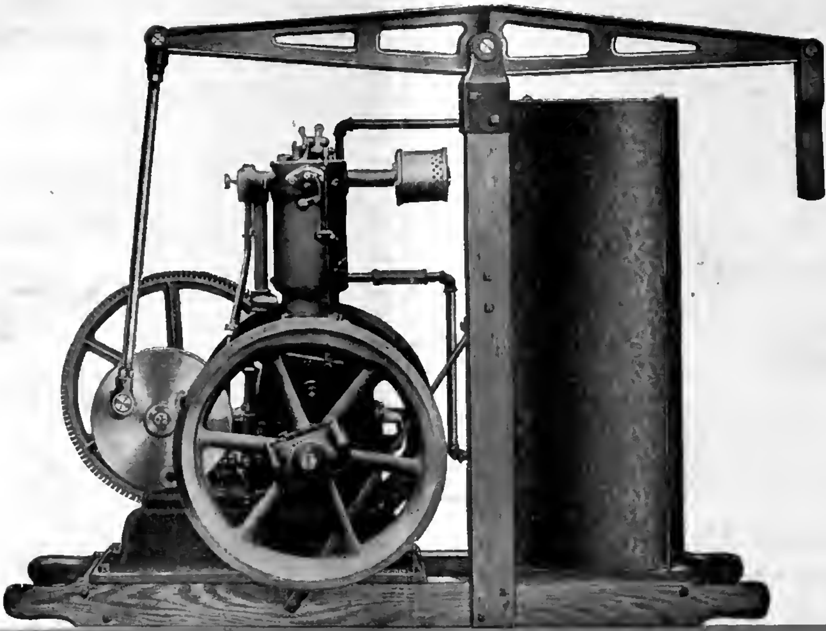

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THE IRRIGATION AGE
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THE DRAINAGE JOURNAL
ESTABLISHED 1879

CHARLES A. COX CHGO.

SPECIAL FEATURES

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Sunnyside, Washington.

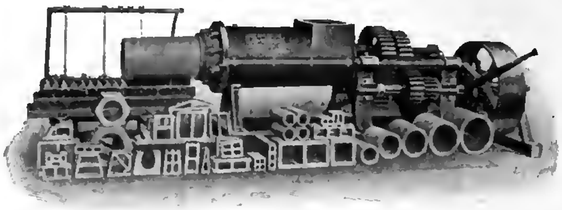
Current Wheels.

Tri-State Land Co. vs. Reclamation Service.

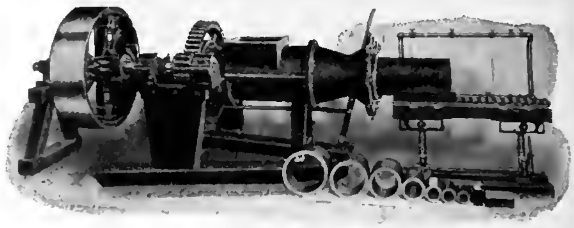
Irrigation in Yellowstone Valley.

After More Money

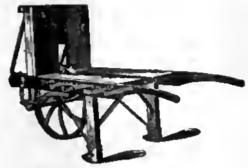
Montana's Hope is Irrigation.



Centennial Auger Machine



Mascot Auger Machine



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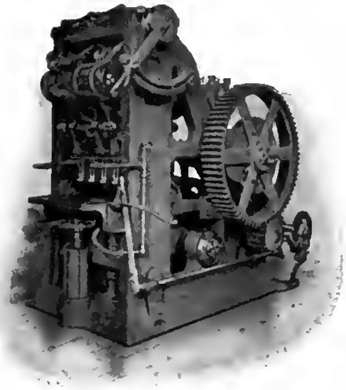

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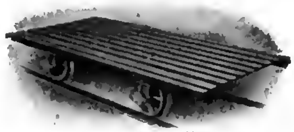

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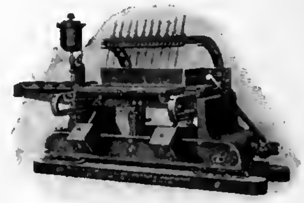

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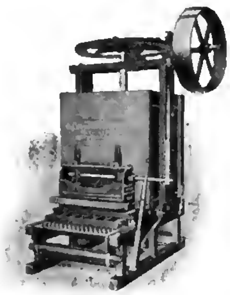

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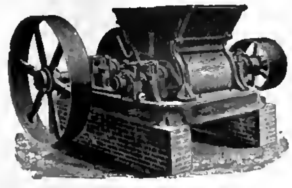
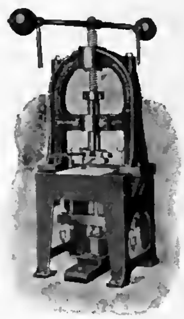


Disintegrators



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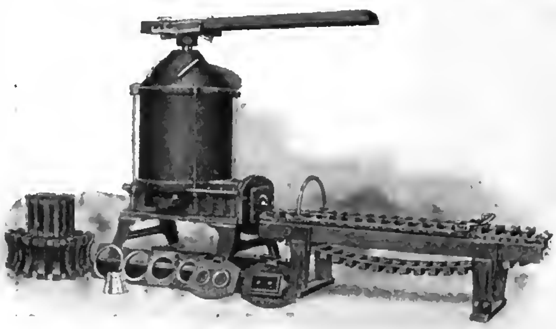

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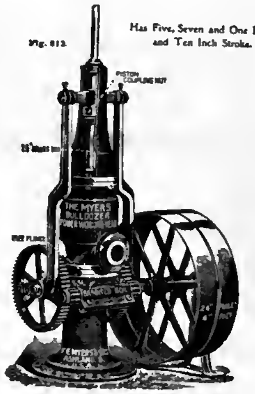

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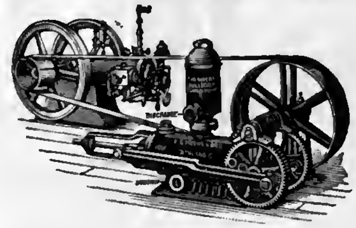

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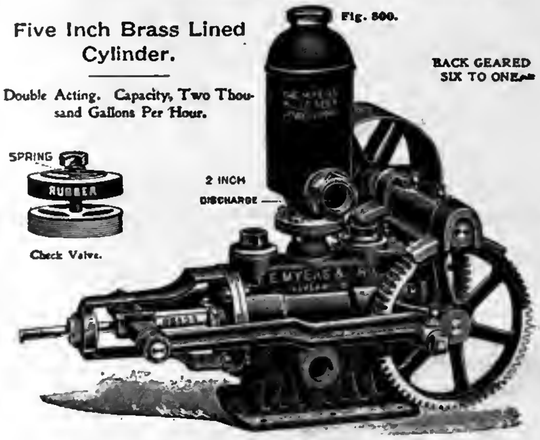

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THE IRRIGATION AGE

VOL. XX CHICAGO, AUGUST, 1905. NO. 10

THE IRRIGATION AGE

With which is Merged

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

Articles for Homeseekers. THE IRRIGATION AGE has made arrangements with over forty leading agricultural publications throughout the country whereby these journals will be furnished regularly with information concerning development along irrigation lines. In this series of articles, which will be published during the following twelve months, a fairly complete history of the development of the irrigation industry in the United States will be given. It will be our aim to so prepare this matter as to give people who are looking to the West for homes a clear insight to the possibilities of agriculture under irrigation and furnish information covering all conceivable questions that would be likely to come to the mind of one who intends moving from the central or eastern States to what is known as the Arid West.

The series of articles will appear in the columns of THE IRRIGATION AGE as well, and in our issue of July the first article was presented which, although general in its character, furnished information leading up to detail of development. In this issue is given a short illustrated article on the far famed Sunnyside district in Washington, known as the model large irrigation project of the United States under private control. The Sunnyside enterprise has been brought to its present state of perfection for its owners by Mr. Walter N. Granger, who has had much to do with good irrigation work throughout the West.

A representative of this journal will leave Chicago early in August for a month's trip through Montana, Washington, Idaho and Oregon and will collect data which will form the groundwork of the articles mentioned. Much of the matter contained in articles during the next six months will treat of conditions existing along the line of the Northern Pacific Railway in the States named. Later on the articles will cover information along the lines of other railways in Nebraska, Colorado, Utah, Nevada and California.

If yourself or friends are contemplating moving to the West, THE IRRIGATION AGE will gladly furnish any information in its possession or refer you to men who are in a position to furnish details concerning any particular locality or enterprise.

Irrigation Congress. The question whether another Irrigation Congress would ever be held after the abortive session at El Paso, Texas, last year, is solved in the affirmative. The thirteenth National Irrigation Congress is called to meet in Portland, Oregon, August 21st to 24th, inclusive, says the Salt Lake *Tribune*.

The composition of the congress will be as heretofore, the official members as usual, and the appointive delegates on the old basis, as shown in the call—fifteen delegates by each governor, ten by mayors of cities over 25,000, five by mayors of cities of less, two by the county governments, two by each commercial body, irrigation, agricultural or horticultural society, agricultural college or university.

It is to be hoped that when delegates are sent, they will be men of ability and firmness, who will stand for irrigation interests on practical lines. Last year the proposition carried to have the irrigation fund extended to the benefit of Texas, which has no United

States lands within its boundaries, and which could not possibly contribute a cent to the irrigation fund. The State owns its public lands, and if it wants the irrigation reclamation system, nothing is easier than for it to adopt it as a State proposition, put up its own money and do its own work. But the idea of the National officers going upon lands of a State, where the Nation has no claim, and spending Federal money there under the irrigation act, whose fund comes exclusively from the sale of National lands, is preposterous. This action should be reversed at the coming session, if the congress does not wish to stay ridiculous.

That El Paso convention fell into the hands of foolish and crafty persons who caused it to declare itself upon certain other questions which it should have let alone. We trust that a spirit of wisdom will prevail at the coming session in Portland. Otherwise, the Irrigation Congress might as well go out of business.

A Farmer's Legacy.

A writer in a Western exchange says some good words for a man who recently died at Orland, California, who left a legacy that may be appropriated by every farmer and orchardist on the Pacific Coast or elsewhere. It is not a legacy of dollars nor lands, nor garden seeds; but of suggestion and example. A legacy that is of more value —if one counts the successes of farm life—than money or lands. Samuel C. Cleek bought an acre of ground twenty-seven years ago in a field of stubble from which a wheat crop had just been cut. It contained no running water. It was an uninviting place to begin the making of a home. But Mr. Cleek had energy and a full brain pan. He had but a few dollars, so he housed himself and wife in a cabin of one room. That was the best he could build at the time. Thenhe got water, by irrigation, on his land and laid out the little farm in the most economic fashion. The acre produced enough in the twenty-seven years to keep his wife and himself comfortably clothed and well fed and to add three more acres by purchase, and to leave four thousand dollars in bank for the wife when he came to die. This unique and famous acre was described in the March number of *Orchard and Farm,* showing the greatest variety of products from a single acre of ground that has been recorded in America. In Europe and in some sections of the East the limited acreage obtainable demands the most rigid economy in the tilling of the soil. But in the West there is land to spare, and it is this fact and the comparative cheapness of it that induces extravagance and carelessness. Originally Mr. Cleek's economy was caused by poverty. But thrift and economy, as practiced by him, were the birthright of a man who started right in life—and who ended right. He did not become a rich man. Probably he had no desire for riches. But his famous acre represented the expenditure of time and intelligence and energy devoted to the science of farming, that was of greater account to a man of his character than riches. He lived a quiet, contented and happy life, and gave to the farming world something to thing about and profit by. So this is the legacy that Farmer Cleek left to his fellows everywhere: an object lesson in economy, thrift and wisdom applied to the tilling of the soil with the aid of irrigation. To be sure, Mr. Cleek was not the only economic and intelligent farmer of his day. There are thousands of them; but there are also many others that would with a deal of fear and trembling face the problem of the single acre and the one-room cabin.

Cook County, Oregon.

Crook County, Oregon, once a barren sagebrush and juniper desert, will soon be a paradise. What has long been known as the Deschutes valley desert is fast becoming a garden of the Northwest. Water has been turned on about 40,000 acres of the decomposed lava soil, where vegetation shows rapid growth and richness. An irrigation company is under contract with the State of Oregon to construct the canals and laterals to irrigate 140,000 acres of these lands. Another contract has been let to irrigate a large tract south and east of the first segregation, making a total of 214,912 acres of the lands reclaimed by the State.

The land is deeded to the applicant by the State land board at the average price of $10 per acre. The price has been fixed by the State board for the actual cost of irrigation.

About 30,000 acres of these lands have been sold to people of Oregon, Washington, Idaho, Montana, Wyoming, Colorado and the middle western states.

Seventy-six teams were recently counted in one day on their way to these lands. The teams were loaded with merchandise, implements, household effects, from Shaniko, the present terminus of the Columbia Southern Railroad. The land is deeded in 80 to 160 acre tracts, of which many will soon be in cultivation for future homes.

The water is taken from the Deschutes River, which is fed by the immense springs and snow capped mountains at its source.

The Deschutes River flows 3,500 cubic feet of water per second, as estimated by engineers. The canals are of the gravity system, and no dam is required to take the water rom the river.

The Deschutes River has long been known as a famous river on account of its uniform flow, varying but a few inches from month to month, and also for its swiftness, numerous rapids and its falls. The highest fall is forty feet, almost perpendicular, which could furnish ample power for factories and electric lines.

Surveyors have run cross lines and section lines on the lands. Contour lines have also been run. A report from R. W. Thatcher, chemist of the Washington State

College of Pullman, Wash., on the analysis of the soil shows it to be rich in lime and potash. The soil at three feet is almost as rich as the surface soil.

It his immense bodies of yellow pine timber surrounding to furnish fuel and lumber. There is plenty of game, such as deer, antelope, geese, ducks, grouse and sage hens, and it is a poor angler who can not basket a hundred speckled trout in a few hours, as they are abundant in every stream and lake. There is attractive scenery for the tourist and settler, such as Mount Hood, Mount Jefferson, Mount Adams, and taken all together this is a desirable location for a home.

Kennewick, Washington. In our issue of September will appear an illustrated article on the Kennewick, Wash., irrigation district. This is a country of great possibilities and with a very low altitude, 362 feet above sea level, insures a mild winter climate and an exceedingly long and early growing season, the season opening three weeks earlier than at points of higher altitude further up the Yakima Valley. This section offers splendid inducements to prospective settlers who are figuring on securing small tracts of five, ten or twenty acres under irrigation.

PUT IN IRRIGATION PLANT.

E. R. Cowdrick, the well known pork packer and life insurance agent of Napoleon, Ohio, has put in an irrigating plant on his farm. It consists of a gas engine plant on the river bank, which forces the water through nearly 1,000 feet of pipe to the house, barn, peach orchard, garden, etc. The engine will force the water through six hydrants at once, or throw an inch stream to the top of the house or barn.

It is so placed as to be used to irrigate one-half of the farm at present, and can be extended to cover it all. Mr. Cowdrick has, so far as we know, the only irrigated farm in Ohio.

INDIAN AS AN IRRIGATOR.

Texas has at present about 300,000 acres of irrigated land, of which 75,000 acres are planted in ordinary crops and 225,000 in rice. For years stock raising had been the only industry of the arid and semi-arid portions of the State, but the homesteaders of the last decade have cut up the great ranches into small farms and created a demand for water with which to make their crops grow.

Cotton fields are pushing their way now into western Texas. The rice fields are confined for the most part to the coast country, but the belt of irrigated land where general farm products flourish extends from El Paso to the Guadalupe and from the Rio Grande to the Red River on the north.

IRRIGATION KNOWN TO INDIANS.

Irrigation, however, is no new thing in Texas. It must not be forgottetn that the Lone Star State is a commonwealth with the romantic history that befits a border State. Long before it became a republic the Indians were irrigating land along the Rio Grande. Afterward the Franciscan friars, who came with the early Spanish conquerors, carried on irrigation for the cultivation of their fields in the southwestern part of what is now the State of Texas. In the northern and central parts of the State irrigation has been carried on to a limited extent for many years.

For some time irrigation development in the Pecos and Rio Grande valleys has been retarded by the lack of water supply which the heavy demand on those rivers in New Mexico and Colorado occasions. There are many places, however, in the trans-Pecos country where impounding dams might be constructed across narrow canyons or gorges to form reservoirs for the storage of flood waters.

IMPOUNDING RESERVOIRS NEEDED.

The use of impounding reservoirs has not entered largely into the irrigation economy of the State, but as the demand for water grows, attention is turned to this source of supply and the storage reservoir at Wichita Falls will soon be duplicated at scores of other points in Texas. San Saba valley, above the town of San Saba, is one of the most fertile sections in the world and definite plans have been made for the construction of a dam across the canyon eighteen miles above the town to form an immense storage reservoir from which water can be conducted to the valley below.

This canyon is fifty miles in length and, by means of series of dams and canals, it is believed that 40,000 acres above and below the town might be made to form an immense storage underditch. Irrigators along the stream from the head of the canyon to the springs already have taken practically the entire normal flow of the stream, making any system in the lower San Saba dependent largely on storage water.

SUNNYSIDE DISTRICT, WASHINGTON.

The Yakima valley, comprises about nine-tenths of the irrigated area of Washington, while nearly one-third of that area is comprised in the Sunnyside district. The Sunnyside irrigation enterprise, owned by the Washington irrigation company, is not only the largest in the valley but the largest in the Northwest and one of the largest in the United States. For this reason and the further reason that the writer is more familiar with it than with any other, the Sunnyside district will be described at some length and in greater detail. Much of what is said with regard to its crop productions and general advantages would apply with equal truth to the entire valley or in fact to any of the irrigated districts of the State. The main canal is fifty-seven miles long and there are about 500 miles of branch canals and laterals serving an area of 65,000 acres. The intake is about 7.5 miles below North Yakima. Here a dam has been thrown across the river, built of steel upon a concrete foundation, the canal lined with masonry for some distance above and below the headgates. which are massive and of approved design; and a modern stone residence house has been built for the gate-tender. The canal has a bottom width of thirty feet, top width of sixty-two feet and depth of eight feet with side slopes of one foot in two. The grade is fifteen inches in 5,000 feet and its present initial capacity is 800 cubic feet of water per second. The company's appropriation from the Yakima River is 1,050 second feet.

GEOGRAPHICAL.

The Sunnyside irrigation district begins in the highly improved Parker bottom, eight miles down the river from North Yakima, and extends along the north bank of the river for fifty-seven miles, the present terminus being about two miles north of Prosser. The lands are bench lands and form a part of the wide valley through which the Yakima River flows for eighty miles after passing Union Gap. The lands reclaimed by the Sunnyside canal border the Yakima River for fifty miles in an oval shaped tract, having an extreme width of eight miles. The territory is accessible to the Northern Pacific railway just across the river, the average wagon haul to stations being about eight miles. The distance will be reduced through the construction of the Sunnyside railway connecting with the Northern Pacific at Toppenish, to an average wagon haul of about two and a half miles. The surface is rolling, undulating or gently sloping with a general trend to the southeast. Its exposure to the forcing rays of the sun has given it its appropriate name "Sunnyside."

COST OF PREPARING LAND FOR CULTIVATION.

The cost of clearing, grading and placing water upon the land in the Sunnyside varies, but does not ordinarily exceed $12.50 per acre, which will place the land in condition for planting or seeding. The surface is covered with a dense growth of sagebrush and it is customary to first run a steel rail, or "railroad iron," over it, a team being hitched to each end, for the purpose of breaking down the sagebrush which is then uprooted with a mattock, a good worker being able to grub an acre a day. The sagebrush is used for summer fuel or burned or placed upon the highway, making, when worn down, an excellent road. After removing the sagebrush the land is plowed and the knolls or hummocks are cut down with a "slip," or Fresno scraper or a so-called buck scraper to which four horses are hitched, the dirt being deposited in the depressions. A leveller or smoother consisting of two long timbers with six cross pieces which catch the high points and carry the earth into the lower places is also used.

Irrigated Field, Sunnyside District, Washington.—[Said to be best illustration of furrow irrigation ever produced.]

METHODS OF APPLYING WATER.

Practically all irrigation in the Sunnyside district is by the furrow system. This consists in marking the land to be irrigated with shallow furrows about three feet apart, although on new ground they are often made only eighteen inches apart. The furrows follow the general slope of the ground and lead at the upper ends to the head ditch or flume. From the head ditch the water is turned into the furrow through small pipes or spouts from two to three feet in length made by nailing four laths together. One end is run through the bank of the ditch and the other extends to the furrow. The flow is regulated by a button upon the end of the spout.

If flumes are used holes are bored through the side and the flow regulated in the same way by means of a button. The soil is well adapted to the furrow system, which method also admits of the least expense in preparing the surface for the application of water. The length of the furrows depends upon the grade and character of the soil but should not in any case exceed forty rods and in most cases twenty rods is preferable.

LANDS IN CULTIVATION.

The crop area of the Sunnyside district is increasing at the rate of from 5,000 to 8,000 acres per year. During the season of 1904 there were in cultivation 27,219 acres and next year at the same rate of progress something over one-half of the lands under the canal should be in crop. The crop table for the year is as follows:

Crop.	Acres.	Yield. Per Acre.	Total Tonnage Yield.
Alfalfa	17,214	8	137,712
Timothy and Clover	3,758	4	15,032
Orchard	3,342	8	*5,600
Potatoes	870	10	8,700
Corn	264	1.5	396
Hops	317	1.25	396
Miscellaneous	1,454	5	7,270
	27,219	..	175,106

*From bearing orchards.

In verification of the figures for tonnage yields on various crops it may be stated that the writer had occasion recently to interview some of the leading farmers of the country on this subject and the averages of twenty-three statements in writing which they were willing to verify under oath are as follows:

Main Ditch, Sunnyside, Wash.

	Tons. Per acre.
Alfalfa	8
Timothy and Clover	5.5
Orchard	12.7
Potatoes	13

It will be noted that these figures are generally higher than those given in the above tables which give the general average, there being some farmers undoubtedly who are not as successful as these individuals.

MARKETS.

The great bulk of the hay crop is sold to stockmen and fed in the country to cattle and sheep which are driven in from the surrounding ranges for winter feeding, the usual price being from $4 to $5 per ton in the stack. Perhaps 20 per cent of the crop is baled and shipped to Puget Sound and Spokane markets or to intervening points along the lines of railroad. Vegetable crops are principally marketed on the Sound, although many carloads of potatoes which are of superior quality annually go to eastern markets. Fruits go both east and west and are always in strong demand because of their excellence in appearance, quality and flavor. Notwithstanding the large apple crop of the East during the season of 1904 many carloads of winter apples were purchased here by eastern buyers at $1 per box and upward for shipment to the Chicago markets. In brief, it may be stated that the market environment of the Sunnyside district is one of its strongest features.

Bar yard and Orchard, Sunnyside, Wash.

PROFITS OF FARMING.

After what has been said regarding tonnage yields and markets it is an inevitable conclusion that farming pays. Net returns of $30 per acre upon hay land and from $100 to $500 per acre upon hops and fruits are the rule rather than the exception. It is a fact frequently commented upon that in no other new community can be found so large a percentage of contented and prosperous farmers.

SCHOOLS, CHURCHES, ETC.

An irrigated country naturally attracts the intelligent and enterprising American citizens, and fully 75 per cent of the people are of that nationality. As a consequence the countryside is dotted with schools and churches, there being now fifteen churches and thirty-two school houses in the Sunnyside district. There is a local telephone system with about 200 subscribers and the long distance system of the Pacific Telephone Company has four stations in the district. There are five rural free delivery routes in daily operation. The numerous fine residences and beautiful homes are a source of constant surprise to the stranger. The common objection to country life, isolation, does not apply to the conditions existing there.

LAND VALUES.

Raw lands with a water right sell at from $60 to $90 per acre; alfalfa lands from $125 an acre up; and bearing orchards from $200 to $500 per acre, according to varieties and improvements.

TOWNS AND VILLAGES.

Sunnyside, the largest town in the district, has a population of about 700, Zillah has about 250 and there are several small centers with a school house, church and store. The present population of the district, rural and urban, is about 6,000.

SUNNYSIDE CANAL EXTENSION.

It is proposed to extend the Sunnyside canal a distance of about sixty miles to cover lands in the lower Yakima and Columbia River valleys. This would also mean the enlargement of the present canal ultimately to several times its present capacity. The area of arable lands lying under the proposed extension will exceed 200,000 acres. Of this area 56,000 acres were selected by the State of Washington more than a year ago under the provisions of the Carey act. Under the

View of Sunnyside Canal, Washington, Mt. Adams in Distance.

conditions of said act the securing of title by the State to these lands is contingent upon their reclamation, which is provided for in proposals filed with the proper State authorities by the Washington Irrigation Company. The State's selection lists are now before the honorable Secretary of the Interior for his approval. Should this action be favorable, and there is no reason to anticipate otherwise, the construction of the proposed extension may be said to be assured. It is apparent that the consummation of the project will mean a long step in the advancement of the irrigation interests of the Yakima Valley and of the State at large. Further, it will lead incidentally to the creation of a State reclamation fund as already provided by law, of over $500,000, to be used in the advancement of general State irrigation projects, besides doubling, as already stated, the present irrigated area of the State.

The arid region of the United States has already assumed large importance in national affairs. It contains all that is left of the one time seemingly unlimited public domain. In its development lie the largest opportunities for successful home making and the consequent upbuilding of the nation. Upon a map of the United States it comprises one-third of the area and embraces a part of sixteen States and Territories. Point out one, or any part of one, that possesses the advantages of arid Washington in geographical importance of location, in existing and prospective transportation facilities, in the extent and variety of its surrounding resources, in climate and fertility of soil. Consider then that the value of water irrigation depends upon what can be grown with it. On this subject Elwood Mead, in "Irrigation Institutions," says: "In no part of the West, outside of California, can so many kinds of crops be grown on the same acre of land as in the irrigated valleys of central and southern Washington. Alfalfa meadows and prune orchards, hop fields and vineyards, apples, peaches and Hamburg grapes, all flourish alike in the open air, and the fields and orchards under the canals present a marvelous contrast to the light colored, ashy deserts which surround the watered areas. As Washington has no rival except California in the diversity of its products, it also is second only to California in the value of irrigated land."

It appears, therefore, that natural conditions, public interests, the individual interests of homeseekers, all favor and demand that the irrigation development of Washington, through Government aid, shall be given precedence over any portion of the arid West. To accomplish this end certain State legislation is deemed necessary by those in charge of the administration of the reclamation act. Irrigation development through government agencies and by the investment of private capital should go hand in hand. The one should supplement, not supplant the other. The great work already done by private capital should be safeguarded and protected. It is only through the recognition of these principles by the law making body that the best interests of the State will be subserved.

We are showing in this connection, along with several other illustrations, a cut of an irrigated field in the Sunnyside district, Washington. The original photograph of this was taken by Mr. Elwood Mead, of the office of Experiment Stations, United States Department of Agriculture, and is a good illustration of the process of furrow irrigation. Professor Mead had the photograph enlarged and colored and it was exhibited at the Paris Exposition. Mr. Walter N. Granger,

Sunnyside Canal, Wash.

of the Sunnyside district, to whom we are entitled for the use of this illustration, informs us that Professor Mead always considered it the best picture of furrow irrigation that he had ever seen. The picture represents a timothy meadow which was owned by Mr. Granger at the time the photograph was taken.

CURRENT WHEELS; THEIR USE IN LIFTING WATER FOR IRRIGATION.*

CONSTRUCTION OF CURRENT WHEELS.

CONSTRUCTION FOR A SWIFT CURRENT IN IDAHO.

(Continued.)

The wheel shown in Fig. 12 has been in use on Lost River, Idaho. It was built to raise water about ten feet for the irrigation of 2.25 acres in garden and grain. It is fourteen feet in diameter, with paddles six feet in length mounted on a shaft eighteen feet long, spanning the stream. The shaft is an eight by eight inch square timber. For six inches near each end it is turned round to form a bearing. The spokes are very substantial, being made of two by six inch material. Each paddle carries a 3-gallon pickle keg on one end. The kegs are set on a bevel, as shown in the figure. The device for raising and lowering the wheel is very simple, consisting of two uprights which support a pulley, beneath which a wooden bearing is hung by a ¾-inch rope. A piece of gas pipe is used as a windlass (Fig. 13).

When the wheel was built it was set between two supports at a point where the river is about forty feet wide, the supporting posts being driven into the bed of the stream at either side of the deeper current. The swift current in the center of the stream turned the wheel very satisfactorily for a time, but owing to the soft nature of the bed, which at this point is composed of coarse gravel, during the high water the current washed out a deep channel directly under the wheel and left it high and dry when the flood subsided. To obviate this difficulty, the wheel is to be remounted between two crib piers at a point where the river channel at high water is only about fifteen feet wide. In low water the channel is only about ten feet wide, the current being about five feet per second. This narrow channel of the river is only a few years old, and although it appears to consist of a hard cemented gravel, still it is by no means certain that in the course of time the wheel may not again be left stranded above the current.

Four hundred feet of lumber were used in building the wheel and twenty-five pounds of bolts, making the cost of material about $12, not including the buckets. The heavy construction of the wheel would be unwise under most conditions; but in a current as swift as five feet per second in low water and much swifter when the water is high, any but the most substantial construction would prove unsatisfactory. The notching of the main arms where they cross at the center of the wheel weakens them seriously. Were this avoided by placing one set nearer the middle of the shaft, leaving space enough so that the rim of 1-inch boards could be nailed on the inside of one set and on the outside of the other, two by four inch material would be strong enough. While the eight by eight inch shaft would sustain a weight at the center of over 10,000 pounds, still it is none too heavy for the wheel weighing 1,600 pounds; since it is evident that the friction in the bearings is greatly increased by a comparatively slight bending of the shaft.

The wheel raised sufficient water to irrigate the 2.25 acres in forty-eight hours, the water being applied four of five times in the season. It should then raise sufficient water for the successful irrigation of forty acres using the water for 160 days.

Wheel Operating a Rotary Pump, Yakima River, Washington.

*Courtesy U. S. Dept. of Agriculture.

DIRECT LIFT WHEELS IN IDAHO.

In the Payette Valley, Idaho, are a dozen direct-lift wheels of the same general type shown in fig. 14. This large wheel is very carefully made, fitting into a flume with only two inches clearance. The construction is shown in Figs. 14, 15, 16 and 17. The crude method of raising and lowering the wheel contrasts with its excellent workmanship. At the end of the season it is laboriously raised out of the water by jacks and is blocked up until the opening of another season. While in use it remains at one height regardless of the stage of the water.

In several ways the efficiency of this wheel could be raised. When the water is too high to run the wheel to advantage, part of it could be carried away in a second flume, leaving just enough running under the wheel to give the greatest speed. Or, better still, a "stop" could be placed in the ditch and the water run into the flume under a gate, giving it great velocity. In a great many cases a "stop" or "drop" already existing in a ditch could be utilized to good advantage in this way.

The cost of the wheel, flume, and supports was $150. For six years there were no repairs and no running expenses except for grease and for raising and lowering the wheel twice in a season. In the seventh year, 1903, repairs cost $50, mainly for a new shaft, and in subsequent years repairs will doubtless be required to the extent of $10 or $15 a year.

Chain and Bucket Operated by Overshot Wheel, Selah, Washington.

Twenty-five acres in alfalfa and fruit are irrigated by this wheel, the value of the crops raised being estimated at $2,337 annually.

WHEELS FOR RUNNING PUMPS.

A wheel operating a rotary pump is shown in Plate III. It is in use in the Yakima River, near Prosser, Wash. It is homemade, but a fine example of a cheap, serviceable wheel. Being suspended between two heavy timbers anchored in the banks, no expensive pier is required. The wheel is eleven feet in diameter and 17.5 feet long. The paddles are two feet wide of 1-inch stuff. The whole wheel is easily raised and lowered by one man by means of double pulleys and a windlass with long spokes, seen to the left of the center of the picture.

The main driving pulley is nailed to the spokes of the wheel, and is seven feet in diameter. A 1½-inch rope runs over this pulley, carrying the power to a 28-inch pulley on a countershaft. The driver on the countershaft is ten feet in diameter and is connected by a ⅞-inch rope to a pulley at the pump, which can be adjusted from eleven inches to a larger size, as speed requires. The pump shaft revolves thirty-two times to each revolution of the water wheel. The pump raises water forty-eight feet, and at full speed discharges one-third of a cubic foot per second. When the river is low much less is pumped.

The cost of the wheel was $40 to $50 for materials, or, counting the owner's time in construction, say $70 to $75. Of this cost $20 was for a steel shaft. The cost of the pump was not given, but was probably $75 to $85. The entire plant may have cost $200. It successfully irrigates eighteen acres in fruit and alfalfa, the land being valued at $20 per acre. The annual expense for rope, oil, and repairs is nearly $20.

In the lower Payette Ditch, in Idaho, are eight wheels, used to run pumps. One of these plants is here described as an example of a well-built and expensive outfit, which is, however, eminently successful. The plan and construction of the wheel are shown in Figs. 18 and 19. The wheel is connected by chain and sprocket to a 3-piston, 5-inch pump, which forces the water through 1,800 feet of 4¾-inch pipe to the upper side of the owner's ranch, thirty feet above the canal. The pump has three parallel pistons connected to eccentrics on the same shaft, so arranged that each piston in turn comes into action. The cost of the plant was as follows:

5-inch trible action pump	$165
3-inch steel shaft, 18 feet long	35
3 castiron flanges, 3 feet diameter	30
2 boxings for main shaft	8
Castiron sprocket, gear wheels, and chains	115
Lumber	60
1,800 feet of 4¾-inch galvanized iron pipe	274
Labor	50
Total	$737

Of this cost only about $120 is for the wheel. No attention other than daily oiling is required. As the plant was put in in 1903, no repairs have as yet been necessary. The annual cost for maintenance should fall below $10.

The amount of water raised is about 0 3 cubic foot per second, which is used to irrigate twenty-seven acres in fruit. Water is applied 145 days, making the total depth of irrigation in the season almost exactly three feet. The orchard of 2,500 young trees—prunes, apples, and pears—should, when older, yield an annual crop worth $5,000.

CHAIN-AND-BUCKET GEARS.

A water elevator of the chain-and-bucket type is shown in Plate IV. It is run by a 5-foot overshot wheel of ordinary construction, but since it is equally adaptable to current wheels, it is of interest in their discussion. The elevator consists of two endless chains running over sprocket wheels, each chain carrying twelve galvanized-iron buckets, as shown in the illustration. The lower sprocket wheels are thirty-two inches in diameter, set on a 3-inch shaft. The upper sprockets are twenty-one inches in diameter on a 1⅝-inch shaft. The sprockets are set eighteen inches apart and the distance between shafts is twenty feet. The cost of the outfit was given as about $250. Of this amount the chain cost $75 and the buckets $20. Estimating the four sprocket wheels at $10 each, the two shafts at $12.50, and the four boxings at $4.50 each, the cost of the lifting apparatus without the wheel was about $145. The owner found No. 77 chain too light and recommended heavy gear throughout for the constant service required.

A simple application of chain-and-bucket gear to current wheels is suggested in figure 21. The power is transmitted by a rope to one of the shafts—in this case

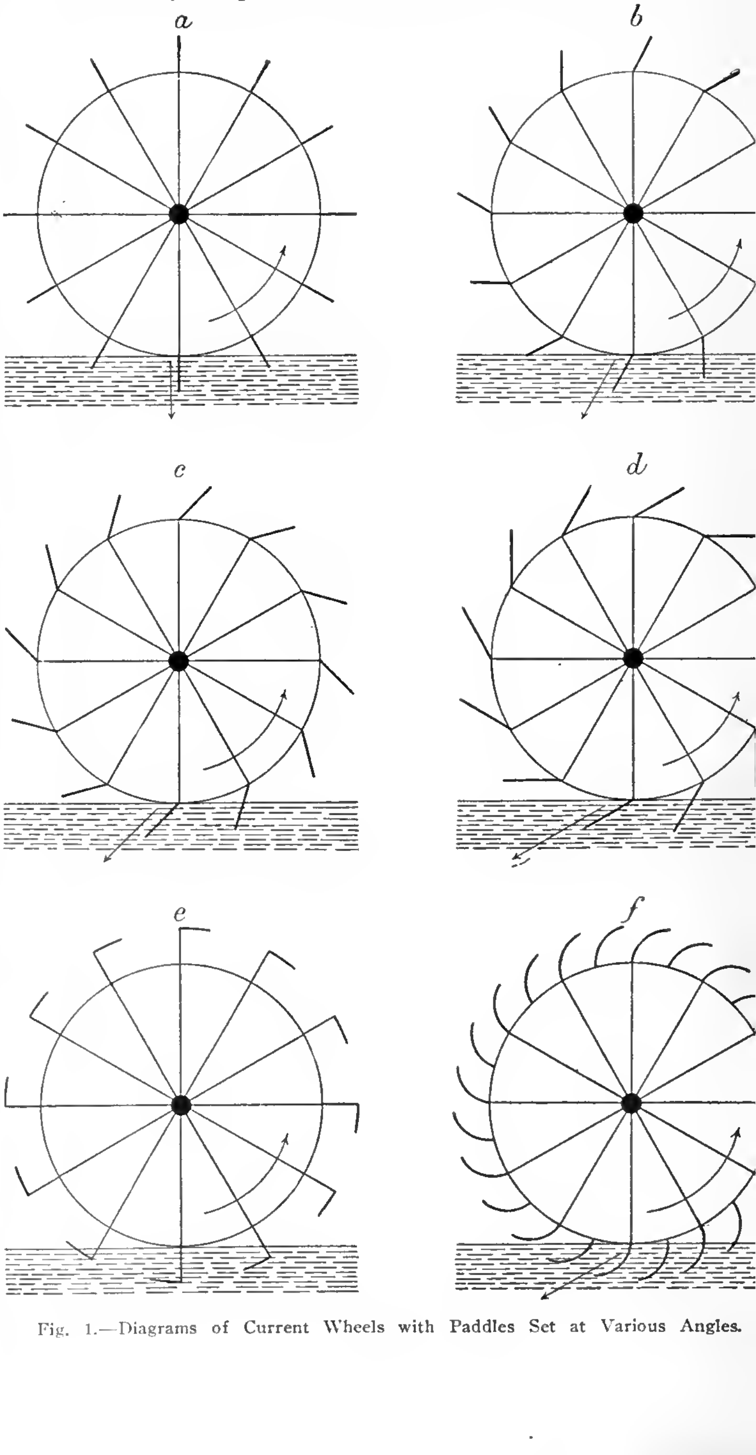

Fig. 1.—Diagrams of Current Wheels with Paddles Set at Various Angles.

the lower one. The arrangement makes it easy to place the whole apparatus near the bank of a stream, or, if desired, the elevator could be placed at any convenient distance.

ITALIAN CURRENT WHEELS.

Two wheels on opposite sides of the swift Adige River in Italy, just above the city of Verona, are fifty feet in height, raising water forty feet. The construction is the lightest possible owing to scarcity of wood in that region, the spokes being light single poles braced by two sets of still lighter strips. The rim is a continuous wooden box divided into compartments, each with a sort of trap door which opens when entering the water and closes of itself as it begins to rise. To this box or rim the paddles are fastened on either side, being nailed to cleats. They are braced at the ends by slender sticks run through holes bored in the paddles and keyed or wedged in place. It is usual to arrange two wheels with a flume between them, though the advantage of this arrangement is not evident. A wing dam turns the current into a flume running under the wheel.

A floating current wheel also in the Adige River, is used for operating a grist mill.

A typical modern current wheel in Milan, Italy, is used for power. The curved blades are made of sheet iron, the entire framework being of steel. The water runs swiftly down a sluice striking only the tips of the blades. Owing to their curvature, it slides smoothly up the blades, comes to rest, and is discharged with very little velocity. An offset in the tailrace just below the wheel provides ample waste way.

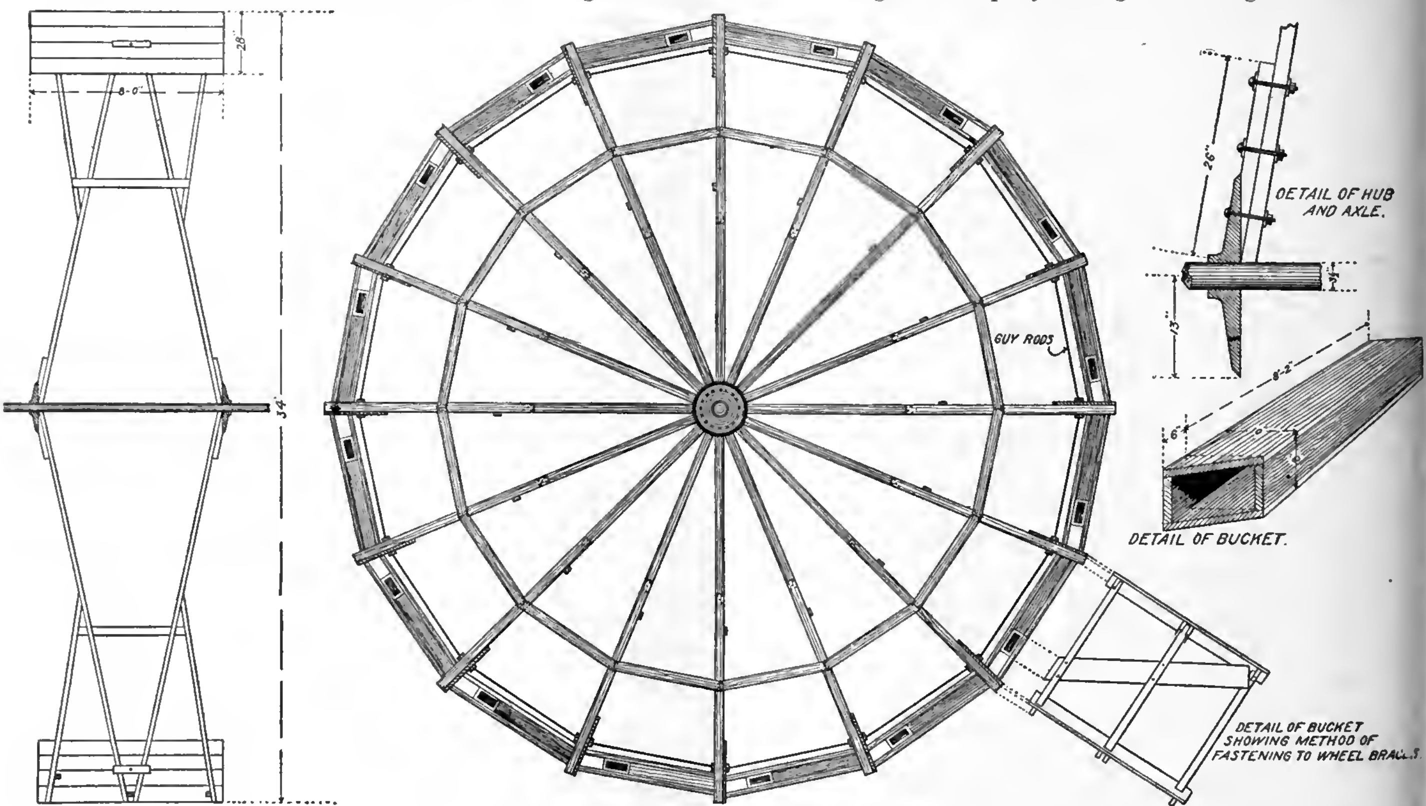

Fig. 2.—Wheel on Grand Valley Canal, Colorado.

THE TRI-STATE LAND COMPANY AND THE RECLAMATION SERVICE.

G. L. SHUMWAY.

One of the requirements of the Reclamation Service is that land owners under a projected canal must form a water users' association. That part of the North Platte project under the proposed interstate canal proceeded to do so. Understanding its primary initial purpose was to secure water subscriptions for deeded lands, the temporary board of directors was made up of the largest land owners, the original composite owning about half of the deeded land under the interstate canal and above the line of the proposed farmers canal.

This farmers canal is owned by the Tri-State Land Company, of which Heyward G. Leavitt is president. It has one of the oldest appropriations on the river and the original company has gone through various vicissitudes, including bankruptcy and sale under court orders to H. F. Walker, who transferred it to the present owner last November. Mr. Leavitt's company has acquired about 40,000 acres of land under this canal out of a total of about 70,000. The owners of probably 20,000 of the 30,000 acres not represented by this company are asking for Government water, but organizers of the water users' association deemed it prudent to eliminate such membership for the reasons—

First—It was believed that Mr. Leavitt's company held vested rights to water these lands.

Second—To keep free from litigation.

Third—Not to take a position hostile to private enterprise.

Fourth—Not to assume the responsibility which up to this date no federal representative has given us to understand the Government will sanction or assist us to maintain.

Consulting engineers have verbally expressed opinions. "I see no reason why you can not include this membership." "I guess the Government will take care of you" (this latter in a manner implying conviction) etc. As business men we want it stronger than a mere guess, and we do not desire to plunge ourselves into a controversy because some one "sees no reason why" we will not be sustained. There might be reasons which he does not see.

Mr. Blanchard says in a general letter where a probability exists that private enterprise will complete an exploited project, it is not the purpose of the Reclamation Service to interfere. We believe Mr. Leavitt intends to build the farmers' canal. John E. Field, the Government engineer in charge, professes not to believe so and has insisted upon a reorganization of the water users' association to commit it to the line of his opinion. The secretary, which was his selection, is noted mainly for his irrational antipathy to Mr. Leavitt.

Those who have had the temerity to criticise this action of Mr. Field, I regret to say, have had their motives impugned. They are accused of attempting to discourage the Federal enterprise. I do not believe an employe of the Federal Government is any less human than the rest of us. I believe one is just as susceptible of evil influences of human passions and prejudices and as prone to err, and criticism of executive acts should not be interpreted as an assault upon the majesty of the nation. If the particular executive referred to does not yet know, he has yet to learn that Federal employment does not make a man infallible.

Fortunately or unfortunately, we have here the ultra contention, the Federal reclamation and private enterprise. There is not in all the contemplated projects of any other locality so large a body of land susceptible of irrigation at moderate cost. The good business men and farmers of this locality with no ulterior motive save public welfare, have, since the inauguration of the work, sought to have each of the projects go forward with as little friction as possible. The work has been difficult for the reason that each of the interests have been too arrogant. Such position might be excused from the point of private enterprise, for it has natural desires for increased power and profit. But a Federal representative needs a developed power of repression, he should be comprehensive, firm and just, and while he is human, he should have strength to control his animosity, and not indulge in acts or expressions which might give appearance of personal venom. For instance, he should not call the "Tri-State Company the "Tri-Bluff Company," for our national dignity should demand of a Federal employe fair treatment and respectful comment when mentioning the humblest person or corporation in the nation. Whether in the right or wrong, these journeymen make up the composite of our glorious unity. We laud the American inspiration that impels the Federal servant to seek to make his work as great and grand as possible, we cheer examples of aggression which push forward Federal work with great rapidity, and we regret the tendency of some to take offense at these suggestions from us minions of the populace. But not so much do we regret as to deter us from our duty to our own community.

In any event I know one unit in the North Platte valley who will as fearlessly commend or criticise a reclamation personality or principle as he will an attitude of any corporation. If he displeases both *he will not fall for he is now upon the ground.* First he will make his arguments with those who offend his sense of justice or do violence to his deliberate judgment, and if unavailing there, the offenders will hear from him through press and other avenues until he exhausts his ingenuity. And this one knows the needs of west Nebraska, knows it soil and climate, productive capacity and what is necessary to its progress to the acme of perfection requisite for the maximum number of pastoral domiciles.

THE NORTH-WESTERN LINE CHICAGO TERMINALS.

A descriptive pamphlet with large scale map of its extensive and complete terminal facilities at Chicago has been prepared by the Chicago & North-Western Railway. This will be of interest to the industrial concerns located on these terminal lines, and more especially to those seeking new sites with adequate railway conveniences. Send for free copy to Industrial Department, C. & N. W. R'y, Chicago, Ill.

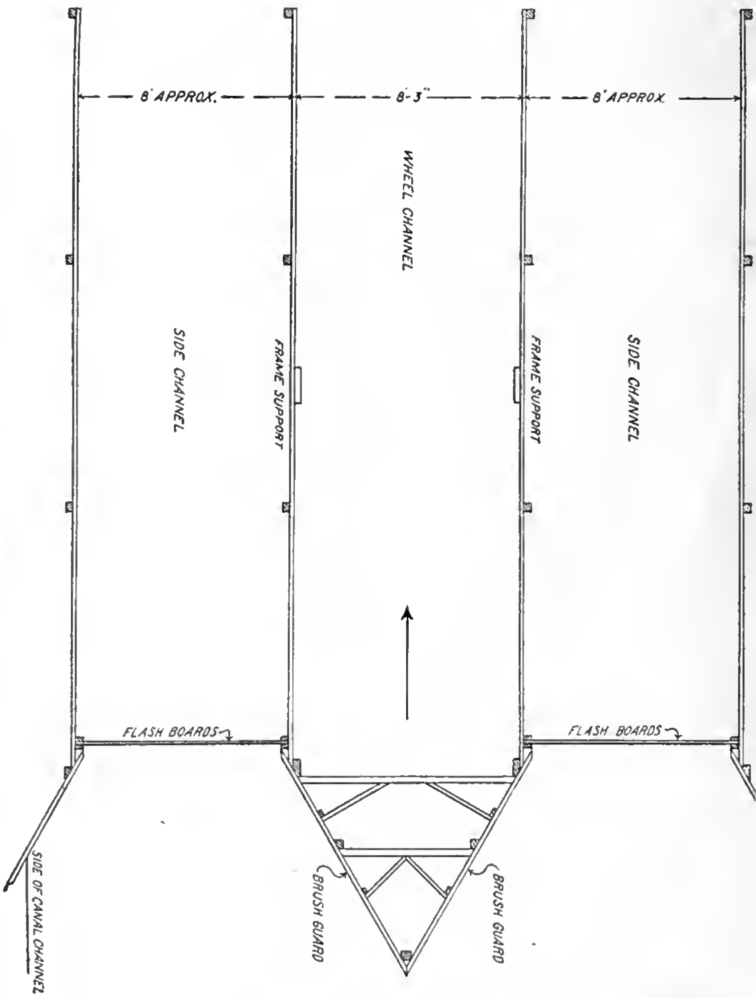

Fig. 3.—Flume and Brush Guards for Wheel on Grand Valley Canal, Colorad

IRRIGATION IN YELLOWSTONE VALLEY.

What It Has Done for Billings, Mont.

The Billings correspondent of a Wisconsin journal has just furnished his paper with an interesting article dealing with the irrigation question as it relates to the Yellowstone valley. The article follows:

It is only recently that the horseback farmer of eastern Montana has either been made to dismount or has been driven so far back onto the ranges that he no longer impedes agricultural progress. For many years the only semblance to agricultural pursuit was sheep raising and the growing of alfalfa on the bottom lands to furnish winter food for the immense flocks. Then democratic wisdom intervened in the nature of the Wilson bill, now a matter of mere memory, only recalled as a lesson of comparative politics during campaigns, and the Montana sheep men were relatively reduced from princes to paupers. All this had its influence upon the past and future development of Billings, the metropolis of eastern Montana.

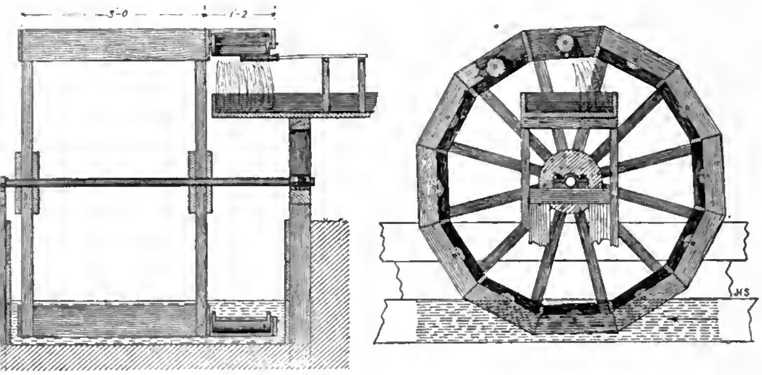

Fig. 4.—Wheel on Farmers' and Gardeners' Ditch, Colorado.

It is here that the conservatism and shrewdness of the East meet the progressiveness and energy of the West, and out of the amalgamation comes a city typical of the vast country of which it is the business center. Its metropolitan blocks, public buildings, commodious homes and all other features constituting what is without doubt one of the best towns in the Northwest disclose the secret of the city's growth and stability. This rests upon the fact that home money has made the town and no tribute is paid to eastern capital, in rentals, interest charges or dividends upon investments. Home men own Billings and its industries, its ditches, its far-stretching ranges and furnish the energy as well as the money to identify its remarkable successes.

METROPOLIS OF GREAT DISTRICT.

The city is not only the metropolis of Eastern Montana, but when the day comes to divide a territorial extent now over seventy miles long into two states, Billings will be the capital of the new State. This division may not come within the next ten years, but it is sure to follow the settlement now going on. The claim is made here that this is only a matter of time, and that Montana will be divided into an argicultural state in the eartern portion and a mining and manufacturing state, taking in the mountains and timber sections of the central and western part. The irrigation of vast areas now projected will induce a settlement of the eastern half and the population will be increased many times over during the next five years.

There is a method or system in city making. Towns in the East and Middle West of five times the population of Billings fail to make half as metropolitan a showing. Here it seems as though the entire "outfit" got together under the right sort of influences and the result is a surprise in the way of showing what men can do when they set about it in true western style. Conscious of the fact that Billings was and is a business center of importance, with home money sufficient for all legitimate development, its citizens organized to promote its best interests by attracting the attention of the outside world to its manifold business advantages. This plan differs essentially from the one usually pursued in city making, for many a good town, with excellent industrial advantages, has gone into the somnolence of a country cross-roads village because it waited for outside capital to come in and develop water powers or establish factories. Unmindful of the fact that there was enough home capital to do the work, these towns are still waiting. Billings makes no demand upon the outside world for its money, for it has enough money of its own and to spare. It simply calls upon the more densely settled sections of the country to contribute of their surplus population so that Montana's productiveness can be increased and its unoccupied lands placed under cultivation. Billings wants farmers with money if they can be secured, but the money part is not the all essential, for all here have such unbounded faith in the possibilities of the Yellowstone valley that they believe and know that any man willing to work and who is fairly intelligent in farming will succeed.

WAS STOCK COUNTRY ORIGINALLY.

Originally this entire section was given over to the stockmen; first the cattlemen and then the sheepmen, with their herds of thousands, ranging over a territory within this one county larger than the State of Massachusetts. The cattle business on the ranges failed to pay, and the stockmen then turned to sheep raising. This was profitably engaged in until Mr. Wilson of West Virginia, through democratic connivance and possible ignorance of specific Montana conditions, tinkered with the wool schedule. Neither scab nor foot rot, with general infliction and insurable effect, could ever have wrought more wholesale devastation with the sheep of Montana's hillsides, but it brought with it a lesson of incalculable value. It changed Eastern Montana methods as completely, almost as though strangers had taken up the work of developing the agricultural resources of the State.

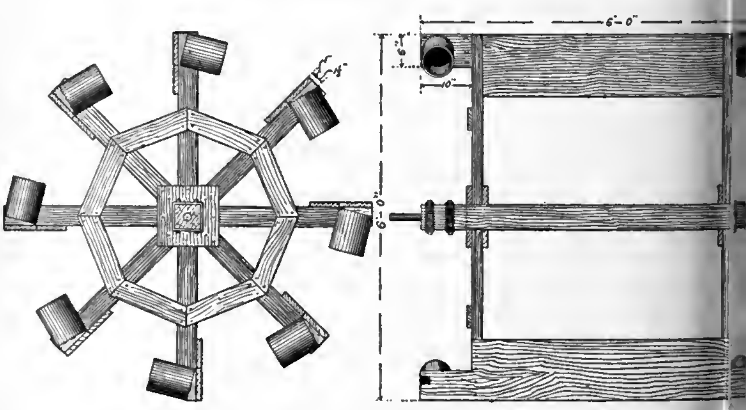

Fig. 5.—Wheel at North Yakima, Washington.

The old times were the days of free cattle and sheep ranges, when the river bottoms, the benches above them, the railroad and government lands were either

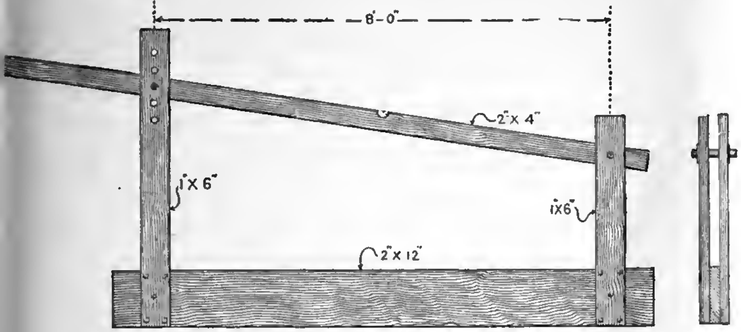

Fig. 6.—Lifting Device for Small Wheel.

absolutely free or subject to leases at low rentals. The Wilson bill schedule, whatever its cheapening effect to the consumer, put an end to the sheep industry in Montana. The lesson it brought was the fact that practically the only men who survived the blow were those who had, to some extent, engaged in alfalfa growing. These men managed to pull through the crisis and when better times came were equipped to re-engage in the stock business, while the range men failed to survive the wreckage. Dating from that time, as a result of the object lesson, Eastern Montana, or at least that part of it in the Yellowstone valley, turned its attention to farming.

RAILROAD STARTED IRRIGATION.

In 1882 the Northern Pacific reached Billings and the town was named after the president of the road at that time. Coincident with the building of the road, President Billings gave orders that an irrigating ditch should be constructed, tapping the Yellowstone River some forty miles west of this place, and the road and ditch were contemporaries in the progress and development of the valley. The ditch made it possible to grow crops and the road carried off the surplus production. It was years, however, before the land owners of the valley awakened to a realizing sense of the value of their possessions. The Billings ditch, as it is still called, was the first attetmpt made at irrigating in Montana, and its early day success was only lacking because of a failure to use it for farming purposes. When the time arrived that the stock ranges were abandoned and winter feeding adopted its utility and incalculable value became apparent. Today not only is the old ditch in use, but another canal has been constructed by the Billings Land & Irrigation Company which carries the water of the Yellowstone miles farther down the valley, and reclaims thousands of productive acres.

North Dakota's irrigation "congress" made sufficient fuss to get half a million dollars of the reclamation fund set aside for irrigating works in that State. Now the money will not be spent because the farmers who own land along the proposed ditches refuse to give the right of way for ditches, from which their own land may be irrigated, without being well paid for it. If there were not this universal habit of getting all one can out of the Government these farmers might be severely censured. As it is, they are simply doing what others do. They have, however, no complaisant secretary of the interior to deal with now.—*St. Paul Dispatch.*

DEEP FURROWS ARE BEST, SAYS PROFESSOR FORTIER.

The work of the irrigation department of the agricultural college for the year 1905 is the subject of a lengthy bulletin written by Prof. Samuel Fortier of California and printed by the department of agriculture at Washington.

According to Professor Fortier the irrigation work which is of most interest and importance is that to determine the effects of evaporation on surface land, shallow furrows and deep furrows. Experiments have been conducted at the Pomona station, where soil from various parts of southern California were treated by the various methods used by farmers in their irrigating, the result going to prove that surface flooding is the most wasteful and that deep furrows conserve much more water than do shallow furrows.

Experiments have been carried on at Berkeley to determine the effect of temperature on the rate of evap-

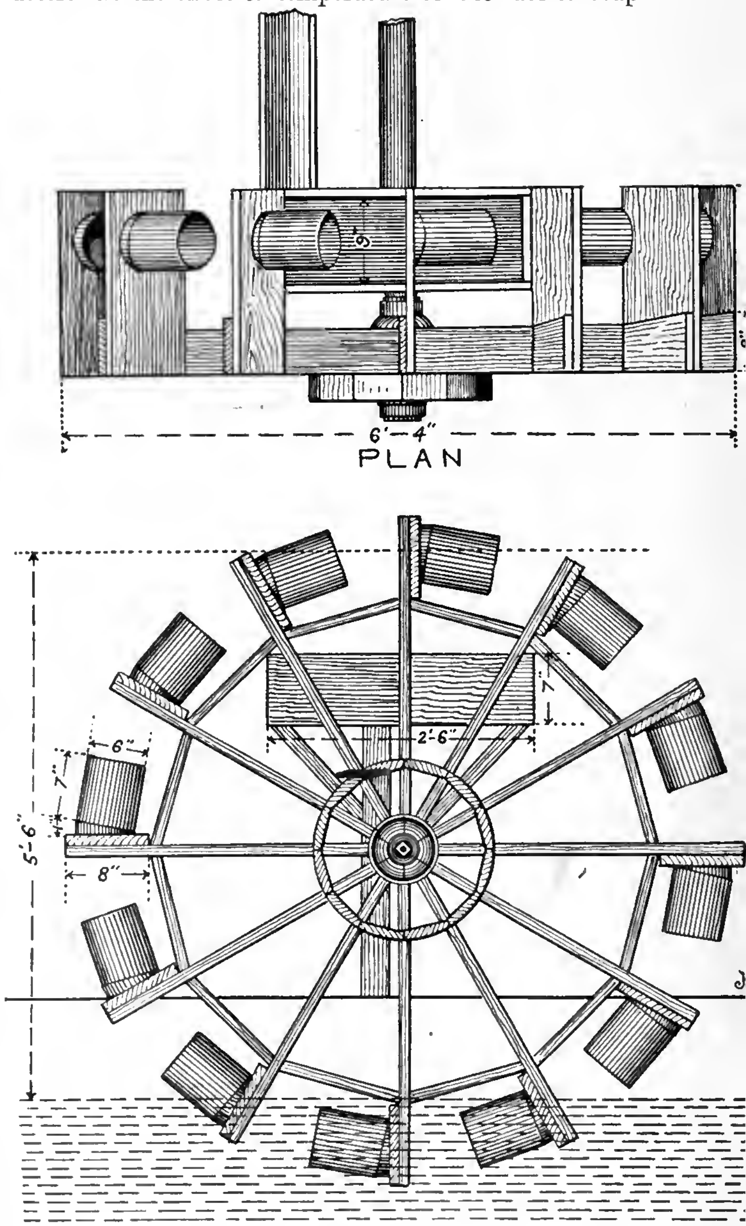

Fig. 7.—Wheel Near Morgan City, Utah.

oration. The amount of evaporation was shown to be largely dependent on the temperature of the water.

The effect of water on cereals in well-worn soils of the San Joaquin valley has been tried. The application of sixteen inches of water increased the yield of barley from nine to twenty-two bushels per acre. In a wheat field that produced only straw four inches of water produced a yield of ten bushels per acre, and sixteen inches of water increased the yield to thirty-eight bushels.

WATER FOR FRUIT.

An investigation into the value of irrigation in fruit orchards showed that the quantity of fruit increased where irrigation was practised and that the quality was superior. Hundreds of growers contributed testimony to this effect. Alleged injuries to fruits and vines by irrigation was found to be due to errors in irrigation and not to irrigation itself.

One of the most important branches of work planned by the irrigation staff of the university is declared by Professor Fortier to be now under way in southern California, where Dr. Loughridge is conducting a series of experiments in the orange groves to demonstrate what are the relative merits of shallow and deep furrows; how much more water is evaporated from a wet than a dry soil; what amount of water will produce the best results and when it should be applied.

Field experiments in irrigating wheat near Modesto by each of the three standard methods, namely, checks, furrows and flooding from first laterals, are being made. A continuation of the investigations of pumping plants, to determine how their efficiency may be increased and their cost decreased, is in progress.

The great Uintah reservation will be open for homestead entry August 28th, although registration will commence at Grand Junction, Colo., Price, Provo and Vernal, Utah, on August 1st and continue until August 12th. The procedure necessary to secure lands in this greatest of Government reservations is outlined in detail in a pamphlet just issued by the passenger department of the Denver & Rio Grande Railroad.

WIND AND WATER.

Professor Elwood Mead, chief of irrigation, Washington, D. C., has recently ordered shipped to Cheyenne, Wyo., a two-wheeled power windmill manufactured by the Double Power Mill Co. of Appleton, Wis. It is the intention of Prof. Mead to erect this mill on an experimental farm belonging to the government at that point for the purpose of pumping water used to irrigate the farm. He expects to order two more mills of the same make for like work in the western states.

Recent tests with this new design of windmill at the Iowa State College Experimental Farm leads him to extend the experiments to the far west.

It is to be hoped that Prof. Mead will teach those in need of irrigation just how to harness the wind for that purpose, and sooner or later the same good wind may be used by Edison to create power for his new storage batteries whereby electricity can be furnished for power, light and heat wherever the wind blows.

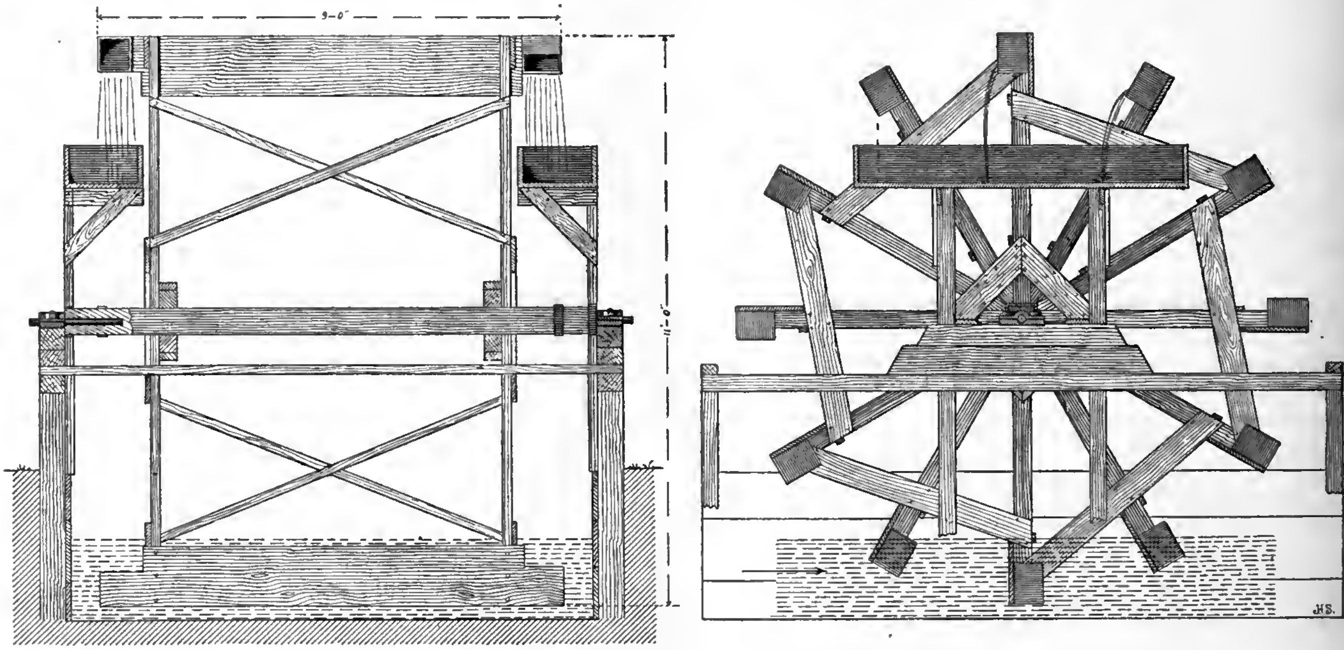

Fig. 8.—Wheel in Lower Natchez Valley, Washington.

Next we must look to the waves of the sea to create power for this same storage battery, but as we can all get nearer to the wind than the sea in this locality we would suggest sticking to our "first love," the wind.

AFTER MORE MONEY.

The following, clipped from The Globe-Democrat, St. Louis, of recent date, will give a fair idea of how the Maxwell-Boothe band organize and lay plans to secure contributors to their "two-man" combination known as The National Irrigation Association. If the gentlemen who are likely to join the St. Louis branch could know that other branches throughout the country have withdrawn from membership as soon as they learned about the history of the organization and that the two men, Maxwell and Boothe, are not able to control either legislation or development work along irrigation lines, they would not be likely to put up good money for some one else to spend. The ever decreasing membership in different sections of the country is evidence of the weakness of the deal. St. Louisans would better investigate before putting up their money. The only excuse for publishing the following is to illustrate the smoothness of the scheme:

"The St. Louis headquarters of the National Irrigation Association, in the Carleton building, were turned turned over yesterday to Tom L. Cannon of St. Louis, who succeeds C. B. Boothe, chairman of the national board, in the work of organizing the southwestern section. Mr. Cannon was elected general secretary of the association at a meeting of the directors held in Chicago a few days ago.

The board designated the St. Louis headquarters as one of the three general offices, and assigned Mr. Boothe to the New York office; George H. Maxwell, executive chairman, to the Chicago office, and Mr. Cannon to St. Louis. Mr. Cannon was formerly secretary of the St. Louis Manufacturers' Association. He will have as an assistant A. W. Hadley, of Owatonna, Minn. Mr. Hadley is a former newspaper man who has been actively engaged in the association educational propaganda for several years.

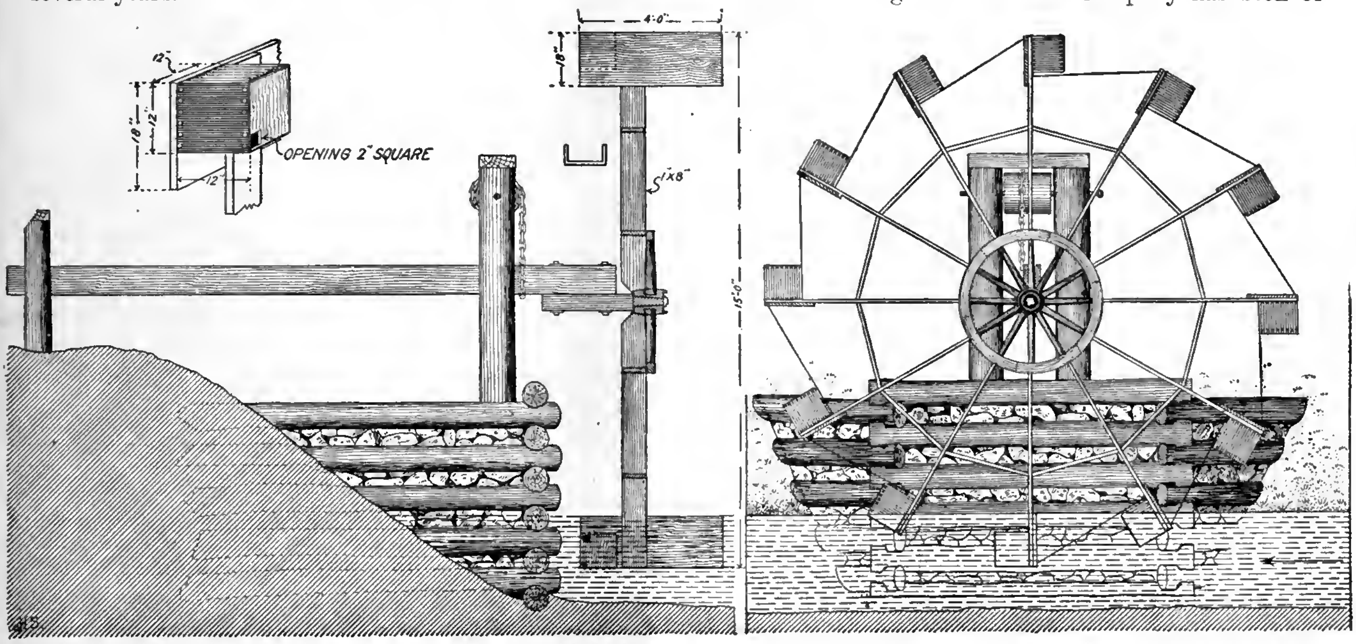

Fig. 9.—Wheel on South Platte River, Near Mouth of Bear Creek, Colorado.

The first important organization move for the southwest section will be the formation of a section advisory board, composed of ten or fifteen association members, representing important interests of the southwest. Several prominent St. Louisans will be on this board. Another division of the work is the organizing of a delegation to represent St. Louis at the national irrigation congress, which meets at the Portland exposition August 21 to 24.

OFFICERS FROM MISSOURI.

The officers of the congress for Missouri are: Otto L. Teichmann, honorary vice-president, and H. H. Wernse, member of the executive committee. Delegations are to be appointed by the business men's League, the Merchant's Exchange and the Manufacturer's Association. Governor Pardee of California, president of the congress, has invited Governor Folk to make an address.

Mr. Boothe will leave for Portland today on organization work connected with the congress. The official call for the congress has just been issued, fixing the apportionment for the states, cities and organizations. Members of congress and governors of states are ex officio delegates. Fifteen delegates are to be appointed by the governor of each state and ten by the mayor of every city of over 25,000 population. Two delegates are accredited to any duly organized irrgation, agricultural or engineers' society and two to each agricultural college. Mr. Boothe is of the opinion that the program will be the most comprehensive and exhaustive ever presented on irrigation and related subjects, while the attendance will exceed any previous session of the association.

CORRESPONDENCE.

Wenatchee, Wash., July 15.—Just across the Columbia River north of Wenatchee lies a flat of land containing nearly 6,000 acres, which at the present time is only dotted here and there by an occasional shack of the homesteader. This land is known as Columbia Valley, and it is now a settled fact that at least 3,000 acres will be irrigated. A stock company has been organized and the management of the affair is under the direction of Mr. Stewart, who has been connected with the Government reclamation service for two years past. Mr. Stewart is now on the ground and says his company will be able to furnish water for next season's crop for at least 3,000 acres at $80 per acre and $4 maintenance fee per acre. The water will be raised by means of an electric pumping plant, power for which will be generated at the fall of the Wenatchee River above Leavenworth and about twenty-five miles above its junction with the Columbia. The power developed will be about 5,000 horsepower, and can be increased at any time to twice that amount. The water will be taken from six pumping stations, above and below Wenatchee.

The soil of Columbia Valley is identical with that of the Wenatchee Valley, and with water on the land will be just as productive. Should the bridge now under contemplation across the Columbia River be built, this land will be worth just as much as the best irrigated fruit lands of the Wenatchee Valley. Already many contracts are being signed up, and another year will see great changes in that section of the country.

MONTANA'S HOPE IS IRRIGATION.

United States Senator Thomas H. Carter Talks About His State and Its Prospects.

Throughout the entire Northwest, as well as in the country at large, few men are better known than is Senator Thomas H. Carter, of Helena, Mont. His services as United States senator have done much for Montana, for his knowledge of conditions there was gained after years of closest observations. As commissioner of the general land office his experience and knowledge for a number of years identified him with public land matters upon which can be based an intelligent estimate of the situation in this State. In speaking of conditions in Montana, Senator Carter said:

"It appears to me that conditions here could not be better, in a general sense. Our copper production leads the world, for we produce from $50,000,000 to $60,000,000 worth of copper a year. Our gold production is $5,000,000 and our silver output amounts to twenty million ounces annually. The lumber interest of the western part of the State supplies our mines and leaves us a supply to ship to Nebraska, Kansas, Iowa, the two Dakotas, Wisconsin and Minnesota. I can not state the exact value of the lumber output, but it is of large proportions. The State has about 7,000,000 head of sheep and 500,000 head of cattle. It has an area of 146,000 square miles, being the third State in its area. Of this vast amount of land about 10,000,000 acres can be placed under irrigation, leaving 84,000,000 acres of free range land.

MILLION ACRES UNDER IRRIGATION.

"There are at the present time about 1,000,000 acres of land, in different sections of the State, watered by artificial irrigation. Individual settlers have located upon lands where the water from the streams can be diverted and made available by individual effort; thus, it occurs that the bottom lands contiguous to small streams were taken up by settlers and these embrace the million acres now tributary to the ditches.

"The second bench lands, requiring large canals, expensive head gates and dams on the streams beyond reach of individual capital, remain unreclaimed, and the recent movement by the Government for the reclamation of its lands in this arid region contemplates the construction of the large dams, canals and reservoirs necessary to reclaim these high benches. The Government now has three large projects in course of development within this State. The first embraces that vast empire known as the Milk River district, along the northern boundary of the State. Through this valley the Great Northern Railway extends for about 400 miles. The two remaining projects are in the Yellowstone Valley, along the line of the Northern Pacific Railway. The project east of Billings is intended to reclaim about 60,000 acres of land recently ceded by the Crow Indians to the United States. This body of land of unsurpassed fertility slopes gently from the foothills in a northerly direction to the Yellowstone River, from a point a short distance east of Billings to the town of Forsyth, the county seat of Rosebud County. The second project in the Yellowstone Valley will reclaim about the same amount of land between Glendive, on the Yellowstone River, and Fort Buford on the Missouri River.

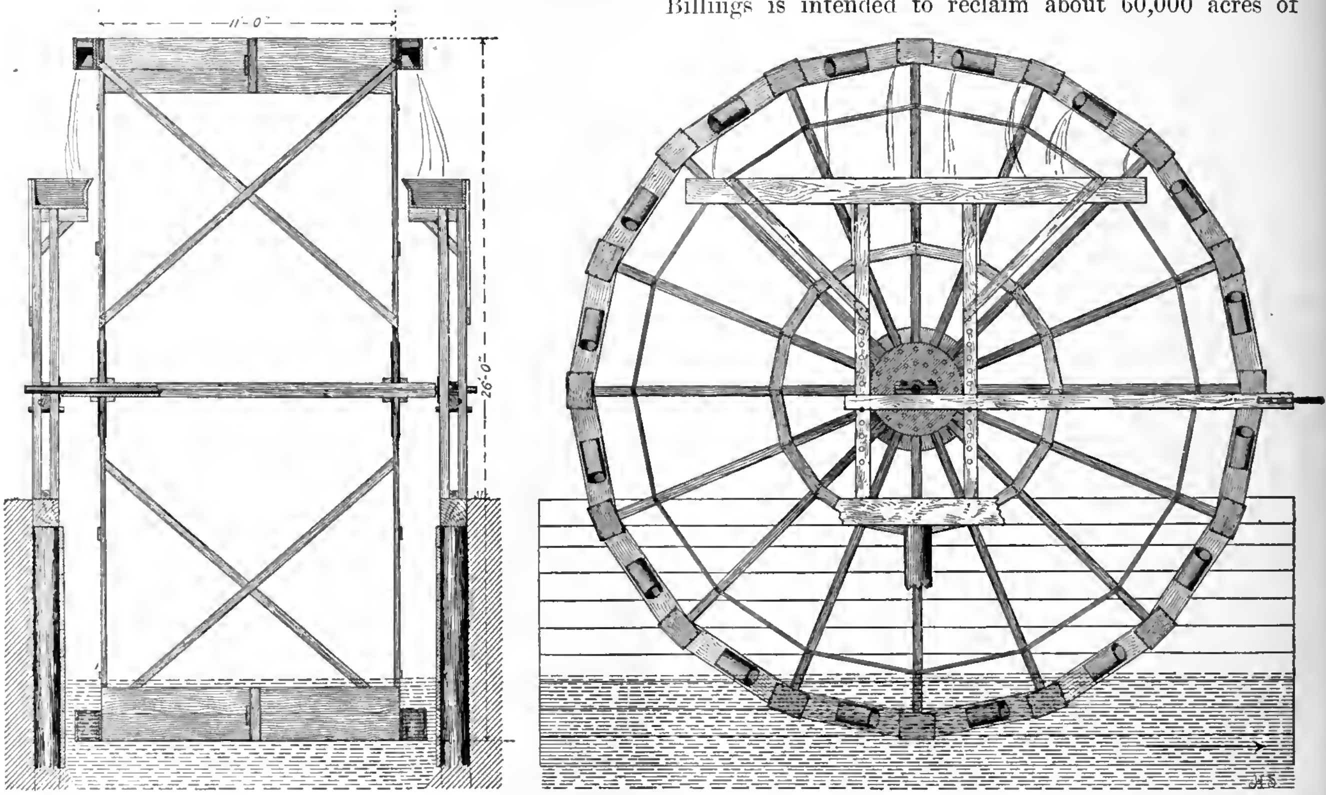

Fig. 10.—Wheel on Yakima River, Washington.

PROFIT ON ALFALFA IS $20 AN ACRE.

"Under the proposed Government canals, the soil is free and consists of an alluvial deposit ranging from five to forty feet in depth. The fertility of this soil as demonstrated by the small part reclaimed, surpasses belief. The alfalfa hay yield is three crops a year, with an average of one and one-half tons an acre moderately estimated, at each cutting. In many localities the production is from six to eight tons, and I believe that possibly the average yield would reach five tons per acre. In the fall this hay in the stack brings $5.00 a ton, and with modern machinery it is cut and stacked at not to exceed $1.00 a ton, leaving a net profit of $4.00 a ton, or $20 an acre per annum.

"When the fact is considered that alfalfa once set will endure indefinitely without reseeding, the raising of alfalfa as a business proposition presents a most enticing field for investment. It should not be forgotten that after the removal of the third crop, the alfalfa fields furnish luxuriant fall and winter pasturage. The foregoing calculation is upon the basis of a sale by the grower to a third party who desires to feed it to sheep or cattle. For the farmer who raises the hay and feeds it out to stock there is, upon a modest estimate, according to the reports of experienced men, from 30 to 50 per cent additional profit. In other words, this alfalfa is worth from $7.50 to $10 a ton to the farmer prepared to feed it to his own stock.

SIXTY BUSHELS OF WHEAT IS COMMON.

"Wheat is grown in Montana most successfully. While the census reports the average yield to be about thirty bushels to the acre, contact with farmers who actually raise wheat leads me to believe that less than forty bushels per acre is regarded as a short crop, and sixty bushels per acre is not uncommon. The development of an Oriental demand for flour in recent years provides a market on the west coast within an average of 1,000 miles railroad haul for Montana wheat, hence it occurs that the average price paid for wheat in this State equals the price in Minnesota, Wisconsin, or Illinois.

"The Montana oat crop has up to a recent time been wholly consumed within the State, but the demand for the crop has within a few years come from oat mills established East, owing to the unusual development of the grain and its especial adaptability to oatmeal manufacture. Formerly one cent per pound was the going price, but within the last two years the demand from the oatmeal manufacturers has been such as to increase the price to 1½ cents per pound. The average yield of oats ranges from 70 to 120 bushels per acre.

"What has been said of the development of the oat crop is equally true of the barley product. The far famed Gallatin valley has become a factor in the barley production of the country and the superior quality of the barley is attested by the demand for the entire crop coming from Berlin, Germany, Stockholm and Liverpool, where it is used for the brewing of high class beer and the various malt extracts. All is shipped by boat from Duluth and the crop is moved early in the season, before the close of navigation.

"All cereals of commercial importance produced in the United States are successfully grown in Montana, save and except Indian corn, which is, however, successfully produced in the Yellowstone valley. All kinds of vegetables are raised in quantities amazing to the outsider. Formerly the growth of fruit was not attempted. Some ten to fifteen years ago orchards were planted in the western part of the State and there great supplies of apples, pears, plums and cherries are now produced. From one small valley, known as the Bitter Root, 160 carloads of apples were shipped to the Illinois market. The success attained in fruit growing in the western part of the State led to experiments east of the main range of the mountains and it is now apparent that apples of the hardier varieties can be produced in any part of the State successfully. Vine fruits are especially adapted to eastern Montana and berries are everywhere raised."

WASTING WATER IN IRRIGATION.

E. L. Koethen in *Field and Farm.*

At one time it was considered desirable to make just as many furrows as could be crowded into the space between the trees. Now the best practice is to use but four or five furrows, or at the utmost, where trees are planted unusually far apart, six to the row. They should be made just as deep as possible for a great saving in water is effected by deep furrows. Of course, this implies deep cultivation, as among older trees the soil below the surface mulch is usually so dry when furrowing time comes that but little impression can be made in it with an ordinary furrowing plow. With young trees it may be necessary to irrigate before the subsoil is so much dried out. The drain on moisture is tremendous among large trees, but they also draw from deep-feeding roots that make them less susceptible to the influence of drouth.

The amount of water to irrigate a given tract is so variable and elastic that it is difficult to give exact calculations. Certain it is that with modern methods of cultivation and general care of orchards the required amount has been gradually reduced. When we first began irrigating for a five-acre orchard we used fifteen inches of water for three days of twenty-four hours, every thirty days during the summer months. Now we use fifteen and ten inches, a two days' run every six weeks on the same land and the orchard is kept in better moisture supply than it was then, with the trees thirteen years older. The scarcity of water in many sections during the intervening years has taught us all lessons that we do well to heed, the most important of which was that we were wasteful with our water supply when we had an abundance from which to draw.

In regulating the water it is convenient to have the rows numbered at the head and the lower ends. This will facilitate checking up in regulating the water. For this we use a very simple method, which might be called the plus and minus system. If in row one the first row is running too fast, it is marked plus. The second furrow may be too slow and must be marked minus. The third and fourth may have been running too fast and cut down too low and should be marked nought. It would then read thus: Row No. 1—one plus; two minus; three and four nought. This would mean to cut the first furrow down a little, increase the second and remove the trash from three and four so as to start them running again. Thus we go through the orchard, checking up at the lower end and then regulating at the funnels.

For the first few hours after the water has been started the gates are simply regulated by guess and occasional trips are made across the rows at increasing distances from the head ditch in order to see that there are no breaks in the furrows and to keep the stream in each within its own channel. By evening of the first day all furrows should be so regulated that the night may be passed without the water wasting. We usually begin at the upper end and regulate the water unless there is enough to furnish all the furrows at the same time, in which case we arrange the lower end with an overflow ditch so that if the gates should become clogged during the night no damage can be done. Otherwise the upper rows are finished first and the water gradually worked down to the lower end.

WOODEN WATER PIPE.

BY TREW LANIER, LOS ANGELES, CAL.

That wooden water pipe manufactured of redwood and fir staves is in close competition with cast iron and steel riveted pipe is a fact which a few years ago would have appeared absurd to those brought in direct contact with pipe and pipe fittings.

Now, however, wooden pipe is winning new converts every day. Especially is this true of the western States, and particularly so in California, where many miles of wood pipe are in use and giving entire satisfaction. There are many new towns in the West constantly being organized and opened up and the majority of these towns are installing wood pipe systems.

In northern California at Barber and Stirling City the whole water system is composed of wood pipe, which was installed by the National Wood Pipe Company. The Imperial Valley is also using wooden water pipe for supplying all the towns therein with water, the chief ones of which are Imperial, Holtville, Brawley and Calexico. The new town of Las Vegas, Nev., which the Salt Lake Railroad is backing, has but recently signed a contract with one of the largest wood pipe companies in the State of California and Dallas, Tex., is under contract with the Excelsior Wood Pipe Company to inaugurate a wood pipe system for that city.

Last month while in San Francisco I visited and was shown through the factory of the National Wood Pipe Company, whose headquarters are at that place. This company organized a few years ago in Los Angeles, Cal., and now is running large factories in Olympia, Wash., and Los Angeles and San Francisco, Cal. Pipe manufactured at these places is in use all over the Pacific coast and as far east as Colorado and Texas.

The small pipe, ranging from three to eighteen inches in diameter, is known as machine banded pipe, and is made from three or more wood staves banded spirally with a heavy steel rod which is thoroughly galvanized and passed through a bath of hot asphaltum as it is wound on the pipe under a regulated tension which seats it in the wood. This pipe is banded for pressures from 20 to 300 feet. The bands are spaced from $1\frac{1}{2}$ to $4\frac{1}{2}$ inches apart, depending upon pressure and size of pipe. The ends of the pipe are sawed off square and turned down to a slight taper. The joints are connected by cast iron collars which taper from both ends to the center to correspond to the taper of the pipe, but made one-eighth inch smaller to allow for compression in driving, which is done with a heavy maul and driving block, thus making a joint which will stand 200 pounds pressure per square inch even before swelling.

For the smallest pipe a galvanized rod is used more than four times as thick as No. 16 gauge steel pipe, and for pipe of larger size the rods are from five to seven times as thick as No. 16 gauge steel pipe. The weak joint in metal pipe is made strong in wood pipe by exposing the minimum amount of metal surface to rust and protecting that small surface with a coating of galvanizing and asphaltum much heavier than could possibly adhere to a large flat surface.

When one thinks of the fact that from 75 per cent to 95 per cent of the body of the rods must rust away before the pipe leaks from their yielding, it is readily understood why wood pipe is so durable. Soils abounding with mineral and alkali have a tendency to act upon iron pipe and destroy it, causing leakage and other trouble. Such soils do not affect wood pipe in the least and so it is the ideal pipe for conveying water to and from mines. The Cananea Consolidated Mining Company and the Detroit Copper Mining Company have both installed wood pipe systems recently for this reason, and the same is proving satisfactory in every respect.

Wood being light reduces the cost of transportation

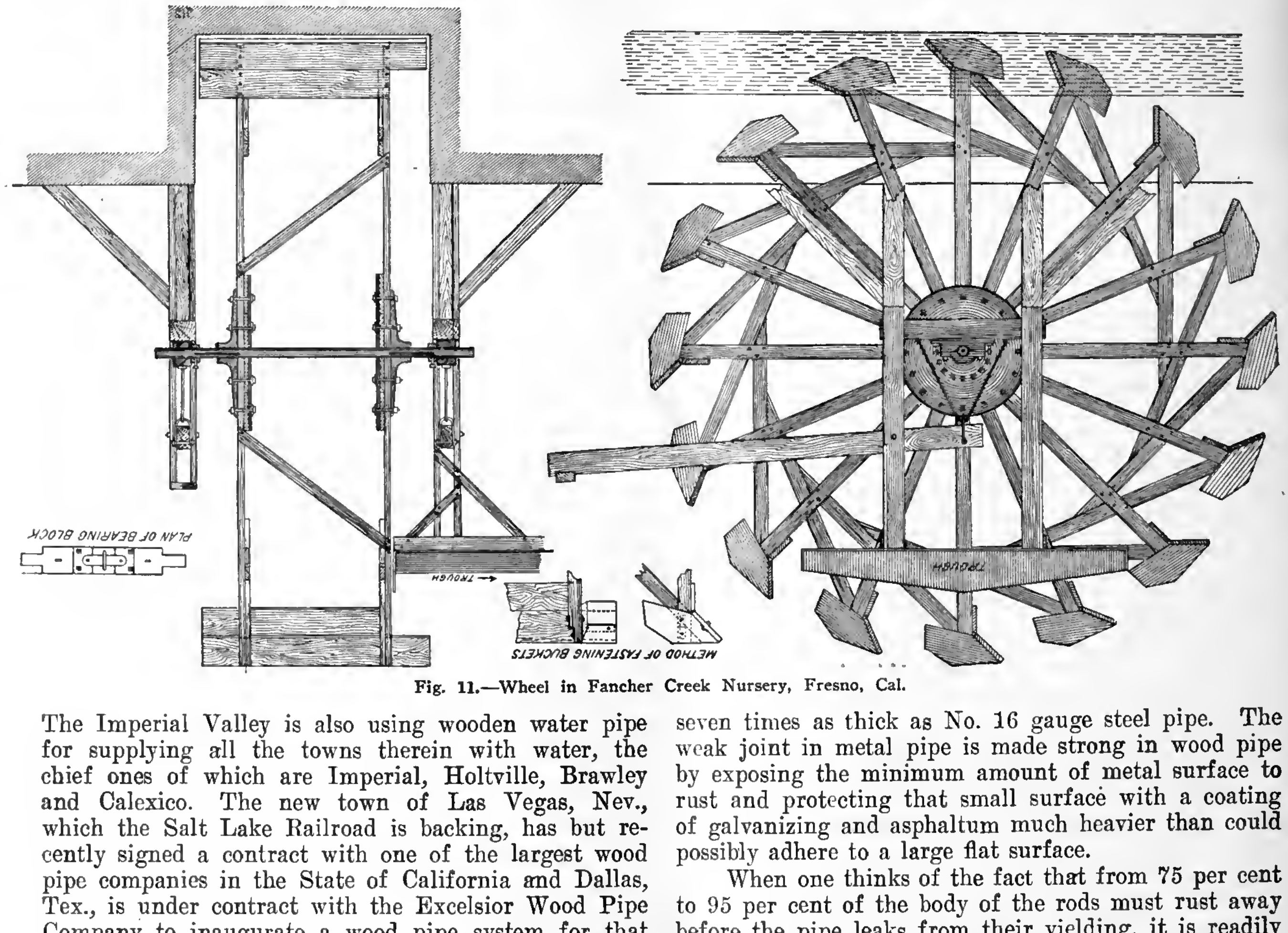

Fig. 11.—Wheel in Fancher Creek Nursery, Fresno, Cal.

considerably and this, together with the ease and rapidity with which it is laid, has much to do with its popularity. Wooden pipe is not considered a cheap substitute for cast iron, for it compares most favorably with cast iron. In addition to its comparative cheapness over cast iron it possesses the advantage of keeping clean inside, whereas iron pipe becomes covered with

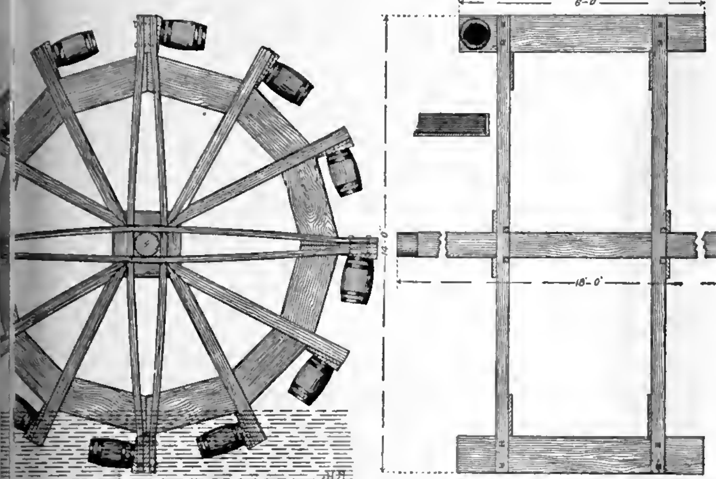

Fig. 12.—Wheel on Lost River, Idaho.

large tuberculations growing to the size of a walnut which in time naturally retard the discharging capacity of the pipe.

The fittings for machine banded pipe are made of cast iron and are protected by a heavy coating of asphaltum. So far as stave pipe is concerned, when it is well burned there is no danger of the wood rotting. The danger is confined to the corrosion of the bands.

The larger sizes of wood pipe are known as continuous stave pipe and in size it ranges from ten inches to ten feet in diameter and from 100 feet to 100 miles in length. This pipe is especially adapted for general irrigation work and water power systems. This pipe will carry water where fluming can not be considered. Inverted siphons are found more economical than a high trestle which carries the ordinary flume, to say nothing of the danger of the action of the elements upon the trestles, such as high winds, freshets when they cross river beds and other dangers. Continuous stave pipe can be made to carry water direct to the place it is desired the water to go. It is not necessary to wind it on an easy grade around a mountain side, as it is a flume, for it can be placed along the hill sides without regard to elevation or grade wherever there happens to be a natural foundation.

It is as durable as the best cast iron pipe and its carrying capacity is greater than cast iron or steel because it is smoother inside and remains smooth.

The following simple table furnished the writer by the National Wood Pipe Company, of San Francisco, shows the economy of wood pipe. The table is based on 6 per cent interest compounded annually on the difference in cost between wood and cast iron pipe.

Size.	Wood.	Cast Iron.	Difference in favor of wood pipe.	The interest on the difference in cost will rebuild
6 in.	$ .34	$ .65	$ .31	in 13 years
12 in.	.68	1.61	.93	in 9½ years
24 in.	1.60	4.32	2.72	in 8 years
36 in.	2.50	8.33	5.83	in 6 years
48 in.	3.60	14.29	10.69	in 5 years
Average				6½ years

Continuous stave pipe, as the name implies, is always built continuously in place. The material which is shipped in knocked down form, consists of wooden staves, wooden tongues in boxes, straight steel rods in bundles, and cast iron shoes or clips in boxes or barrels. The stave ends are slotted and joined together by means of a patent oak tongue. These oak tongues being of the same substance as the staves, swell and make a perfectly tight joint when wet, and do not corrode or rust.

While wooden pipe was used in Boston from 1652 until 1796 before iron pipe came into use, it is only comparatively recently that wood pipe has become perfected. Though it has been pushed in the background during the development of iron and steel pipe, it is being recognized by leading engineers as fully equal, if not superior, to cast iron and steel. Particularly is

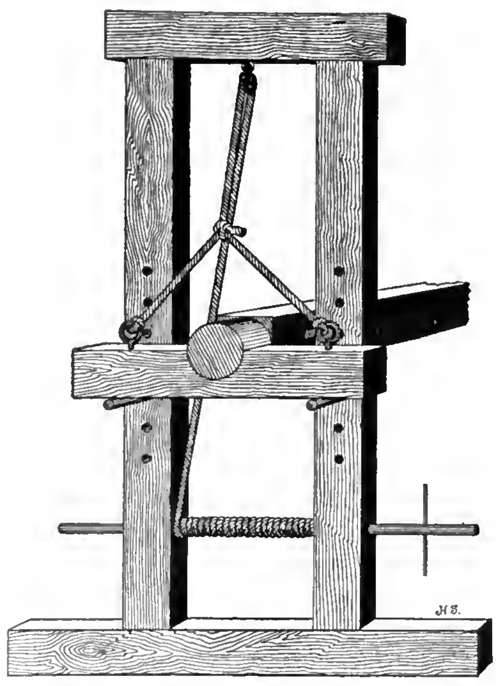

Fig. 13.—Lifting Device for Current Wheel on Lost River, Idaho.

this true where the soil is of adobe or alkaline in nature and when water is mineral or aciduated.

The irrigation and development of water in the West and Southwest, particularly, will greatly stimulate this industry, which seems to have reached a very promising stage.

FAKE IRRIGATION DITCHES AND RESERVOIRS.

A correspondent of the *Washington Star* has the following to say concerning methods employed to cheat the Government:

Among the various land frauds that have recently been brought to the notice of the Interior Department there is a new one in relation to the desert land act. This act provides that a settler putting land under ditch can take up 320 acres. Desert land, within the meaning of the act, it is declared, is about as productive as the top of a dining table until there is water on it, and then it will usually raise phenomenal crops. Some of the very best fruit and vegetable crops in the United States are raised off desert land under irrigation. Turnips weighing twelve pounds and peaches that are too big to bite into are not at all uncommon under irrigation. So the one time worthless desert land is not a bad thing to own, especially when there is a chance of either the Government or a private company furnishing a ditch for it.

Land frauds of all sorts have been abundant in the West, some of them supposed to be perpetrated with the connivance of the land office and others that it is hard to detect unless an inspector of the department actually gets on the ground. The latter sort have been perpetrated and attempted extensively in connection with the desert land. The Interior Department has recently received a picture of one of the fake "reservoirs and ditches" under which the thrifty settler proposed to add 320 acres to his domain.

The "reservoir" was described as "a stone embankment" inclosing a natural reservoir site, while the "ditch" was large enough to bring sufficient water to irrigate the land under the reservoir. The picture shows Mr. Chadwick, one of the department's inspectors, standing in the middle of the reservoir, which would not have retained a jack rabbit, much less a gallon of water.

The ditch was a furrow scratched by a plow alongside the site of the "reservoir." The cost of the whole construction was not over $10, and the only reason that the work was done at all evidently was the mistaken idea on the part of the claimant that the work was enough to save him from the penalty of perjury if the case was investigated.

This sort of "reclamation" has been done on a large scale, farmers on adjoining tracts swearing to each other's affidavits that the reservoir building has been done. These claims come in to the department, and unless an inspector happens to be available to go directly to the ground, it is said they stand a good chance of being favorably reported on as genuine claims.

In contrast to some of this fake work the Interior Department has innumerable pictures showing genuine work that has been done in the arid region. As samples of private enterprise that really comes within the meaning of the desert land act, another picture shows the upper stretch of the New York Canal near Boise Canyon, Idaho, and a great sweeping reach of a ditch constructed by the Crow Indians on their agency in Montana. The Indian ditch is designed to bring about 35,000 acres under cultivation.

When it is considered that most of the land between the 100th meridian and the Rocky Mountains has to be irrigated to raise crops, and that when once it is irrigated it is among the most valuable land in the country, it can be seen just what the opportunity is for such frauds and how they will pay if successfully carried through.

The latest reports to the Interior Department on this subject showed that there was up to date about 8,000,000 acres of land "under ditch" in the United States, and that it was producing crops valued at $100,-000,000.

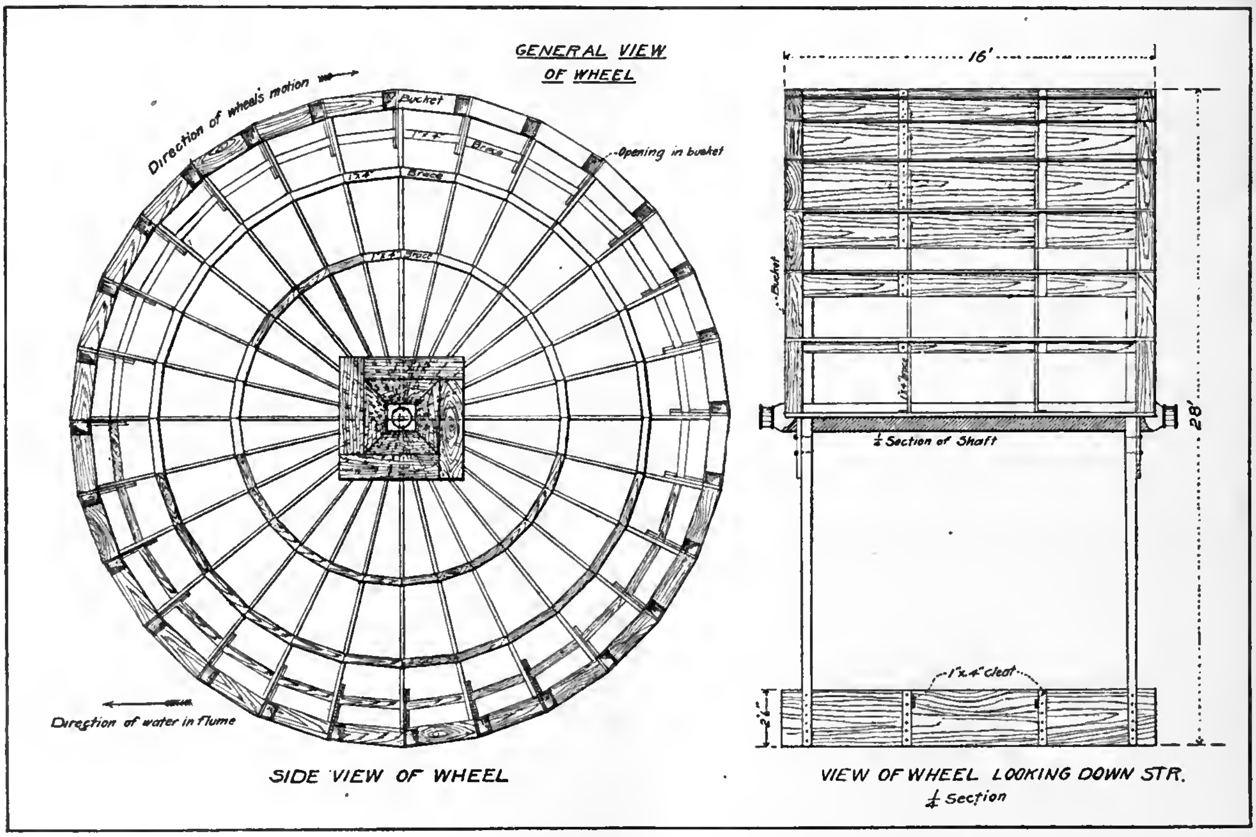

Fig. 14.—Kind of Wheel in Payette Valley, Idaho.

HAY CROP ON IRRIGATED LAND.

E. C. Specker of Prosser Gets Over 16 Tons From 2¼ Acres.

Prosser, Wash, July 19.—As an evidence of what can be produced on irrigated land, the experience of E. C. Specker, whose farm is located a mile and a quarter east of town, is worth relating. He brought to town last week nine tons and 850 pounds of timothy hay, which he raised on two and one-fourth acres of land, measured ground, selling the hay for $7.50 per ton, $1 less than it is really worth. This was the first cutting of the crop, which yielded the owner $67.50. If he had received the market price it would have been worth $76.50. The second cutting, Mr. Specker estimates, will yield seven tons, which, if sold at the same figure, will give him $52.50, or $120 for his crop from two and one-fourth acres. If it had sold at the market price it would have been worth $136.

Such yields as this are not unusual in this valley this one being mentioned for the simple fact that it came under the personal notice of your correspondent. And the crop was raised without any labor whatever, except that put in in irrigating. The land was seeded four years ago, the crop requiring no attention in the meantime except turning the water on and harvesting.

This may sound like an extravagant story to eastern farmers, not acquainted with the yield on irrigated land, but hundreds of such instances can be cited and verified. Similar land is selling in the vicinity of Prosser for from $70 to $100 per acre. An ordinary hay crop will pay for it in one season, after which the owner has the income from it practically without labor. Such land is now selling around North Yakima for $250 and $300 per acre. It is an absolute certainty that it will be worth the same here in three or four years' time.

The Prosser country is in the same condition now that North Yakima was when the Sunnyside canal was built.

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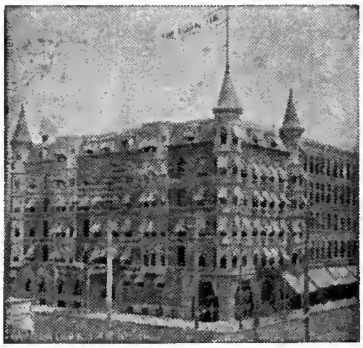

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HOUSTON, TEXAS

Vol. XX. No. 11.

THE IRRIGATION AGE

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CHARLES A. COX CHGO.

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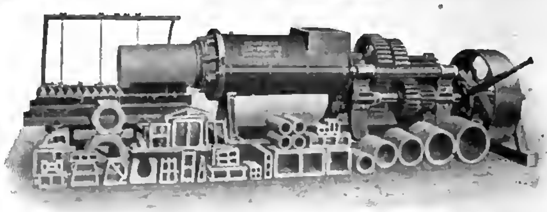

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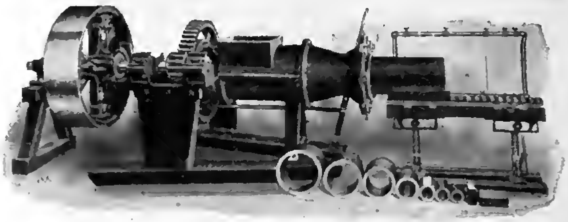

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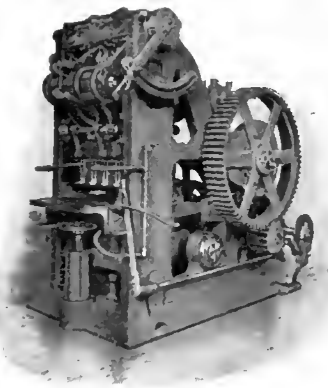

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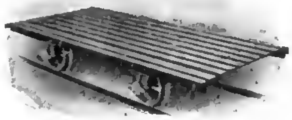

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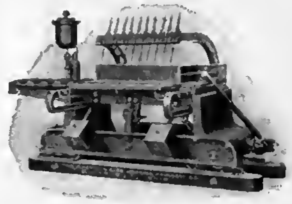

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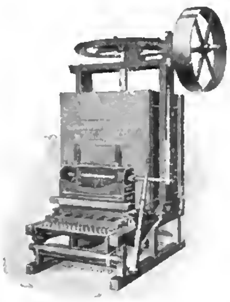

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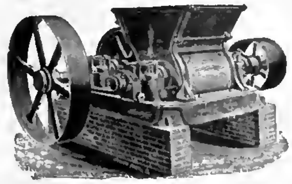

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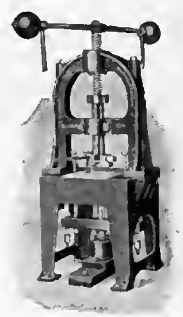

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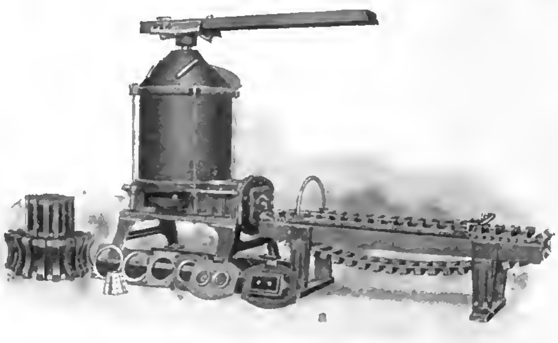

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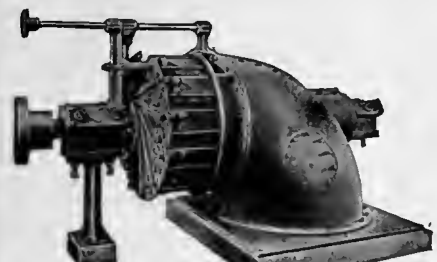

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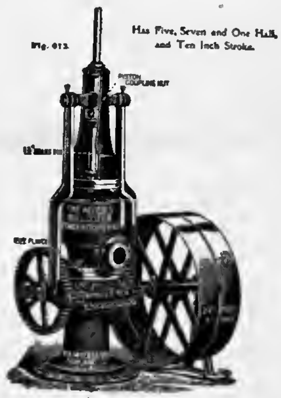

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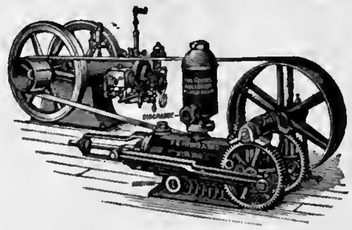

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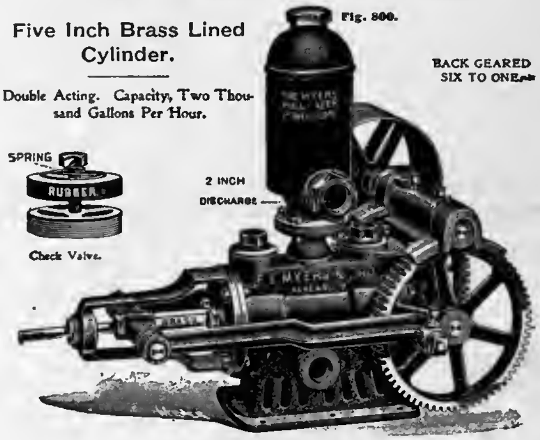

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THE IRRIGATION AGE

VOL. XX CHICAGO, SEPTEMBER, 1905. NO. 11

THE IRRIGATION AGE

With which is Merged

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

Notice. This issue of THE IRRIGATION AGE is being sent forward to all delegates to the Thirteenth National Congress, regardless of whether they are paid subscribers or not. If you are not a regular subscriber and care to keep posted on irrigation development and wish to learn all the truth about Government work along this line, send one dollar and THE AGE will be mailed to you regularly for one year. During that time all of the important papers delievered at the Congress will be published, along with portraits of the prominent speakers.

Billings, Montana. Beginning with our October issue will appear a series of finely illustrated articles descriptive of the irrigation development around Billings, Montana.

The city of Billings is already known the country over as one of the bustling, wide awake points in the West and her citizens are deservedly credited with being broad minded and resourceful, using every effort to extend her trade and increase the productiveness of the surrounding country. Our readers will be much interested in the story of Billings.

That Resolution. The treatment received by George H. Maxwell and his association, known as the National Irrigation Association, at the hands of the National Irrigation Congress was exactly what was expected by all who were acquainted with the situation.

It only remained necessary for a sufficient number of members of the Congress to unite on a suitable expression which could be embodied in a resolution. After that only one result was expected.

The truth of the matter is that the Maxwell-Boothe band could have easily avoided their present dilemma had they been far sighted enough to have published a financial statement of their association at any time before the recent Congress. This statement would have contained strange information, to be sure, but it would in any event have forestalled the action of the Congress.

Irrigation Congress. The Thirteenth National Congress has come and gone into history. It was in all respects a notable gathering and taken all in all was one of the most successful meetings ever held by that body. The papers read by prominent men before the different sections will in time be published and thereby add much to irrigation literature and knowledge.

This Congress, like the one held at El Paso a year ago, demonstrated the fact that the sectional meetings should not interfere with holding daily open meetings of the Congress and a wise ruling was made permitting the holding hereafter of an open Congress in the morning and continuing the section meeting arrangement in the afternoon. This will permit of more general discussion, which is, in fact, the main distributing feature, the life blood of the Congress. This arrangement will not in any way detract from the good to be derived from papers read in the sections and will, it is expected, prove more satisfactory to all.

Astounding Information. A trip through the Dakotas, Montana, Washington and Oregon completed late in August by the editor of THE IRRIGATION AGE revealed the remarkably prosperous condition of all interested in agriculture by irrigation.

This journey was taken to secure data for future articles to appear in these columns and upward of one hundred splendid photographs were secured to be used in connection with relative descriptive matter. An astounding condition of prosperity exists throughout this broad area and not one of the hundreds encountered on the trip had a word of disparagement to utter concerning present crop or other conditions. Every one with whom we talked expressed satisfaction with the outcome of this year's work and unbounded confidence in results from future effort. Accompanying the writer on this trip was Mr. Nicholas Sinelnicow, special representative of the Minister of Agriculture of Russia, who secured a large number of photographs of agricultural and irrigation scenes which are to be reproduced in form of a book which that gentleman will prepare for his government. Mr. Sinelnicow was deeply impressed by the many evidences of prosperity and it was difficult for him to comprehend the achievement of many irrigation farmers who informed him of their success. He could with difficulty understand how a man could purchase a twenty or forty acre farm under irrigation at from fifty upward to one hundred or one hundred and fifty dollars an acre and raise crops the first year sufficient to pay the entire cost of the land.

Many instances of this character were encountered near Billings, Helena, Bozeman, Manhattan and Missoula in Montana and along the line of the Northern Pacific Railway in eastern Washington. All of these facts will be brought out and illustrated in future numbers of THE IRRIGATION AGE as well as in the book to be prepared by Mr. Sinelnicow.

A PLAN FOR SUB-IRRIGATION.

A. Hemmant says in *Denver Field and Farm:* I have a very small irrigation plant raising water from a well by wind power, using part of the water for surface irrigation and part for sub-irrigation. For sub-irrigation I use three-inch tile laid fourteen to sixteen inches below the surface in rows five and one-half feet apart, the rows connected by a head row in which is laid one T joint for each lateral row. The rows must be absolutely level, not following the inequalities of the surface in order that the low places shall not get more water than the higher ones and the ends of the rows must be closed with brick or stone, so that moles, rats or other vermin can not get in.

A square box set in the ground at one end of the head row gives access to it and from thence to all other rows and it should have a wire netting over the top to keep out trash as well as vermin. The top of the box should be raised above the surface of the ground enough to keep out storm water, as by that means mud and trush would be carried in and fill up the tilings. The tile is porous and the uncemented joints allow the water to pass through freely. This mode of irrigation has several points to recommend it above others: First—One can turn on the water and not have to watch it.

Second—The ground does not begin to bake in a few minutes after the flow of water is stopped as in the case with cultivated ground under surface irrigation. Third—Most of the moisture being several inches below the surface, the rootlets go down instead of spreading out near the top of the ground as in surface irrigation where they are likely to be burned by the hot sun and torn by the cultivator.

THE THIRTEENTH NATIONAL IRRIGATION CONGRESS, AT PORTLAND, OREGON, AUGUST 21 TO 24.

Many Important Papers Read and Resolutions Passed.

Resolution Declaring That No Relationship Exists Between the National Irrigation Congress and Maxwell's National Irrigation Association and that No One Ever Has Been or Will Be Authorized to Collect Money for or in Behalf of the National Irrigation Congress—Next Congress to Meet at Boise, Idaho, in 1906.

The Thirteenth National Irrigation Congress met at Portland, Oregon, on Monday, August 21, and was in session four days, its labors being ended on Thursday afternoon, August 24. There were nearly 4,000 delegates appointed by Governors of various States and others authorized to send representatives and of that number nearly eight hundred registered and took part in the deliberations of the Congress.

The meeting was called to order Monday morning by the president, Governor George C. Pardee, of California, and addresses of welcome were delivered by Governor George E. Chamberlin on behalf of the State of Oregon; by Mayor Harry Lane, on behalf of the city of Portland, and H. M. Cake on behalf of the Portland Commercial Club.

The responses were made by Governor Albert E. Mead, of Washington, and Hon. H. D. Loveland, of San Francisco.

This was followed by an able address by the president, Governor Pardee, after which addresses by Chairmen of sections were delivered by Gifford Pinchot, Forest Service; Dr. A. C. True, Director Experiment Stations, Washington, D. C.; F. H. Newell, U. S. Reclamation Service; H. E. Williams, U. S. Weather Bureau, and C. W. Eberlein, of Rural Settlement Section.

A song service was given as part of the program on the evening of the first day, at which time the splendid Mormon choir of two hundred voices from the tabernacle of Ogden, Utah, rendered the Irrigation Ode, after which Mrs. Gilbert McClurg delivered an address.

The real work of the Congress began with the naming of committees on nominations, resolutions, etc.

The committee on resolutions was as usual the most important of all and its deliberations were exceedingly interesting.

This committee attracted a great deal of attention owing to the many resolutions presented which had much to do with affairs of the country at large.

A SLAP AT THE MAXWELL-BOOTHE CROWD.

The entire forenoon Tuesday was consumed by the resolutions committee in a debate which ended in the adoption of a resolution offered by Mr. Cobban, of Wisconsin, and strongly supported by United States Senator Thomas Carter, of Montana, which was a slap at the National Irrigation Association of which George H. Maxwell is executive chairman. A resolution had been presented stating that there was no connection between the association and the National Irrigation Congress. It contained the name of George H. Maxwell. Senator

Carter championed it as chairman of the sub-committee of three named to draft a resolution covering the ground. Judge J. E. Raker, of Modoc County, California, attacked the resolution, stating that it was an unjust reflection on the association and that mention therein of the irresponsibility of the congress for the collection of money by the association in the name of the congress was not justified by the facts.

Debate became heated. Scipio Craig, of California, joined Judge Raker in the protest against the resolution, and others aligned with them.

MAXWELL'S NAME CUT OUT.

Senator Carter insisted on the resolution, and finally consented to eliminate the name of Mr. Maxwell.

Judge Raker attempted to induce the committee to accept several amendments, each of which failed.

C. B. Boothe, chairman of the executive committee of the congress, and also chairman of the board of directors of the association, was called to the room, and declared that all insinuations that the association had ever collected money in the name of the congress were false. He called upon some one to father the assertion that money had ever been collected in that manner.

Senator Carter stated that he had not said that money had been so collected, but that the people in his State had been given to understand that the association was the father of the congress and in a measure responsible for its acts.

After several hours of debate the resolution of Senator Carter, with Mr. Maxwell's name eliminated, was adopted as follows:

WHEREAS, The National Irrigation Congress consists of an association of persons selected annually by designated States and other authorities to meet annually to consider questions relating to the reclamation of the arid lands of the country, and

WHEREAS, The delegates so selected attend the annual congress at their own expense and without compensation, and

WHEREAS, Said congresses are not engaged in the collection of money, and

WHEREAS, The impression prevails to some extent that the so-called National Irrigation Association is connected with and authorized by the National Irrigation Congress to collect and disburse money, and

WHEREAS, No connection nor authority exists, therefore for the purpose of correcting an error be it

RESOLVED and announced that no person nor association of persons is in any manner authorized to solicit or receive any money or contribution of any kind for or in behalf of the National Irrigation Congress.

The resolutions committee met Tuesday night and had a stormy time. Reflections were made against the sincerity of the Government reclamation engineers and the insinuations were resented by Judge Raker, of California.

In the forestry section Gifford Pinchot presided, and papers were read by E. A. Sterling on "Tree Planting Along Irrigation Canals and Around Reservoirs"; Frank Lamb on "Disposal of Timber Lands of the West"; J. M. Lawrence on "Forest Reserves and Grazing."

In the section on production by irrigation, Dr. A. C. True presiding, papers were read by Professor Gordon H. True, Nevada Agricultural College, on "Animal Production"; Dr. James Withycombe, of Corvallis, and C. F. Saylor, United States Department of Agriculture, on "Dairying and Sugar-Making"; President E. A. Bryan, of Pullman Agricultural College, Washington, Prof. H. T. French, of the University of Idaho, and Congressman W. A. Reeder, of Kansas, on "Education for Irrigators."

In the climatology section Maj. Alfred F. Sears Sr., of Portland, spoke on "The Coast Desert of Peru," and several other papers were read.

ENGINEERING AND MECHANICAL SECTION.

An important paper was read before the engineering and mechanical section of the congress in the American Inn by E. I. Davis, engineer in the United States Reclamation Service, and entitled "The Umatila Project." By means of a large wall map the speaker illustrated the more important points of his speech.

The meeting was opened by the chairman, Frederick H. Newell, chief engineer of the United States Reclamation Service. Irrigation in general, including all the various phases of the subject, were touched upon by him.

Charles D. Walcott, director in the Reclamation Service, gave a sketch of irrigation as carried on by the Government from the first days of the scheme to the present day. "The propaganda for national irrigation," said the speaker, "was pushed forward at all times in season and out of season by Major John Wesley Powell. From 1874 to 1892 it was always in his mind, and no amount of discouragement or defeat could convince him that it was not a wise thing for the nation, and that a full measure of success would come in due time.

"Irrigation was in disfavor at the capital in the earlier days. A new and powerful force was added to the irrigation movement by the succession of Theodore Roosevelt to the Presidency. June 17, 1902, he signed the Reclamation Act and thus closed the long contest for recognition and national aid in the irrigation of the lands of the arid and semi-arid States and territories.

"During the last three years the difficult organization of a body of men whose field of operations covers so large a territory has been perfected and precedents established along approved lines. Construction is now in progress on eleven projects. These are as follows: Salt River, Arizona; Yuma, California; Uncompahgre Valley, Colorado; Minidaka, Idaho; Huntley, Montana; North Platte, Nebraska; Truckee-Carson, Nevada; Hondo, New Mexico; Fort Buford, North Dakota; Belle Fourche, South Dakota; Shoshone, Wyoming.

"The following projects have been approved by the Government: Klamath, Oregon; Milk River, Montana; Buford Trenton, North Dakota; Bismarck, North Dakota, and Okanogan, Washington. The Reclamation Service is constantly being importuned to make surveys in all parts of the country and expend money broadly.

"The time has arrived, however, when it is necessary to limit general surveys, as there is not enough money in the fund to construct more than one or two projects in each State or territory.

"The estimate of returns to the Government from irrigation, as given in the last quarterly statement, was that the receipts during the fiscal years of 1905 and 1906 would together equal those of 1904, $6,826,000, and that the increment thereafter would average $2,000,000 annually. Should this estimate be verified by the experience of the next three years, the entire receipts to the fund on June 30, 1907, will be $32,200,-000.

"The Reclamation Service will welcome friendly suggestion and constructive criticism from all the friends of national reclamation," the speaker concluded.

Other papers were "Public Interest in Irrigation," C. J. Blanchard, statistician in the reclamation service: "The Truckee-Carson Project," L. H. Taylor, supervising engineer; "The Reclamation Work in Idaho," D. W. Ross, district engineer; "The San Joaquin Valley in California," F. C. Finkle; "Irrigation in California," J. B. Lippincott, supervising engineer, and "The Irrigation Exhibit at the Lewis and Clark Exposition," E. T. Perkins. These papers were discussed during subsequent sessions.

As stated above, great interest centered in the Committee on Resolutions, where many stormy sessions were held. The resolution by Mr. Cobban, of Wisconsin, published above, created much heated discussion and was only allowed to go in and before the main convention by friends of the opposition after many meetings, at which it was decided that it would be better to allow all the resolutions to go through than to single out one of such importance and make such a fight against its adoption as to attract still further the attention of the press of the whole country.

The fact of the whole matter is that the Maxwell-Boothe crowd feared to have it come up in the convention as the side favoring its passage was too strong in debate for them and had too much evidence to present, which would have worked still more serious injury to the National Irrigation Association. As it stands now, the public generally have been informed that the money paid into the hands of Mr. Maxwell, Mr. Boothe or any of their hired men is not used for the benefit of the National Irrigation Congress; the public understands, moreover, that it is impossible to secure a statement of the manner in which this money is disbursed. As affairs are now, people who pay money to the Maxwell-Boothe Irrigation Association do so fully understanding the case and may call upon those gentlemen for an annual or semi-annual statement as they see fit.

In another section of this journal is published some of the papers delivered before the different sections. It is our intention to publish one or two of these papers each month so that all of them will appear during the coming year.

NOTES ON THE CONGRESS.

The friends of clean work along irrigation lines are deservedly proud of their success in carrying through reform resolutions which will materially aid in clearing the atmosphere.

♣ ♣ ♣

One thing is certain, Mr. George H. Maxwell has lost control of the Congress and can no longer pose as the father of all that is good in irrigation affairs.

♣ ♣ ♣

Mr. Boothe suggested before the Committee on Resolutions that he would like to "smoke out" the individuals who have been maligning his association, but when United States Senator Thomas Carter, of Mantana, suggested that he use a little fire or smoke on him, Mr. Boothe found that he was out of dead leaves and punk, so that job was indefinitely postponed.

♣ ♣ ♣

One of the brightest minds and the best debator in the whole Congress, with the possible expection of Senator Carter, of Montana, was Land Commissioner Ross, of Washington. Mr. Ross is masterful in debate and a good fellow to have on your side in a stand-up and knock-down fight.

♣ ♣ ♣

It is a pity that such a bright mind as that under the hat of Judge Raker, of California, should have been on the weak side of the fight of the Committee on Resolutions. If conditions had not been so serious, much entertainment could have been derived from his fine manipulations and bright sallies. It is hoped that he may see the error of his way and stand for all that is good at Boise next year. The Judge is nearly or quite as vituperative and vindictive as a Flat Head Indian when arguing against the allotments on the opening of their reservation.

♣ ♣ ♣

It is a pity that George H. Maxwell could not have attended the funeral of his well laid plans. Mr. Boothe looked lonesome.

♣ ♣ ♣

United States Senator Thomas Carter, of Montana, is a good man to fight with.

♣ ♣ ♣

Mr. Thomas Richardson, the genial secretary, won many friends by his uniform kindness and courtesy. It is easy to understand why the citizens of Portland like and honor him. A good word may also be said for Mr. A. H. Devers, vice-chairman, of Portland.

♣ ♣ ♣

Many kindly expressions were heard concerning the citizens of Portland and the delegates all owe a vote of thanks to the local newspaper men who prepared and published so complete a report of the proceedings. There could possibly have been some objection raised by some of the delegates at the manner in which they were portrayed by the local newspaper artists. Mr. Newell, for instance, was made to look like the bad man from Death Valley. Such, however, may be the penalty of standing out in bold relief on a boulder, far up on the mountain side of Fame.

♣ ♣ ♣

John McAlpine, of Duluth, Minn., made a square fight for all that was right on the Committee on Resolutions as well as on the floor of the Congress.

♣ ♣ ♣

The resolution presented by Mr. Alex Cobban, of Wisconsin, relating to the Maxwell-Booth combination, brought that gentleman directly in the limelight and he will not soon be forgotten.

♣ ♣ ♣

Scipio Craig, of the Redlands *Citrograph*., is the same good natured, hard fighting fellow as of yore. Scipio was on the wrong side of the fence at this meeting, but his truest friends hope to win him over before the meeting at Boise. Scipio Craig's most prominent virtue is loyalty to his friends.

♣ ♣ ♣

Walter N. Granger, the man who made Sunnyside possible, was in attendance and deeply interested in the proceedings.

♣ ♣ ♣

Arizona was well represented in the Congress, but none of the delegates shone out quite so brightly as Dwight B. Heard, of Phoenix. Mr. Heard is such a good fellow we are half sorry that his side lost out on important questions.

♣ ♣ ♣

To George H. Maxwell: George, do you remember the story of the Norse King? "Frietjof's Saga" is the title and some of the lines as told us by William E. Curtis run this-a-way:

> Knight, old Ice Trust not,
> Nor Spring day snow,
> Nor sleeping snake,
> Nor prattle of maiden, named Ambition, sitting upon thy knee.

♣ ♣ ♣

President Roosevelt would better call off some of his representatives if they are to make a "gallery play" whenever opportunity presents itself. When Mr. Pinchot, who was heralded and placarded as the personal representative of the President, arose to read his (the President's) letter, some one of the chronic claquers suggested that all members of the Congress should arise and remain standing during its reading. While this was in a way recognition to a good man, the fact remains that too much of that sort of thing disgusts American citizens, particularly when it borders on toadyism, and if Mr. Pinchot, who represented President Roosevelt, had put a stop to it he would have left a much better impression among the delegates. All of this reminds the writer of a circumstance that will bear repeating.

♣ ♣ ♣

Back in 1894 the writer and Capt. W. O. O'Neill, nicknamed "Bucky," spent some time together in the the mountains and plains of Arizona. We were accompanied by another Irishman of the name of O'Toole and many interesting talks were indulged in under the bright stars of Arizona. One night, just as we were about to roll in our blankets, O'Neill turned to the writer and said: "Did you ever look into the history of this fellow Roosevelt?" It was explained that his name was mentioned now and then in the Tenderloin Club in New York, which was then the gathering place for many working daily paper men. "Well," said O'Neill, "Some day you will hear a lot about him, and if I am not mistaken he will fill the President's chair before he is fifty." The matter was discussed at some length and O'Neill made a statement about as follows: "If this fellow is ever elected President there will be for a time an end to this toadyism. I have been watching him and he is not only a coming man, but a good man, and I would like to tie to him." This sort of talk was characteristic of "Bucky" O'Neill, and his sincerity and logic always commanded attention. The writer has often thought of that night and O'Neill's talk and has wondered if he had premonitory notice that he would some day be associated with Colonel Roosevelt as captain of one of his companies of Rough Riders, and we wonder, too, why so good a man as O'Neill was taken away. Had as good a fellow as he represented President Roosevelt at the Congress, no mistakes would have occurred. A Spanish bullet ended Captain O'Neill's career in Cuba.

♣ ♣ ♣

It must not be understood that THE IRRIGATION AGE has any grievance against Mr. Pinchot. He is a noble fellow in a way with a broad forehead, denoting many qualities that are good, and it is safe to say that under careful scrutiny he would register many points above the mediocre. He is ambitious, which in a way is commendable; he should not, however, let personal ambition place President Roosevelt in an unfavorable light.

♣ ♣ ♣

Mr. C. E. Grunsky, whose title is so long that we have forgotten it, turns out to be as good a fellow as the title indicates, and that is no mean compliment. He is, moreover, a fine, hearty specimen of clean manhood, buoyant in spirit and dignified of mien. Hail, Grunsky, may you live long.

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Dr. Dolly, of Casa Grande, and C. D. Reppy, Florence, Ariz., two old-time delegates, were missed this year. These gentlemen would have enjoyed this meeting, as it developed conditions to their liking.

♣ ♣ ♣

The Reclamation Service is decidedly fortunate in having secured the services of Mr. C. J. Blanchard as statistician. Mr. Blanchard is an experienced newspaper man and is a good "mixer," which is, perhaps, more than may be said of others in the service.

♣ ♣ ♣

The Thirteenth Congress elected the following officers:

Gov. Geo. C. Pardee of California, president.

Judge L. W. Shurtliff, Utah, first vice-president.

Congressman J. H. Stephens, Texas, second vice-president.

E. L. Smith, Oregon, third vice-president.

H. B. Maxson, Nevada, secretary.

♣ ♣ ♣

C. M. Heintz, editor of *The Rural Californian*, Los Angeles, was welcomed by many of his old-time friends. Colonel Heintz was at one time secretary of the Congress, but has not attended many of the meetings during the past five or six years.

♣ ♣ ♣

Mr. A. H. Heber, of Imperial fame, attended the Congress and was much interested in the proceedings, particularly the resolutions curtailing the power of Reclamation officials. Mr. Heber has felt the iron heel of that bureau and is hoping for a remedy.

♣ ♣ ♣

Mr. Monte Guinn, the new executive chairman, is a resident of Boise, where the Congress is to be held, and judging from reports of his ability as a hustler, he should make a good official and help make the next Congress a record-breaker.

THE KENNEWICK CANAL, NEAR KENNEWICK, WASHINGTON.

During a recent visit to Washington the writer's attention was called to some remarkable work accomplished by the Northern Pacific Irrigation Company, near Kennewick, a thrifty town in eastern Washington, near the junction of the far-famed Columbia and Snake rivers. The following data and illustrations were secured through the kindness of Mr. O. L. Hanson, superintendent in charge:

The Kennewick Canal takes its water from the Yakima River, twenty-two miles west of Kennewick. The main canal is thirty-two miles long, with twelve miles of laterals, covering about 14,000 acres of land. The ditch was completed in the early spring of 1903, and the first work of actual cultivation was started in April, 1903. At the present time there are approximately 4,000 acres under irrigation and cultivation, the crops consisting principally of early fruits, strawberries and alfalfa. This project is located on the main line of the Northern Pacific Railway, 150 miles west of Spokane, and 254 miles east of Puget Sound. The

Trestle at Badger Canyon Flume No. 2 Northern Pacific Irrigation Canal, Kennewick, Wash.

extremely low altitude, 362 feet above sea level, assures a very mild winter climate, and an exceptionally long and early growing season, being about three weeks earlier and three weeks later than North Yakima or the upper Yakima Valley. Climatic conditions are such that farmers are enabled to raise and place produce on the market earlier than any other part of the entire Pacific Northwest, such articles as European grapes, Clark seedling strawberries, early varieties of peaches, apples, cherries, apricots, nectarines, asparagus, rheubarb, Rocky Ford cantelope, watermelons and all varieties of garden truck, for all of which is found a ready market, at exceptionally high prices. This season about 4,000 crates of strawberries were shipped, which brought an average price of $3.50 per crate on the depot platform at Kennewick. The first berries were picked on the 28th day of April. The first crates were shipped on the 3d of May. This was some two weeks earlier than Walla Walla and Hood River, which places have, heretofore, been the earliest producers of this class in the Northwest. Within a radius of two miles from Kennewick the land is farmed in small tracts, ranging from five to twenty acres. Nearly all this land is set to fruit and vineyard, strawberries being planted between the tree or grape rows—the berries alone this year producing as high as $350 per acre profit. The trees and grapes are not yet into bearing. Outside of the two-mile radius, the land is generally farmed in from twenty to forty acre tracts, the principal crop being alfalfa.

To give a clearer understanding of the length of the growing season, it may be stated that two crops

Bridge and Flume Northern Pacific Irrigation Canal, Kennewick, Wash.

of potatoes are produced on the same land in one season, the first crop being marketed as early potatoes, between the 10th and 25th of June. This gives time to prepare land for the second crop, which should be planted not later than the 10th of July, and they may be harvested any time during November. After the second crop of potatoes is harvested, a crop of rye or winter wheat is planted, which in turn is plowed under in the early spring, to add fertilizer for the season's crops. In this way the soil is kept well fertilized. The soil being of a volcanic origin, which disintegrates each year with the action of sun and water, prevents it from wearing

Northern Pacific Irrigation Canal, Kennewick, Wash., Dividing Gates Main Canal on right, Lateral No. 2 on left.

out, and an analysis shows it to be practically inexhaustible.

EQUITIES OF THE SENIOR IRRIGATOR.

BY PROF. O. L. WALLER, PULLMAN, WASH.

(Paper read before "Production by Irrigation Section," Thirteenth National Irrigation Congress.)

The statutes of this State have permitted claimants to file upon any quantity of water that suited their desires and left without restrictions as to head works, character of canals, etc. Consequently the first of these two classes have usually brought the water to their lands and distributed it as cheaply as possible, used open, poorly constructed, wasteful ditches and distributed it over gravel, through long, leaky furrows. For many years the State as grantor raised no objection, in fact, the commonwealth and rancher both considered it the proper thing.

Now since the irrigator acquired his rights under this régimé, may he not maintain them under the same conditions? Is it right that he should pay the bills to cover all legislative errors? When the State becomes wise and wishes to curtail so improvident a use of water, should she not provide a way to help the farmer to more thrifty and economical methods, or shall she pass laws

Northern Pacific Irrigation Canal at Kennewick, Wash., showing town of Kennewick, looking northwest.

limiting the use and thereby place a heavy tax on the farmer caused by extensive changes and repairs to his canal and distributing system, the installation of more head ditches, flumes and cement linings, etc.?

Who are the chief beneficiaries of all this expense? Clearly the State, by way of increased taxable property, and the junior appropriators who get in on the surplus water thereby provided. The junior appropriator reaps a double benefit. He not only gets the surplus water, but he selects land fairly in the midst of improved areas and close to city markets, all of which have been provided by the labors and hardships of the senior appropriator.

But we are told that the water belongs to the State and that no one should have more than he can beneficially use; that he may not waste water; that the State holds it in trust for all. We may grant this, but who will define beneficial use and waste? Beneficial use is surely a function of the method of application, and of the crop raised. The State, however, has never prescribed the manner of applying water to arid lands, nor the amounts needed for specified crops. Neither has she defined waste. Not only this, but the very method provided by the State of securing the use of water has encouraged very wasteful methods. Waste is hard to define, it clearly depends on the methods of applying water and on the retentive or non-retentive character of the soil receiving it. It is largely a function of locality. What would be considered an economical and frugal use of water in one locality and on one class of soils would be extremely wasteful in another.

There are thousands of acres of river bar farms in the Yakima valley which have shallow soils and deep, coarse gravel sub-soils. They are veritable strainers. The loss in ditches is extremely large, then again if the furrows are any length the losses near the head ditches are excessive and the plan must be made correspondingly large if any of it is to reach the lower ends. You can carry water in a leaky pail, in a rather dilapidated flume, or over porous gravel, but always at great loss. Farmers on such lands in digging ditches follow about the same system of irrigating that their neighbors do on deep, loamy soil. The expense of getting water onto the land in both instances is not different. In the method of appropriating, however, the State has made no distinction as to the lands. In the first instance twice to three times the amount of water must be diverted from the river for use on the lands as in the latter case. The ditches are harder to maintain. In some instances expensive flumes must be built and maintained to even get the water over the gravel and on to the land. The ditch must be excavated extra deep and wide and be refilled with fine material to make it carry water at all. In some soils water penetrates slowly, is kept near the surface and is thus easily carried over in ditches with little loss, while others are coarse, open and leachy. The water penetrates them like a seive and is rapidly lost in a leaky sub-soil. Once beyond the roots of the plant it is wasteful so far as performing any service to the plant is concerned.

Now some one comes along and says these fellows are using too much water, makes a filling on the stream above them for some big project. The State accepts the filing, permits the claimant to construct a large system of canals and to sell lands and unguaranteed water rights to innocent purchasers. The State becomes a party to the fraud. When the shortage of water comes, or the State by statute limits the amount to be used, the senior appropriator find that a heavy outlay in flumes, pipes, lined ditches, more numerous head ditches, etc., is necessary if he is to maintain the output of his farm. If the junior appropriator should be fortunate enough (as most of them are) to have a deep, loamy soil, the old plan of ditching will be ample for him.

In the above illustration the senior appropriators have done no wrong, they were the pioneers, suffered the hardships of an arid country and complied literally with the requirements of the State in their water appropriations. Can the State honorably abandon these people to greedy interests that seek to reap a harvest of wealth from the irrigating waters of the State? Can the State honorably fix a statutory limit to the amount of water to be used per acre in irrigation farming without first making a systematic study of the actual need for thrifty farming? Shall we legislate a limit to the amount to be used? Or in other words, shall we call upon the legislature to add their guess as to the quantity required, or shall we study the soils and climate and methods of cultivation and of applying the water, and make a scientific study of the quantity needed for the several crops best adapted to the particular region?

Who can say how much water is needed in the several irrigated valleys in the State of Washington to make farming profitable? What are the crop demands for water? Some require more, some less. If we either legislate or contract for a limit to the amount of water to be used, then we should specify either by legislation or contract the particular kind of crop to be raised on each tract of land. In irrigated agriculture today, the question that most needs answering is the duty of water and specific crops and a study of the most economical and profitable way of applying it. So many things from year to year enter into the problem that only by studying during a series of years can the answer be given and then the duty should not be based on the most favorable years or conditions, but on the mean, keeping in mind always that the husbandry should be good.

This is neither a plea for, nor a defense of, the sloppy, wasteful irrigator. As a rule in many places more water is used than is needed. How to use water most economically should attract the attention of every water user. Many irrigators think the conditions on their farms are entirely different from those on other lands. Yet that affords no excuse for waste. Every acre of irrigated land is entitled to all the water that can be beneficially used but to no more. However, before fixing any limits or permitting them to be written into contracts it is clearly the duty of the State to establish a rational basis for such limits. The State should make a study of conditions as actually found and pass a rational code of laws to honestly and fairly meet the exigencies of the case and at the same time maintain the honor of the State for fair dealing with her citizens.

Millions of money is now being expended on storage reservoirs, structures and canals. Hundreds of thousands of untrained irrigators are buying and moving onto these raw lands. In the end they will have put more money and labor into their farms than all the reservoirs and canals have cost. They pin their faith to the statement that the amount of water to be supplied is ample.

If injury comes from a bad guess, who will be the injured party?

In arriving at a statutory limit or in writing one into a water contract, upon what evidence have the findings been made? Always upon a guess of the party or parties to be benefited. Usually the promoter who would reap a profit and unload his plant upon the public before the real shortage comes.

Any law now enacted limiting the use so as to require the expenditure of money and labor to meet the requirements of such a statute would be clearly *expost facto* and would work a hardship upon our citizens unless some means were provided by the State or through some later appropriation to reimburse the farmers for their trouble and outlay in conforming to such a statute. The beneficiaries of such a law should certainly be called upon to make the senior users of water good in their present methods of using water in so far as these methods are within reasonably good and long established practice.

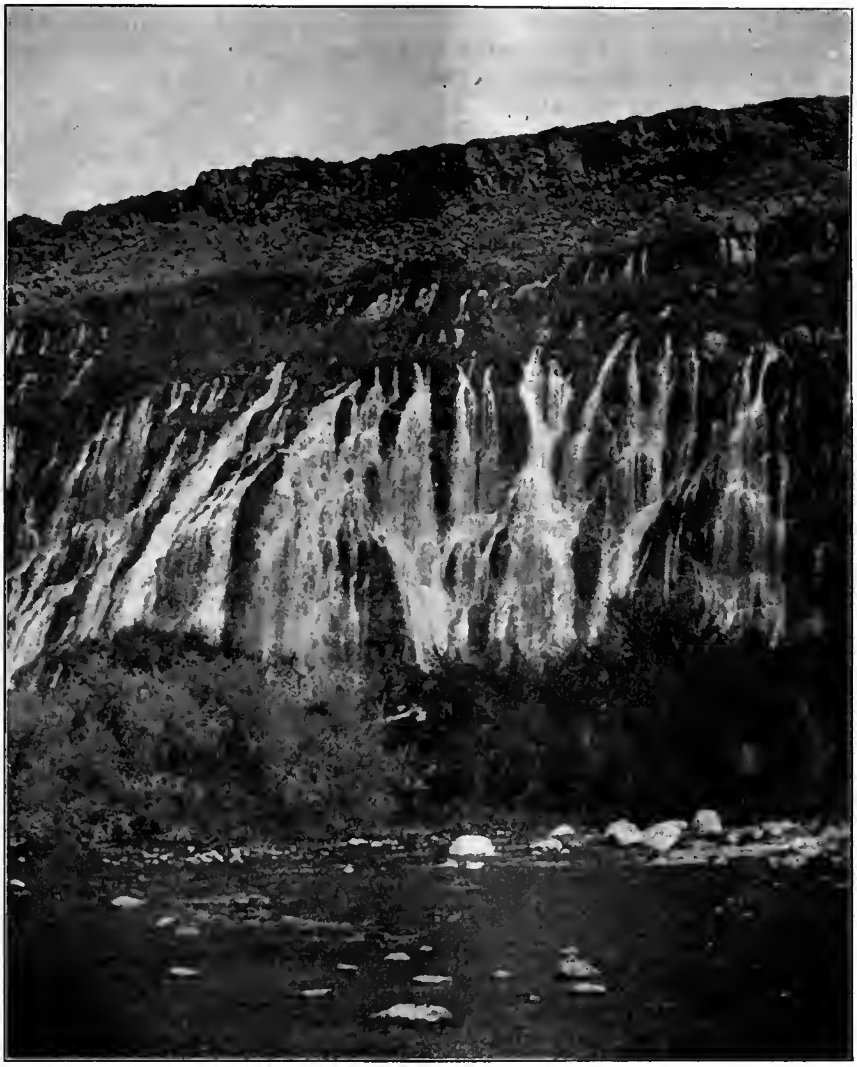
Diversion Dam at Milner, Idaho, Twin Falls Canal.

REMEDIES.

(1) The water requirements of the irrigable lands

should be studied, determined, and mapped and thereafter become a matter of State control. Future claims against the State's water supply should only be honored to the extent of the needs of the land and then only when such claims do not interfere with vested rights. The State, as owner, dispenses water rights, then why should not the State list her water resources, study the requirements for water and adjudge the conflicting interests she has nursed into being?

(2) Water sources should be surveyed and a rational system of dispensing water rights established.



Thousand Springs, near Hagerman, Lincoln County, Idaho, 180 feet high.

This is one of the greatest sources of wealth to the State and to her citizens, yet the statutes governing the appropriation of water are so meager, so weak, and so utterly inadequate as to permit of the rankest frauds under cover of law.

Under present conditions no man really knows whether his water right protects him in the use of a stipulated amount of water, or whether the water he is using is by sufferance of some more powerful or senior irrigator. The rule, "first in time is first in right," sounds well, but the State has made no provision to enforce such doctrine except through expensive litigation. And thus the small farmer, the senior irrigator on rocky land close down by the streams can not well afford to go against the more powerful claimants who dam the river and divert large quantities of water under a loose, ineffective statute that fosters this kind of robbing.

If the State undertakes to dispense the water rights, common justice would require that she should protect her prior grantees in so liberal a use of the waters of the State as they may reasonably require for their particular classes of land and free them from expensive litigation in securing such rights.

When the squeeze for water finally comes the senior appropriators, the small farmers close down along the streams will be the first to suffer. They will not be strong enough financially to cope with the more powerful modern corporations organized to handle large volumes of water.

The State of Washington needs a hydrographic survey and legislation and supervision that will protect these minor holdings against the greed of more recent appropriators.

If the present methods of acquiring water rights and of selling them is to be perpetrated, then we should have a statute making the holder of every water right a guarantor to the perpetual use of water enough to irrigate the lands alienated and of the title to said rights whenever said holder sold or leased to another party. Such a plan would not be difficult to work and would entirely do away with the wildcat schemes that are now so frequently promoted for no other purpose than to enrich the promotors by selling unguaranteed water rights calling for a high duty to innocent purchasers. In such instances common justice would require the grantor of a perpetual right to the use of water from any stream to protect the grantee in his purchase. What would be still better and safer, would be to require the State to guarantee not only the title, but sufficient water for the needs of the land. The State may shirk this responsibility a few years longer, but it can not forever maintain its integrity and remain an interested party to the deception that is practiced upon inexperienced and innocent purchasers of water rights under canals getting water from streams whose entire flow has been previously appropriated under sanction of the State.

RECLAIM MUCH LAND.

Scheme Involves Changing Course of a Big Stream.

A plan by a Seattle engineer is announced to reclaim more than 40,000 acres of the most valuable and fertile land in British Columbia and northern Washington.

Sumas prairie, lying between the international boundary line and the Fraser River, just east of the Northern Pacific, is a large tract of fertile prairie land which is overflowed by high water from the Fraser for two months every year, says the Seattle *Times*. It is considered the richest soil in British Columbia, but is unavailable for agricultural purposes because of being flooded each year just in the middle of the farming season.

The land is clear and level and during the balance of the year produces rich crops of wild grass, which make ideal pasture. The inhabitants, however, all have to be provided with "summer places" in the mountains to which they may take their cattle.

The Sumas scheme has failed hitherto because of engineering difficulties in caring for the waters of the Chilliwack River, which runs across the district.

The difficulties seem now in a fair way to be overcome, however, and that through the efforts of two Seattle men. Sterling B. Hill, a well known young civil engineer of Seattle, a graduate of the University of Washington, has solved certain problems that have heretofore prevented the work, and his idea has the approval of the officials of British Columbia and the Sumas prairie.

William H. Lewis, of the Lewis-Littlefield Company, took up the scheme in connection with Mr. Hill and has succeeded in financing it through Trowbridge & Niver Company, bond dealers in Chicago.

The scheme is unique in its requiring the change of course of the Chilliwack River, a large stream, which will have to be carried around the district instead of through it. This has been the principal difficulty in the past. The district itself is easily dyked, as only the end of it is opened to the river and a dyke of two miles will be sufficient to protect the entire prairie. The dyking and changing of the course of the river will be supplemented by large pumping plants to pump the water into the Fraser River at high water and also to keep the present bed of the lake dry.

OPPORTUNITIES IN IDAHO.

BY HON. T. W. HUNT, EX-GOVERNOR OF IDAHO.

When the joint Congressional Committee on Irrigation visited Idaho a few weeks ago to examine the work undertaken by the Government for the reclamation of the arid lands of the West, Senator Dubois observed that the only spot in the known world in the temperate latitudes, open to the occupation of the white race, lay in the Rocky Mountain states, in the valley of the Snake and along other streams, which were being developed by the Government with the purpose of supplying homes to a people who love a larger freedom than can be found in the more crowded portions of our country. A few years ago the most enterprising men of the West began the formation of irrigation companies, and the construction of canals in Colorado, Montana, Utah and Idaho, but at that time the value of irrigated land was not so well recognized, nor had the demand for it arrived, and many of these very well planned enterprises resulted in financial failure. But there is not one today favorably situated or well managed that is not successful.

It is not generally known by farmers that irrigated land never requires artificial fertilization. The water itself performs that agency and, under proper drainage, washes out alkali and other injurious salts. If an eastern farmer could call upon the elements and at the exact stage and proper time measure a certain quantity of rain upon his fields, he would not thank anyone to insure his crops. Irrigation actually does accomplish this purpose in its fullest sense. Drouth is not a factor of uncertainty, nor do we have summer rains or floods.

A well laid out farm of 160 acres, favorably located and arranged, can be irrigated by one man. Perhaps it is for that reason that the older Rocky Mountain farmers, raising hay almost exclusively, have acquired the reputation of being lazy.

In Idaho the Government is building a canal at Minidoka to reclaim 100,000 acres, and is enlarging the Boise River canal system to cover possibly 200,000 acres of new land. Private capital in this State is constructing canals at Twin Falls, 270,000 acres; at Blackfoot, 95,000 acres; at Mountain Home, 15,000 acres; at Glenns Frery, 25,000 acres; at Bruneau, 200,000 acres, and at Emmett, 25,000 acres. It is of the latter that you have asked for some description.

Emmett is situated on the banks of the Payette river, is a rapidly growing town of 3,000 people, on a standard gauge railroad, twenty-eight miles from Nampa and thirty miles from Boise City. The river emerges from a closed canyon four miles above Emmett and the valley begins to spread to a width of seven or eight miles, with the river in the center, and continues a distance of fourteen miles before the hills on the north side again break into the river. It is much like an oasis in a desert and the view is one long to be remembered. To the south is the divide between the Payette and Boise Rivers and on the north a low range of hills and the great rugged volcano, Squaw Butte, 2,000 feet high, completely sheltering the valley between and making the mildest climate in all of Southern Idaho. In the winter season it is safe to count on weeks of weather when the thermometer will not get under forty degrees above zero, and will never go below zero during the entire winter. The river does not freeze and ice must be put up from water run into ponds.

The bench land on the north side of the river from Emmett consists of about 20,000 acres, and is the land that the Canyon Canal is designed to cover. It is generally conceded to be the choicest agricultural spot in Idaho. The soil is a decomposed lava washed from Squaw Butte and the lower hills that fringe its upper edge, and varies from thirty to eighty feet in depth. It will raise anything that a temperate climate can produce. Fruits of every description, especially peaches and apples, are a certain crop, but hay is the staple of the country, as it is of all far western farmers. This soil has yielded from six to eleven tons of alfalfa hay to the acre, with three cuttings in the season. Seven tons is considered an average crop of a well ordered farm, which is worth $8.00 a ton fed to your own stock.

Six thousand acres of this tract has been entered under the Carey Act, about 7,000 has been homesteaded and the balance, about 7,100 acres, belongs to various State institutions and is to be sold at auction about September 1 next. Much of this bench land is still in speculative hands and will be resold to actual settlers.

The engineering portion of this work has been somewhat complicated. There is no scarcity of water, the river having a surplus for which there seems no future use. But it was a problem to get it out to an elevation of 120 feet at the back edge of the land to be covered, but the tireless energy and experience of Elmer E. Forshay, the company's engineer, overcame all natural obstacles encountered. The river has been dammed at the point of diversion to a height of fourteen feet and 250 feet in width. The headgates are in solid rock, after which the canal, carrying 360 cubic feet of water per second, passes into a flatter country and enters a flume 3,400 feet long on the river bank, but the bents are sunk through the graved to bedrock so that it is considered safe from seepage.

About four miles from the headgates eleven hundred feet of tunnel passes through a high hill of volcanic mud, and two miles beyond, 400 feet of rock tunnel brings the canal into the main river canyon again, and after passing through a fairly rough country, at the beginning of the sixteenth mile, enters the flat country at the head of the bench and begins its work of irrigation.

This work, however, is only in process of construction, but sub-contractors are busy with their men upon almost every mile of it and the general contractor has a large force of men and teams employed, and his time has been limited to April 1 next to complete the construction.

This is not a big country, but it is fortunately situated, at the very edge of the sheep and cattle range, which extends back into the mountains for a hundred miles, and while it is not big enough to fill the demand, it will afford ideal homes for those who are fortunate enough to be able to secure land.

Diversion Dam, Canyon Canal Co., near Emmett, Idaho.

INDUSTRIAL DEVELOPMENT.

Communities on the Chicago & Northwestern Railway to be Benefitted.

An industrial Bureau has been established by the Chicago & Northwestern Railway, the purpose of which shall be to furnish reliable information regarding the many desirable locations along the North-Western Line for new manufacturing enterprises.

The rapidly growing cities and the splendid resources of the territory reached by the Northwestern line combine many of the essentials to industrial success. Fine waterpower locations that may be supplemented by electrical energy developed therefrom, vast forests of hard and soft timber for all kinds of woodworking concerns, mineral wealth that provides the material for foundry and machine work, coal fields close at hand, and an excellent supply of a good class of labor are all found here.

This feature should prove of much benefit, not only to the railway company, but also to the communities along the line.

GLORIOUS MONTANA.

A State of Great Possibilities.

In all the large scope of the national irrigation projects, under the present laws, no State or territory offers such magnificent opportunities, with such certain and splendid results to follow the work, as does Montana. There are three important factors to bring these results, which are not possessed in such large measure by any other section. These are almost unlimited areas of arid or semi-arid lands, which under the inspiration of irrigation will become the most productive acres in the universe; second, an almost unlimited supply of available water (sufficient to reclaim ten million acres running to waste in the State, according to the estimates of experts); and third, an almost unlimited home market for all the products that can be raised when these millions of acres are reclaimed and made to produce. This is a combination which, as said before, can be found in no other section of the country. Of the 1,455,000 square miles of territory within the boundaries of Montana but a small fraction has been brought under cultivation. Immense areas are made available for grazing, and the cattle and sheep industries of the State rank among the first in the country. Yet several million acres of land can be reclaimed without at all interfering with these industries. In fact, irrigation will prove a benefit to them in many ways, and the stockmen, who are popularly supposed to be opposed to any change from the old-time conditions, are heartily in favor of the largest possible reclamation of the arid and semi-arid lands. More and more are they coming to appreciate the benefits of a large and cheap supply of winter feed, and to see that with smaller farms cultivated and "finished" cattle shipped direct to market, their profits would be increased, and the percentage of losses will be appreciably smaller.

GROUP OF DELEGATES THIRTEENTH NATIO

The large mining population of the State makes a good market for products, which now have to be very largely imported. It is estimated that at least five million dollars annually go out of the State for vegetables, fruit, dairy, poultry and hog products, which ought to be produced within the State. It is the old story of the man with five thousand head of cattle, who was buying his butter and bacon and eggs at the nearest market town.

The reports of the Agricultural Department of the Government show that the soil of Montana, under irrigation, will produce a larger amount than in any other state; add to this the advantages of voracious home markets and the benefits that will follow the working of an irrigated farm in this State are evident. There are in the State, as the result of private enterprise, nearly a million acres of land that have been reclaimed, and the fortunate owners of these acres have nothing to complain of. They are prosperous to a degree. It must not appear from this that the State of Montana is entirely arid. There are hundreds of thousands of acres in different sections of the State that grow bounteous crops without the aid of irrigation. Valley and bench lands in Fergus County, for instance, grow forty-five bushels of wheat per acre, without irrigation. Vegetables and other crops are as successfully raised in that section and in others. In the Flathead country, in the extreme northwestern corner of the State, as fine fruit as can be found in the world is grown, with immense crops of grain and vegetables and hay. In the famous Bitter Root Valley fine fruit and vegetables are grown, and in the Galatin Valley the finest wheat and barley in the world are produced, with immense crops of hay and alfalfa. The latter yields three crops a year, aggregating five tons to the acre, selling in the stack at from $3.50 to $4.50 per ton, yielding to the grower a fine profit.

IGATION CONGRESS, PORTLAND, OREGON. Photo by Kiser Photographic Co., Portland, Oregon.

An immense trade has been built up by the farmers

Delegates or others who desire copy of group photograph shown on this page will receive fine unmounted copy, postage paid, by sending $1.50 to the Kiser Photographic Company, Portland, Ore.

in winter feeding of cattle and sheep, thus making a market at their own stacks. Potatoes yield from 300 to 500 bushels per acre, and as high as 1,213 bushels have been produced on an acre of irrigated land. Yet it is estimated that 5,000 tons of potatoes a year are imported into the State.

The present projects under consideration by the Federal Government look to the reclamation of over a million acres of land in Montana. These comprise six large enterprises in various sections of the State, and the preliminary work has been commenced on all of them. The Madison River project, so-called, will divert the waters of the Madison River to reclaim at least 250,000 acres of land in the Galatin, Missouri and Prickly Pear Valleys, including a strip at least one hundred miles long from the head waters of the Missouri to and including the Prickly Pear Valley, in which is located Helena, the capital of the State. This vast area is more acessible to railways than any other in the State, lying on both sides of the Northern Pacific and in sight of it the entire distance, and being at the doors of the two great markets of the State, Helena and Butte. These lands when reclaimed will be the most productive and most valuable of any in the Northwest, owing to contiguity to markets and the demand and prices for their products.

The other projects under way are the Milk River Canal, which will reclaim 250,000 acres in Northern Montana, and will prove of inestimable benefit to that section of the State, as well as to the immense stock interests which have their flocks and herds in that section, affording winter feed for cattle and sheep. The Sun River project will reclaim 200,000 acres in middle Northern Montana, and in addition to this the Conrad project in the vicinity north of Great Falls will reclaim at least 100,000 acres, a portion of the lands already being under ditch.

In Eastern Montana three projects are under way, the Glendive-Buford, which will reclaim 190,000 acres mostly in Montana and a small portion in Dakota. Another project is under way which will reclaim 40,000 acres near Billings, called the Huntley Flat project and the reclamation of a large portion of the Crow reservation, which is to be thrown open to settlement in the near future, as soon as the surveys can be made.

With these great projects the population of Montana will be trebled in the near future. The lands reclaimed will be sold to actual settlers in small tracts, which will result in small farms, more productive than any in the country, which under the stimulus of home markets for their entire products will prove unusually profitable. Fruit, vegetables, hay, grain, alfalfa, dairy, hog and poultry products will find a market right at home and thus the millions of dollars annually sent out of the State for these products will be kept at home, while the miners and mechanics of the State will secure the advantages of lower prices than are now paid for the imported articles.

Scene on Canyon Canal, near Emmett, Idaho.

People from the East and middle West who are thinking of changing their residence can do no better than to thoroughly investigate the possibilities and advantages in Montana. They will find an equable climate, with no sudden changes; bright and exhilerating weather, immunity from severe storms in winter and summer, and all conditions favorable for the making of happy homes and the building up of a prosperous community.

STUDYING ANCIENT IRRIGATION.

An imperial irade authorizes Sir William Willcocks, late director-general of reservoirs in Egypt, to examine into the ancient irrigation system on the Tigris and Euphrates, and he has left for Bombay en route for Bosra and Bagdad, where he hopes to make a preliminary examination of the ground this winter, according to the Egyptian Gazette.

CURRENT WHEELS; THEIR USE IN LIFTING WATER FOR IRRIGATION.*

(Continued.)

IRRIGATION FOR TWELVE ACRES OF ORCHARD.

A very simple wheel is shown in Fig. 20. It is fourteen feet in diameter with paddles nine feet long and two feet eight inches wide. It raises water ten feet. The shaft consists of a 14-foot length of 1¾-inch gas pipe with four 2 by 8-inch pieces bolted around it for stiffness and to give a bearing for the arms. This gives the shaft alone a weight of over 300 pounds, or more than twice the weight of a 2-inch solid steel shaft the same length. The construction calls for 328 feet of lumber, but it could be built very much lighter without reducing its capacity. Its cost is given as $35. The lumber could be purchased for $8.50 and the galvanized iron for $3.50, making the cost of materials about $15, allowing for the gas pipe and bolts. The wheel raises 0.11 cubic foot of water per second, irrigating twelve acres of orchard and garden.

BUCKETS MADE OF OIL CANS.

A somewhat larger wheel in a ditch in the Lower Natchez Valley, Washington, is shown in Fig. 8. It is eleven feet in diameter, having paddles nine feet long and fourteen inches wide. It raises water seven feet. Part of the buckets are made of galvanized iron and part are made by cutting six inches from the bottom of 5-gallon oil cans. The wheel alone contains 328 feet of lumber. The method of bracing the arm is very effective. There are no data at hand for determining the efficiency.

EFFECTIVE USE OF WAGON WHEEL AND AXLE.

An example of extreme lightness of construction in a 15-foot wheel is shown in Fig. 9, illustrating a wheel on the South Platte River near the mouth of Bear Creek, Colo. It is built entirely of 1-inch lumber and an old wagon wheel. The arms are of 1 by 8-inch boards, and are braced by boards of the same dimensions about two feet from the outer ends. Baling wire connecting the outer ends of the arms helps to stiffen the wheel. The paddles are four feet long and eighteen inches wide; the arms are not nailed in the centers of the paddles but a little toward one end, the longer parts of the boards serving to balance the buckets. The entire wheel contains about eighty-five feet of lumber and weighs scarcely 350 pounds.

Its most interesting feature is the method of hanging it and adjusting it to different heights of water. The wagon hub fits on its original bearing, half of the old axle being bolted to a 10-inch beam about twenty feet long. This beam is suspended between two posts set near the wheel, by a chain wound on a drum. The other end is free to move vertically between two smaller posts set as guides. The weight of the 10-inch log balances the wheel, and it can be raised or lowered easily by one man.

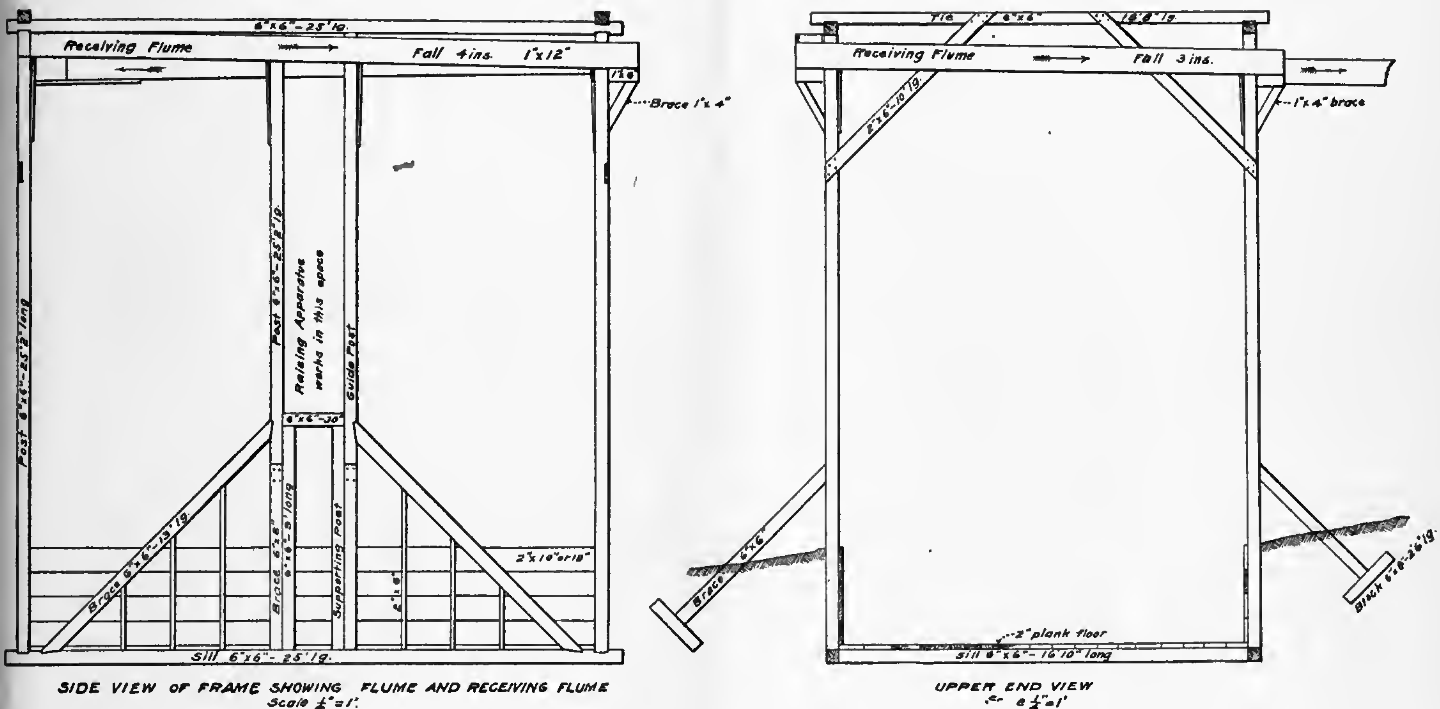


Fig. 15.—Framing for Flume for Wheel Shown in Fig. 14.

The velocity of the water was not measured, so it is not possible to get at the efficiency of this wheel. It raised 0.25 cubic foot per second ten feet, which is five or six times the amount of work done by the small wheels of about the same weight.

A CONTRAST IN COST OF TWO WASHINGTON WHEELS.

A much larger wheel than any of the foregoing is shown in Plate II, Fig. 1, and in Fig. 10. It is in operation on the Yakima River in Washington. It is twenty-six feet in diameter, and the sixteen paddles are eleven feet long and twenty-four inches wide. It raises water twenty-two feet. In a wheel of this size and weight great strain comes on the center fastenings of the spokes. The heavy shaft and large cast iron "rosettes" used in this wheel, with the wedges driven in between the arms, make it a model for rigidity and strength. The buckets of galvanized iron are placed on the outside of the rims and parallel to them, being

*Courtesy U. S. Dept. of Agriculture.

beveled in such a way that they fill about two-thirds full and begin to spill when about four feet from the top of the wheel. Wooden buckets are also used, made as shown in Plate II, Fig. 1.

The device for raising the wheel is shown in Fig. 10. Since the wheel weighs about 6,000 pounds it is evident that the lever will have to be rather long to make it possible for one man to adjust the wheel.

The materials used in the wheel are about 1,250 feet of lumber, 120 pounds of flat iron for the ties, a shaft weighing 260 pounds, four iron rosettes weighing together 200 pounds, 20 pounds of 3-inch bolts, and say 100 pounds of galvanized iron. Allowing 10 cents a pound for the iron and 50 cents each (13 cents per pound) for the cans, the cost for materials is $106 for the wheel alone. The cost was given by the owner as $600, this amount including the pier, platform and fluming. In putting in large wheels it will usually be found that the cost of the wheel itself is a smaller item than the cost of a single crib pier for mounting it. The two cribs for this wheel were placed on a sandy bottom and rest on piles.

This large and expensive wheel irrigates but fifteen acres of fruit and alfalfa, making a total cost of $40 an acre for water. This heavy cost shows first that the advantage of a swift current may be largely offset by great expense for piers, and it shows also the rapid increase in the cost of irrigation, as the elevation of a piece of land above the source of water increases. The cost of materials for this wheel, disregarding the mounting of it, was about $7 for each acre irrigated, while the materials for the wheels described in pages 9 and 10, which irrigated five acres each, cost a little more than $3, or say 70 cents per acre. In general, twice the height of lift means half as much water and usually four times as great cost for materials. Again, the annual repairs and cost of maintenance in the case of the small wheel were too small to reckon, while this large wheel requires $25 a year for maintenance and repairs, or nearly $1.70 per

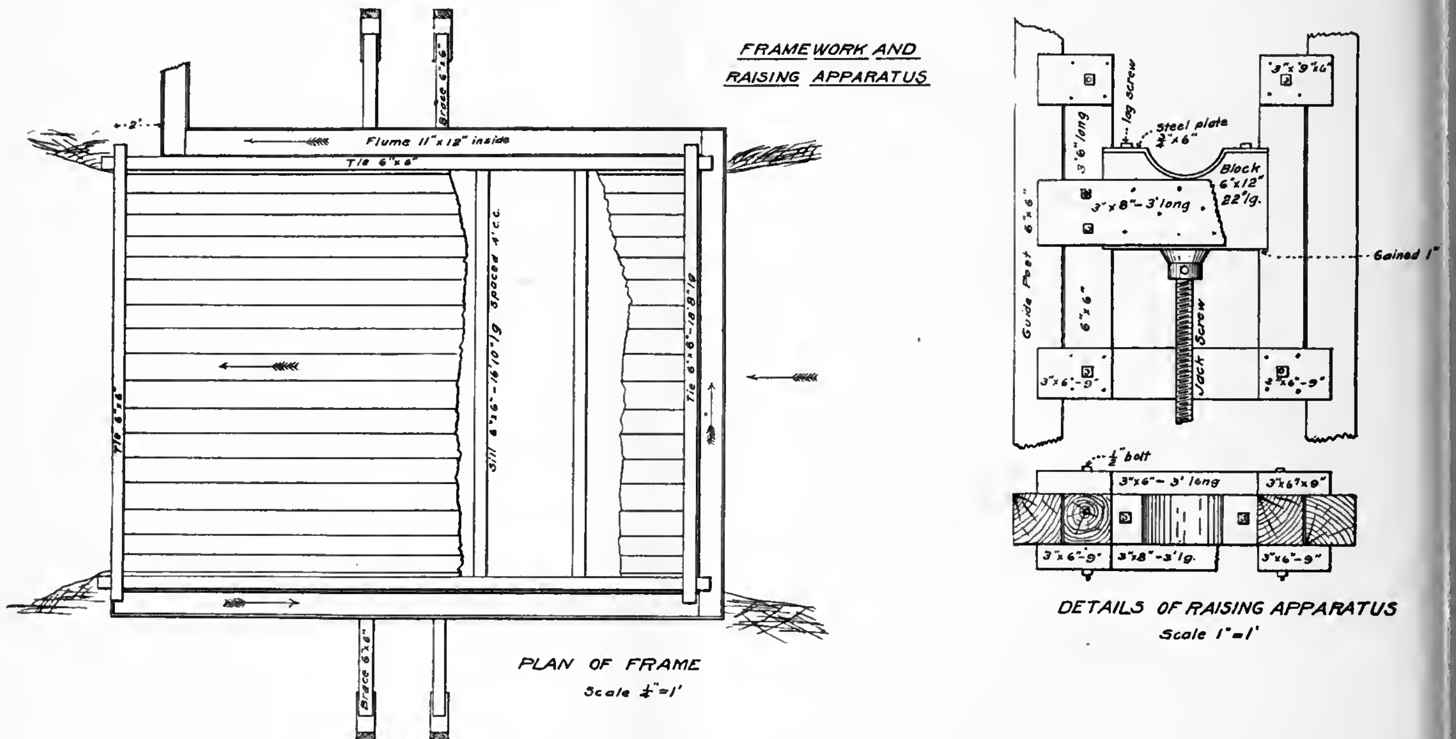


Fig. 16.—Framework and Raising Apparatus for Wheel Shown in Fig. 14.

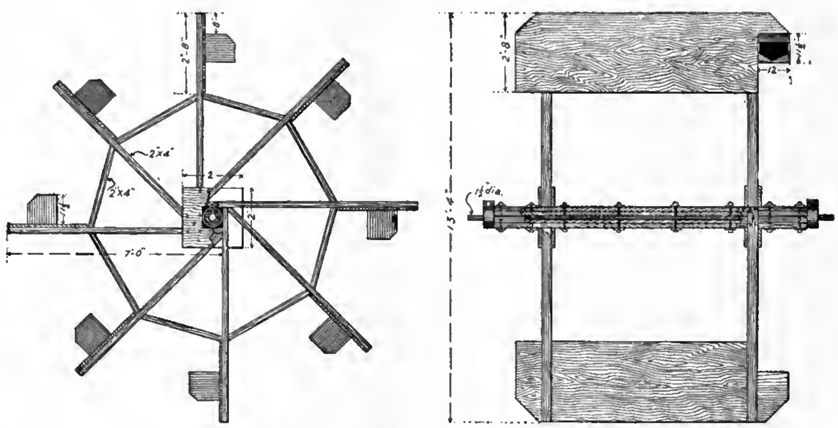


Fig. 20.—Wheel in Yakima Valley, Washington.

acre. So great is the disadvantage of a high lift that, unless the value of water for irrigation is very high, the building of large direct-lift wheels is not to be recommended.

There are two large wheels in the Columbia River at Ellensburg, Wash., which discharge into one flume, both being the property of one man. Though of the crudest construction, they irrigate forty acres of land. Their chief claim to interest is their great size, one forty-two and the other thirty feet in diameter, and extremely low cost, one having cost the builder in cash $10 and the other $7.50. There is almost no iron work about them, the only money paid out being for nails and the lighter lumber. The heavy parts are built of drift logs and odd timbers. This low cost, as estimated by the builder, shows the difficulty in estimating the probable cost of reproducing any certain style of wheel. The necessary expenditure depends very largely on the ingenuity of the builder. The water is carried in two siphons under pressure to avoid a high flume. The upper flume was built on account of the great difficulty encountered in keeping the lower flume tight under a pressure of thirty feet. The pressure on the upper flume is about twelve feet.

DESIGN BY A MINING ENGINEER.

The wheel shown in Plate II, Fig. 2, and in Fig. 11 is in use in Fresno, Cal., for the irrigation of about twelve acres of shade trees and oranges. It is patterned after a design by a mining engineer, and is in some respects an admirable and efficient type of current wheel. It is sixteen feet in diameter, raising water twelve feet. The stiff heavy rims found in most wheels are entirely absent, and instead a series of braces is used which cross the arms and support the paddles. Each paddle is made of two 24-inch boards set at a wide angle with each other. As is shown in the drawing, the angle is such that the paddle leaves the water in a vertical position, with no tendency to throw water.

The form of the buckets is also commendable. They are carefully designed to clear the bottom of the flume and the edge of the discharge trough, and to take in no more water than can be carried to the top without spilling. The entire construction requires 500 feet o flumber. The shaft is very heavy (215 pounds), but not nearly so heavy as the two castings which, according to the drawing, must weigh 800 pounds each, making the entire wheel with the buckets weigh about 4,000 pounds.

The wheel is substantial, but is unnecessarily heavy and expensive. Admitting the necessity of a rigid center fastening, a disk of ¼-inch boiler iron would serve nearly every purpose of the heavy casting. This wheel could be reproduced the same size but made with 1-inch and ½-inch material, with an iron pipe for a shaft, for less than half the cost. Under favorable conditions the Fresno wheel raises 0.5 cubic foot per second to a height of twelve feet. A lighter wheel would do more work.

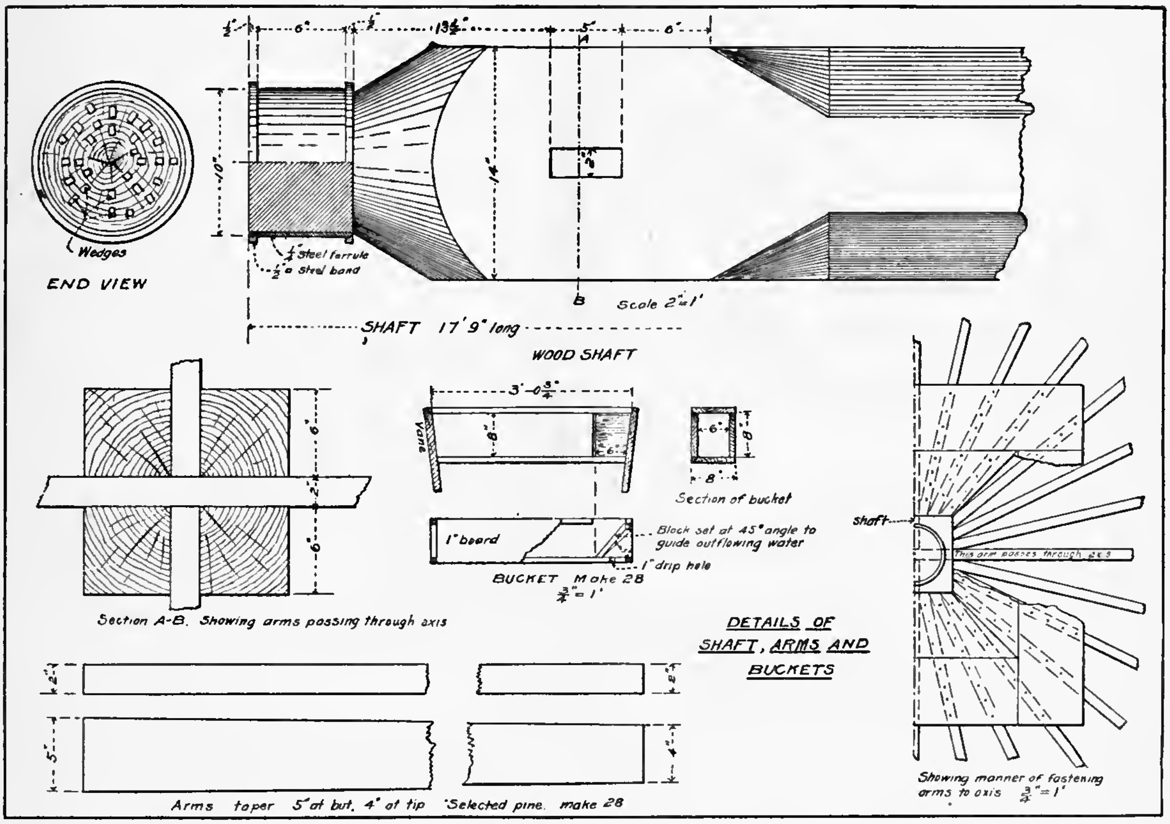


Fig. 17.—Details of Wheel Shown in Fig. 14.

DRY FARMING IN WYOMING.

PAPER BY STATE ENGINEER CLARENCE T. JOHNSTON.

While several million acres may be ultimately irrigated in Wyoming, there must always remain a large area of tillable land which can not be supplied with water. This area will probably amount to as much as 25,000,000 acres. We have a problem before us as to the ultimate use to which these lands should be put. As experiments are continued with grains and plants that resist drought it seems that a large area might be utilized by the farmers of the near future. It has been found that cultivation is an important factor in the growing of crops without irrigation. The Campbell system which has worked so well in eastern Colorado and western Kansas should lead to the utilization of large areas in Wyoming if the farmers are instructed in this method.

Congressman Mondell has done much in the northeastern part of the State along this line. He has found by observation that there are some tracts which can more easily be converted into paying farms than others. Lands lying at the base of a chain of mountains or hills have been found to be best adapted for dry farming and a number of settlements have already been made on such areas in Weston County.

This work is of too great a magnitude and importance to be conducted by one man or by an association. Either the State or the Government should lead in the investigation and the experiments should be carried out on a large scale. It is not sufficient to plant a fiftieth or a tenth of an acre and assume from the results obtained therefrom what would be the returns had the crop been planted on one hundred and sixty acres. If it is impossible for our experiment station to take up this work it would seem that some bureau of the department of agriculture should be induced to undertake it. The bureau of plant industry would have a larger field here than the reclamation service, because the water supply will ultimately limit the usefulness of that work and then leave unreclaimed four or five times as much tillable land as can be irrigated.

Utah has done as much as any other western State toward the development of species of wheat and other grains which grow without irrigation. In beginning this important work in Wyoming we could profit by the experience gained there, and secure seed which has been developed by forty years' experience and selection. Thousands of acres of wheat are planted each fall in Utah and crops are gathered each year from ground that has never received an artificial supply of water. The same can be done in Wyoming. Probably the most profitable farming will be done on lands which can not be irrigated, because the expense of raising crops will be less.

That wheat can be grown here without irrigation has been demonstrated. The question now is, who will undertake this kind of farming on a large scale and show whether or not it will pay? We have in Laramie County a considerable settlement where dry farming has been carried on for many years, but even there this industry would receive a stimulus if the experience of other arid countries could be shown. What we need is a thoroughly and intelligently planned experiment on a large scale, and all interested in the

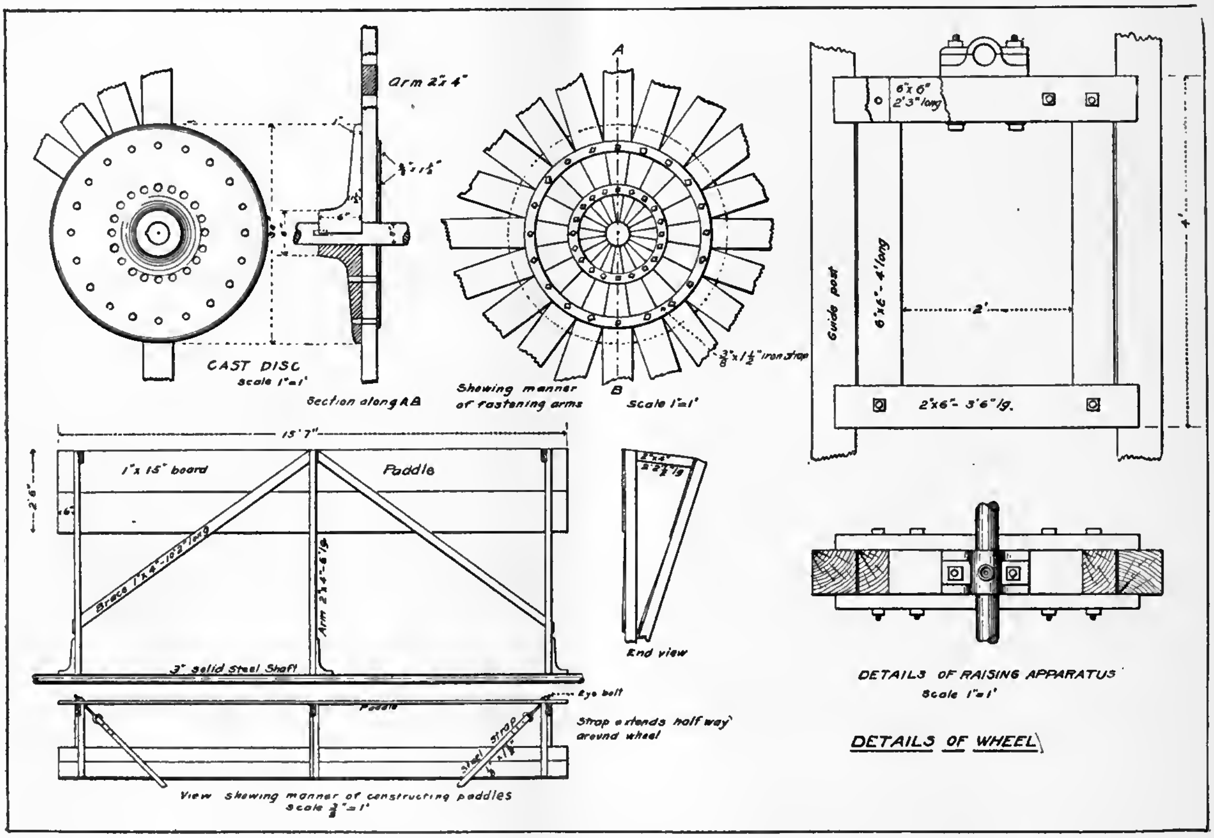


Fig. 18.—Current Wheel Operating Pump in Payette Valley, Idaho.

future of the outlying prairie lands of the State should lend their aid and influence to see this inaugurated.

As to farming around Cheyenne, there is no reason why an agricultural community could not be built up here if experiment shows that the ordinary grains and forage crops can be grown. The success of irrigated communities has largely depended upon the growing of alfalfa, which not only produces a heavy yield of hay, but when turned under it enriches the soil with nitrogen and enables the farmer to grow potatoes and sugar beets where otherwise these more valuable crops would be impossible. The agricultural department has taken up the study of this subject and has sent agents abroad to discover the practice in foreign countries. It has been found that in Germany and other countries enable the farmer to raise one or two crops of potatoes or grain, but after that it rapidly deteriorates. The experience at Salem, in the eastern part of Laramie County, illustrates this. Potatoes are planted on newly broken sod while wheat and similar grains are planted on older ground. If by deep cultivation and intelligent planting we can retain the moisture in the ground and then depend upon the artificial inoculation of the ground by the nitrogen storing germ, it would seem that there can be no question as to the future of dry farming around Cheyenne.

If this can be done, and I believe it can, the Young Men's Literary Club should begin a movement that would lead to an experiment on a large scale to prove the practicability of the undertaking. If successful

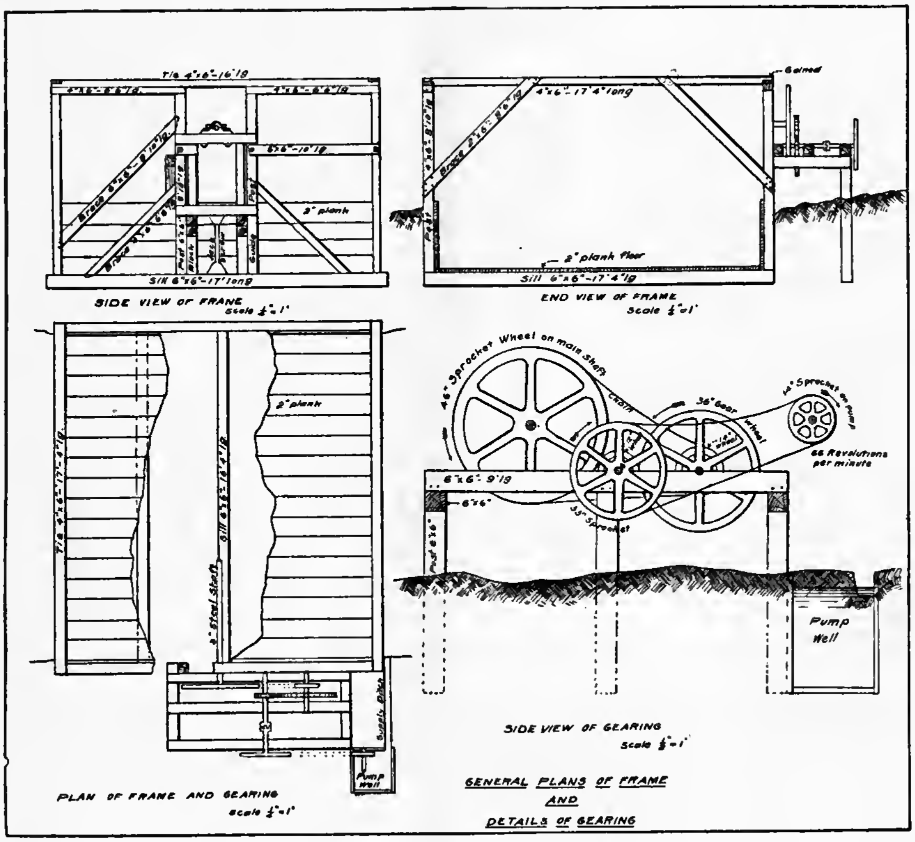


Fig. 19.—Framing and Gearing for Wheel Shown in Fig. 18.

in Europe it has long been the practice to plow under field peas and other leguminous plants to increase the fertility of the soil. Why this should be done agricultural scientists there are as much in the dark as we were here until within the past year.

An examination of the plants which have been found valuable as fertilizers has revealed a small germ. It is this germ which extracts nitrogen from the air and stores it in the ground. The problem for the department to solve was how to cultivate this germ and put it on the market in a commercial way. This has been successfully accomplished and the Agricultural Department is in position today to furnish germs to any farmer who makes application for them.

We must depend upon the scientist, therefore, if the utilization of the unirrigated lands of Wyoming is to be permanent. By plowing under the native grass the ground receives sufficient fertilizing qualities to Cheyenne will in a few years be a different city from what it is today. We will have a large surrounding country producing many kinds of crops about us and instead of depending wholly upon the live stock industry and the railroads, we will have a farming community, the best guarantee for a great city.

The dry farm must provide a limited system of irrigation in order that each family could have a garden. The windmill solves this problem and the garden can be obtained. With this guarantee for cheap vegetables the farmer under the new conditions would be independent because he could prepare the ground for crops by his own labor and depend upon the clouds for moisture. His energy must prepare the ground to retain the moisture and the extra work he must do is spent in this direction rather than in building ditches and reservoirs. It will be easier for a family to begin in such a farming community than it is where irrigation is practiced.

This is a question which should be brought home to all. We are interested not only in the future of Cheyenne, but also in those localities of our State similarly situated. There is nothing in the line of agricultural experiment that promises so much for the people of our city and State. Let us take up the question and see that another year does not pass without being able to record something being done in this direction. Let us look forward to the day (not distant I hope) when Cheyenne will be the center of our agricultural community. The responsibility lies with the young men of the State, who we represent in a way.

"And yer mean ter tell me that's all we hev ter depend on—just what the folks in Washington say about what weather's goin' to be 'round here?"

"Well, when the boss is around, we kinder figure it out ourselves—but if it's different from what Washington says—and we ain't right—there's a kick."

"But if you are right?"

"Nothin' doin'."

Then I'm to understand—"

"See yere, old hayseed, you're to understand that we get our pay from Washington. Kin ye understand that?"

"I think so."

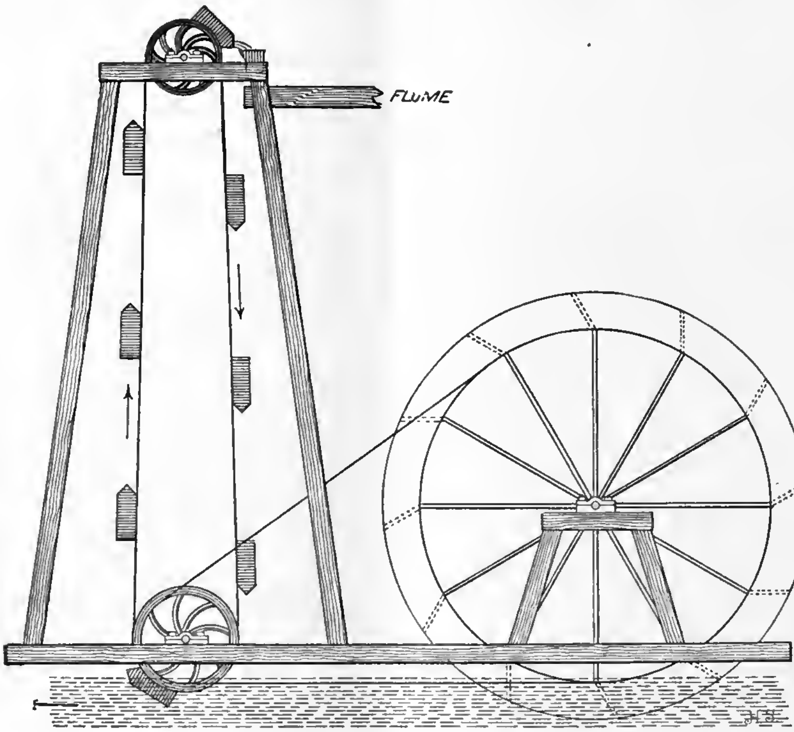


Fig. 21.—Chain and Bucket Operated by Current Wheel.

ABOUT THE WEATHER.

The Man from Jersey Got Inside Information When He Called.

A man from south Jersey blew into the weather bureau the other day. He had fire in his eye.

"Where's the boss of this here office?" he said.

"He's out," said the office boy.

"How long has he been out?"

"Three or four days."

"Well, where's the geezer whose bin tellin' every day that it was goin' to be cooler with showers?"

"Me."

"You?"

"Yep."

"Well, sonny, how did you do it?"

"This 'er way. We can't give out any predictions till we hear from Washington, anyway, see?"

"Yes, I see."

"Washington finds out what kind of weather we're goin' ter have, and telegraphs it on, see?"

"Yes."

"Then all we have ter do is ter say the same thing over again—catch on?"

"Well, we ain't monkeying wid de buzz saw."

"No, you hev to get your salaries, of course—and we farmers hev to pay 'em. But I think Mark Twain will hev to revise his story about the most useless man in America, and call him the weather bureau chief in Washington."

"Mebbe so, but I guess you've been reading some of this hot air in the papers about how we do things up here?"

"No, but I've been gettin' more hot air lately than is good for my farm, and I think I'll let the weather predictions go, and put in an irrigation plant."—*Philadelphia Telegraph.*

BENEFITS OF FARMING BY IRRIGATION.

BY WILLIAM DOHERTY, G. P. AND T. A., ST. LOUIS, BROWNSVILLE AND MEXICO RAILWAY.

No greater truth was ever propounded than that aphorism credited to O. M. Roberts that "Civilization begins and ends with the plow." So conclusive, so self-evident does this fact appear upon meditation that it may well be considered an axiom, a truism.

"Civilization begins and ends with the plow" because all things material emanate in some shape or other from the soil, and because the soil is, after all, one producing element, from which comes the satisfaction of the desires and needs of human kind. In other words, the farmer is the real producer of the wealth of the nation. The millionaire, the speculator, the broker, the merchant, the baker, the butcher, the candlestick maker find the opportunity and the justification for their respective avocations in the fact that the farmer is the producer. The farmer is, in truth, the uncrowned king of American prosperity.

It therefore appears to me that it may be taken as a fundamental and vital proposition that anything which concerns the status of agriculture concerns the prosperity and well-being of the nation, and, accordingly, anything that will serve to elevate, enhance and effectuate the methods and consequently the results of agriculture will redound with equal and corresponding benefit to all lines of activity which go to make up the national life, for it may be accepted as a premise that all activity in America at least, whatever be its character, is depended upon and subordinate to agriculture, the chiefest producing pursuit.

Without presuming to go into detail, it will, no doubt, be accepted without contradiction that the investigation and study in the science of agriculture during recent years have dealt principally with problems of climate and soil. These investigations and their results have been fruitful with manifold benefits. Certain climates have been positively designated as adapted to particular crops. The ingredients of soils necessary and especially conducive to certain crops have been determined and methods pointed out for the provision of certain ingredients that might be lacking. Fertilization has been made the subject of exhaustive study, until now it is pretty well within the power of the intelligent farmer to in at least a measure control the elements of the soil.

In the case of moisture, however, a quite opposite state of affairs maintains. Moisture is the one element remaining from those which compose the triumvirate of essentials in crop production which has yet to be subjected to the control of the tiller of the soil. Until it has been controlled, crop production will continue to be somewhat of a lottery, a gamble, depending largely upon the smile and consideration of that uncertain and often fickle mistress, Dame Fortune.

The foregoing brings me up to the point and purpose of this discussion, namely, that irrigation is the key to the realization of a controlled system of scientific agriculture.

Ask the average farmer in a locality which is yet a stranger to the benefits of irrigation what his crop prospects are. He will invariably reply that it all depends upon the weather, by which he, of course, means the presence of moisture at the proper moment, and its absence when not needed. In other words, his fate, his fortune and his pocketbook lie helpless in the nervous hand of Dame Fortune, to be shaken and tossed about here and there by every whim and fancy. If rain comes at the proper time, and in well-measured quantities, the crop will thrive and mature, and then if it is not injured by untimely rains while it is yet in the field the heart of the farmer will be made glad by the sight of the rich harvest in the granary.

But the contrary is only too frequently the case. Rain comes when it is not needed or it fails to come when it is needed. And if the farmer escapes a total loss of his crop he may have to content himself with probably half a crop or something a little better than no crop at all. Climate and soil conditions may be all right, but if moisture conditions are out of harmony with the needs of the crop, everything will be all wrong.

Nine times out of ten the farmer, who has suffered loss of or damage to his crop, charges his misfortune to the weather.

Irrigation established and operated on an intelligent and practical basis is the best insurance policy agricultural interests of Texas, or any other state for that matter, can adopt for the protection of their enterprise and activity. Promoted in localities where right and proper conditions exist, where soil and climate conditions are favorable, irrigation will establish the pursuit of agriculture upon its ideal basis and assure actual and conspicuous returns year in and year out. It will place within the control of the farmer the only one remaining element that now gives such numerous opportunities for crop failure. Given favorable conditions of soil and climate and a system of controlled moisture, which can be realized through irrigation, and the opportunities for crop failures are entirely eliminated, not only from probability, but from possibility. When the crop needs water, the water is turned on. When it has had enough, it is turned off. Common sense is the only requisite. Moisture is controlled and the farmer is always sure of some sort of a crop. Not only is he assured of a crop, but he is assured of larger returns, a better article and, consequently, better prices in the markets of the country.

Irrigation is, indeed, a new thing in Texas. In truth, generally speaking, it is a new thing in the country at large. Its association with the idea of desert reclamation has blinded the public mind to its value for regions where the need for reclamation does not exist. As a matter of fact, irrigation has its value even in localities where the average rainfall is considered ample for crop production.

Water is one of the most, if not the most, important of plant foods, not only because it is one of the principal ingredients of all plants, but because without it in the required amount the plant can not appropriate the other foods necessary to its growth. No one will question the advisability of saving manures nor the wisdom of using commercial fertilizers when the crop seems to need them. Why should there not be a similar feeling about irrigation, inasmuch as water is the most necessary of plant foods? And yet, year after year, the farmers of the country lose hundreds and hundreds of thousands of dollars simply because they have not at their command a supply of water when it is most needed. The water, which the farmer could have provided for a mere fraction of his expenditure for fertilizers, he has neglected to have ready, and he often sees the hope of return for his year's labor fade away with a few days of drouth. It is a common sight, which can be observed almost anywhere in agricultural sections, to see water stored at no little expense as a protection against fire remain unused while some valuable crop is burning up in the garden.

Such losses, according to the United States Department of Agriculture, are largely due to two things: First, the notion that irrigation is of importance only in arid regions; and, second, ignorance of the ease and cheapness with which a supply of farm water can be stored and distributed.

It would take many times the space that can be allotted this discussion to enumerate the numerous and manifold benefits of irrigation, but suffice it to say, that there is no one single item, which, added to the farmer's assets, will do more toward making his occupation one of certain profit than a practical system of irrigation.

I am particularly interested in the problem of irrigation from the fact that the railroad which I represent traverses a section wherein irrigation is receiving great attention, not only because it is accepted as a desirable thing under any circumstances, but because it is absolutely essential, in most cases, to crop production. Rainfall, generally speaking, is a minus quantity, but, while upon the surface, this state of affairs is not always regarded as a recommendation, as a matter of fact it places the pursuit of agriculture upon a perfect basis and eliminates the speculative element entirely, provided, of course, sufficient water is at hand for irrigation purposes.

Being familiar with conditions in this section of Southwest Texas, where irrigation is a matter of general practice, I have frequent occasion to observe the many benefits which result from irrigation.

In the Rio Grande valley the culture of sugar cane is the object of no little attention. Because of the uncertainty of rainfall, irrigation, with the source of supply, is practiced in its production. Last year one of the growers displayed a few sample stalks of cane at the Louisiana Purchase Exposition. He was awarded the gold medal over all competitors, including the display of products from Cuba and Hawaii.

On the irrigated sugar cane plantations in the Rio Grande valley the average yield is forty tons of the raw material, or 5,000 pounds of refined sugar, to the acre, and the cane produces for eight or ten years before replanting becomes necessary.

In the same locality marvelous yields of alfalfa have been realized through irrigation. One grower last year obtained ten cuttings from a field of as many acres. The average yield exceeded a ton to the acre.

Last year, in the vicinity of Brownsville, an onion grower realized net profits in excess of $600 from less than an acre of Bermuda onions. Irrigation was the reason for his success.

The latter part of February this year a truck grower in this section cleared an acre of land of its investment of chaparral. On the first day of March he planted it to potatoes. By the first day of July, four months later, he had raised and sold a crop of potatoes and a crop of watermelons from the same land. The crop of potatoes netted him $120, and his profit on the crop of watermelons was $160. He irrigated both crops.

Scores of similar instances of the profitable use of irrigation might be given, but the several cited above are sufficient to prove that irrigation is a most desirable thing. Larger returns per acre, quicker production, and a better commodity, all of which argue for better prices, are considerations worthy of meditation, but secondary to the greater consideration of assured returns. These are the benefits attendant upon irrigation and benefits which can be realized in no other way apart from irrigation.

The question of irrigation is one whose requirements are too exacting to be dealt with technically in connection with this brief discussion. Those who are interested in the subject can procure all of the necessary information concerning it, together with practical suggestions with respect to the provision of a system of irrigation, by addressing the secretary of agriculture, Washington. The United States Department of Agriculture has given the question no little attention during the past few years, and the reports of its agents who have been employed to study it in all its phases are replete with valuable facts, figures and suggestions for the farmer who desires to make his vocation one of greater and more certain remuneration.

To say that agriculture has come to have a new meaning in Texas during the past few years is but to repeat a fact which all well informed business men, farmers, bankers—in fact, all those engaged in any manner of enterprise—are familiar. Much has been accomplished and results obtained have reflected themselves in the status of the commercial and financial world. General conditions have improved because conditions agriculturally have been bettered.

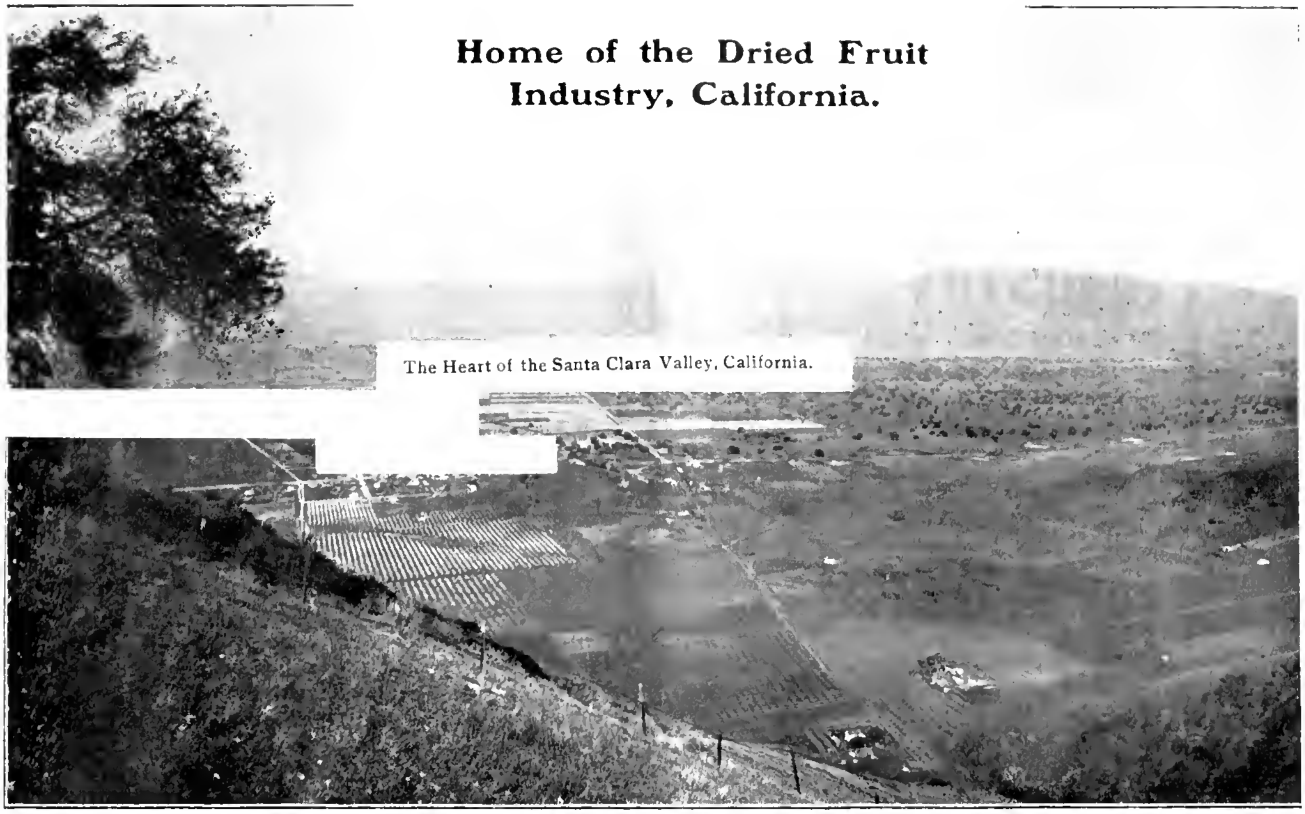
But a greater problem remains to be solved. It is the question of irrigation. No argument is necessary to prove it a desirable thing. But attention should be called to its importance continually as a stimulator of general prosperity. "All things begin and end with the plow" and if we are able to increase the effectiveness of the plow we may reasonably and assuredly expect a betterment of general conditions.

And this can be accomplished through irrigation.

THE SANTA CLARA VALLEY, CALIFORNIA.

There is great development work being done in the Santa Clara Valley, California, illustrations of which are shown in these pages. Our prints show scenes on the famous Dunne Ranch, which is part of what was formerly the great Murphy Ranch, a Mexican grant to one Murphy. There were over 70,000 acres in the Murphy grant, but this property was subsequently cut up and divided among the heirs and Mrs. Catherine Dunne, a daughter of the original Murphy, came in for a great block of the land which is now known as the Dunne Ranch and is being subdivided and sold in small lots to farmers and orchardists. This ranch spans the heart of the famous Santa Clara Valley, including the valley plain, foothills and mountains, and contains 18,000 acres of the princely California domain acquired in early days. It is on the main Southern Pacific coast line twenty to twenty-five miles south of San Jose. It offers all that has made the Santa Clara Valley great. The products include all fruits in perfection, and from this section comes most of our well known California dried fruits, it is the great vineyard section of the valley. The principal town on this property is Morgan Hill.

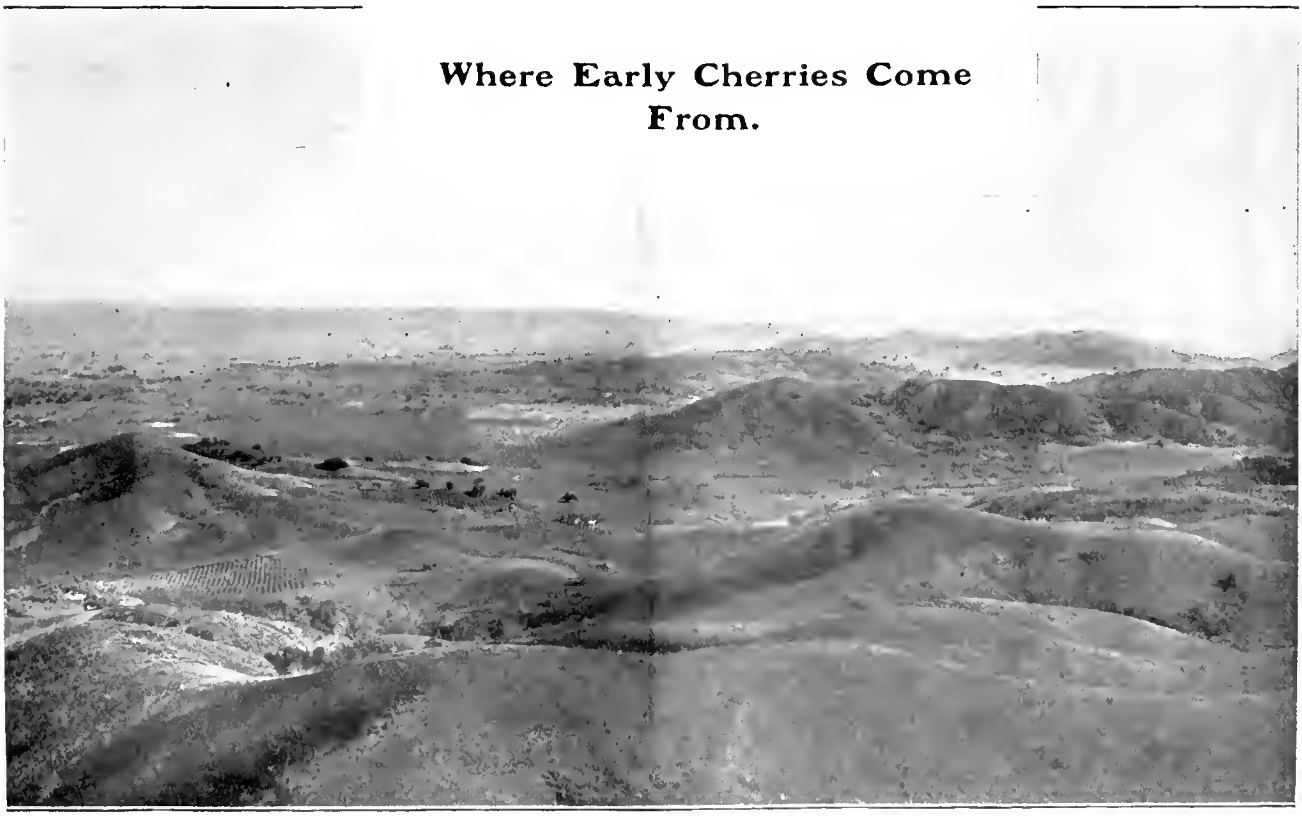
Home of the Dried Fruit Industry, California.



The Heart of the Santa Clara Valley, California.

Santa Clara Valley (North End), California.

Where Early Cherries Come From.



Santa Clara Valley, California (South End).

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THE IRRIGATION AGE

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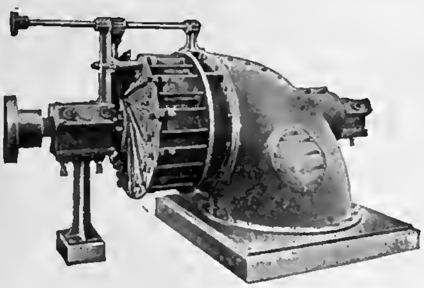

THE IRRIGATION AGE

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THE IRRIGATION AGE

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A monthly illustrated magazine recognized throughout the world as the exponent of Irrigation and its kindred industries. It is the pioneer journal of its kind in the world, and has no rival in half a continent. It advocates the mineral development and the industrial growth of the West.

Duty of Water. We are presenting in this issue an article by Mr. Frank Adams, of the office of Experiment Stations, United States Department of Agriculture, taken from Water and Forest, San Francisco. The illustrations used in connection therewith are presented through the courtesy of that journal.

Visitor From Russia. Mr. Nicholas Sinelnicow, an agricultural engineer of note and special representative of the Minister of Agriculture of Russia, is at present in this country studying irrigation development and agricultural conditions for his government. Professor Sinelnicow traveled throughout the irrigated West with the editor of THE IRRIGATION AGE and was an interested visitor at the 13th National Irrigation Congress recently held in Portland, Ore. While in Portland he met many men of prominence connected with the Reclamation Service and spent several days in the company of Chief Engineer of the Reclamation Service Newell, visiting the more important government projects in Idaho. Professor Sinelnicow also spent some time in Colorado and Utah, as well as North Dakota, Montana and Washington. He later visited California and Nevada and will return to Russia well supplied with data concerning this wonderful country. All who met the gentleman expressed admiration for him and his ability as an engineer. Professor Sinelnicow will probably write a story of his trip which will be brought out in book form later on. While on the trip west he secured about one hundred fine photographs of irrigation scenes which will be used to illustrate his story.

Strange Attitude. Mr. G. L. Shumway of Scottsbluff, Neb., sends us a communication concerning the attitude of Mr. Newell when he was called before the Committee on Resolutions of the 13th National Congress, which is presented on another page. He also explains his motive in presenting Resolution No. 1, which seemed to give Mr. Newell and his assistants, as well as his superior officers, considerable anxiety. The fact of the matter was that Mr. Newell made strange admissions before the Committee and brought in the names of the President, ex-Secretary of War Morton and others in such a way as to leave the impression that when his department is criticised he immediately calls on those higher in authority before answering or forming a decision. That, to be sure, is his privilege, but it is doubtful if the President or ex-Secretary Morton expect him to defend himself by quoting what they would naturally expect to be private conversation. To a bystander, it appears that Mr. Newell tried to detract attention from his department and forestall action on the resolution by pulling in the President, ex-Secretary Morton and a private citizen of Nebraska who was not present and had no representative on hand to defend him. Mr. Shumway, as stated in his communication, withdrew the resolution rather than injure an innocent individual by urging its passage under the misapprehension caused by Mr. Newell's reference to the President and ex-Secretary Morton. Mr. Newell may rest assured, however, that he will hear more of this matter in the future.

Objectionable Tactics. If Mr. George H. Maxwell has ever entertained any doubts about his popularity among the manufacturers of agricultural implements, he had an opportunity to settle the question for good and all at the annual convention held at Niagara Falls September 27-29.

Mr. Maxwell was present as usual and attempted through the assistance of Colonel Nones and one other delegate to convey the impression that the Committee on Public Lands and Irrigation of that body was incompetent.

The members of that committee was composed of the following well-known manufacturers: Mr. C. G. Rowley of the Aspinwall Manufacturing Company, Jackson, Mich.; Mr. Thos. B. Carson, Bettendorf Metal Wheel Company, Davenport, Iowa, and Mr. C. B. Dempster, president of the Dempster Mill Manufacturing Company, Beatrice, Neb.

As usual Mr. Maxwell made an effort to be permitted to deliver a speech, but that was forestalled by the action of the delegates who have grown tired of his long-winded talks. Several efforts were made to secure a place for him on the program, but they were unsuccessful. Mr. Maxwell was not to be squelched so easily, however, and finally forced his way to the front of the convention hall and broke in. He made a prior effort for recognition by the speaker, but was called down.

One of the best known delegates stated after he was through speaking that he had been in sympathy with Maxwell's work in past years, but was now thoroughly satisfied that he has some wrong motive; that no man could force his ideas on a body of men who were not anxious to consider them unless some ulterior motive prompted him.

The implement trade press, to a man, is acquainted with the motives of this individual, and not one of the five leading journals in this line are in sympathy with his movement. It is evident that Mr. Maxwell and his small band of followers will find it necessary to hunt for newer and more verdant fields. Hail! George H. Maxwell, "an-you will" it, good-bye.

MONTANA COOPERATES WITH THE GOVERNMENT IN IRRIGATION PROJECTS—OTHER RECLAMATION SERVICE NOTES.

At the last session of the legislature of Montana it was provided that State lands involved in Government irrigation systems should be sold substantially under the same conditions as the lands belonging to the United States.

This law has been recently construed by Attorney-General Albert J. Galen, of Montana, who has rendered an opinion for the guidance of State Land Registrar John P. Schmidt. The attorney-general's construction of the law has made plain the means provided by the legislature for coöperating with the United States.

The main question involved was the price at which State lands were to be sold. The attorney-general has construed the language of the law to mean that until the time when the Government is ready to furnish water for the lands they may be sold at any price which they will bring; but after that time they shall be sold at the minimum price fixed by the enabling act of the State of Montana, namely, $10 per acre.

Even though in addition to the price of the land the purchaser must pay to the United States the cost per acre of constructing the irrigation works, it is possible that in some favorable localities the lands can be sold at a price in excess of $10 per acre. It is believed, however, that in most cases the State will not be able to sell the land for a greater amount.

Under the provisions of the State law the land must be sold in accordance with the farm units fixed by the United States and subject to the limitations concerning private land found in the Federal Reclamation Act. Amongst these are that the purchaser shall apply for a water right and shall live on the land or in the neighborhood. He is also required to pay the cost of construction per acre as fixed by the Secretary of the Interior in annual installments as required by him, not exceeding ten, without profit or interest.

It is to be observed that while the State in this legislation has apparently made a concession to the United States, it will be definitely benefited by the operations of this act.

In the first place there will be a sale for this land at a higher price than could be obtained under any other conditions without expense to the State.

In the second place, many thousands of acres of State land which could probably never be sold will by means of Government irrigation construction be salable at $10 or more per acre.

In the third place, the possibility of the State lands passing into the hands of parties who will hold them in large blocks and for speculative purposes, will be entirely eliminated and instead they will be owned for all time in small tracts by actual home-makers, resulting in a very large increase in the valuation for taxation purposes and a far greater improvement of the land; involving also a large increase in population and business development.

In the fourth place, the possibility of selling so much State land as could not otherwise be disposed of will add largely to the funds available for school purposes and thus become a lasting benefit to the entire population of the State.

IRRIGATION NOTES.

Adna Dobson, secretary of the Nebraska State Board of Irrigation, said on his return home from the irrigation congress to a reporter of a local paper: "One of the important actions of the irrigation congress was the adoption of a resolution repudiating the alleged connection of the National Irrigation Association with the National Irrigation Congress. The former has absolutely no connection with the latter and no one is authorized to collect funds for the irrigation congress. The congress merely is an annual meeting of those interested in irrigation matters to compare notes."

The most conclusive evidence that irrigation is a success is the large amount of land sold by the Billings Land & Irrigation Company, Billings, Mont., from their newly irrigated lands on the Billings bench. In the short space of time from July 20 to August 15 the company sold over 2,000 acres of land, receiving a total of $100,000 from the sales. The land was sold to farmers from the middle east principally, but a number of the new settlers were from the state of New York and other seaboard states.

Elwood Mead, the irrigation expert, was once in Germany and had great difficulty in having his German understood. Especially was this so at the table. On one occasion he became provoked at a waiter who failed to bring him what he wanted and drew from his pocket a pencil and paper. He wanted mushrooms and he drew one on the paper. The waiter nodded that he understood and proudly returned with what he thought he wanted—an umbrella—which was all the more a joke because Professor Mead is such a believer in irrigation.—*Oregon Irrigator.*

"The forest falls," wrote James J. Hill to the irrigation congress, "the mine is depleted of its precious contents, even the seas might, if searched too severely, cease to give tribute, but the soil is the last unfailing resource. Play games as we may with picture cards, adorned with other names, the man at the bottom, the man with his foot upon a plot of ground, the man who is drawing from the earth food for himself and others is the foundation for all advancement as well as of all prosperity. Make way for him; for where he is decaying the pillars of the state are weakening, and all the more impressive forms of wealth are trembling toward the dust."

"One of our Government's irrigation projects now under way involves the erection of the highest dam in the world, a dam that will rise 240 feet above the water line and will extend eighty-eight feet further down to bedrock. This is to dam the canon of the Shoshone River, in the Big Horn basin, in Wyoming. The dam is at the narrowest point in the canon, the granite walls of the river being here but sixty-five feet apart. But the dam will create a lake covering 5,000 acres which will take the rainfall from the watershed of 1,250 square miles, and will store enough water to irrigate 150,000 acres of very choice land. The water from this lake will be carried to these lands through seven miles of 14-foot tunnels bored through the solid rock. For the building of the dam itself 60,000 barrels of cement alone will be needed. This project is one of the most ambitious feats of irrigation engineering in the world. It will cost the Government about $2,000,000. but it will create land values to the Government of about $4,000,000 and to the land owners almost immediately upon their purchase of about $15,000,000. The annual crop from the irrigated land under this dam could easily be worth twice the cost of the entire dam and irrigation works. The man in charge of this great work is Mr. Jeremiah Ahern, a Government district engineer. This project is one that Col. Bill Cody and General Miles at one time attempted to finance for operation through private capital and failed to raise the necessary funds.

THE LOSS OF IRRIGATION WATER BY EVAPORATION AND HOW TO LESSEN IT.*

BY SAMUEL FORTIER,

In charge Pacific District Irrigation and Drainage Investigations, U. S Department of Agriculture.

The loss of irrigation water is becoming an old theme in a region where the practice of irrigation is comparatively new. The reasons for so general an interest are obvious. Of the many natural resources of the west, water ranks first in importance. It is yearly becoming more difficult to obtain, and of higher value. So long, therefore, as water is needed to overcome the aridity of an otherwise fertile soil, its economical use is likely to constitute one of the chief problems of western agriculture.

For a number of years the agents in charge of irrigation investigations of the office of experiment stations of the United States department of agriculture have devoted a part of their time in seeking to determine the extent of the various losses to which irrigation water is subjected. As a result of their efforts in this direction the losses caused by leakage, evaporation and percolation from a large number of typical canals have been ascertained and from these data it has been possible to estimate somewhat accurately the total loss from these causes. In like manner the waste of water due to faulty and crude methods of measurement and distribution have been pointed out, as well as the large losses which occur on most irrigated fields through carelessness in not properly preparing the surface, or through unskilled methods of applying the water.

PROF. SAMUEL FORTIER.
In charge Pacific District Irrigation and Drainage Investigations, U. S. Department of Agriculture.

The investigation of the various ways in which water is wasted from the time it is taken from the

*Paper read before Thirteenth National Irrigation Congress, Portland, Oregon.

stream, or other source of supply, until it is absorbed by the fibrous roots of living plants, has led us into a new field of inquiry. We have found, particularly in the warmer portions of California, that the greatest loss of irrigation water is from moist soil into dry air. There would seem to be no end of tolls on water on its way to the plant. To such an extent is this true that the amounts actually utilized by vegetation frequently bear but a small percentage to the volumes diverted. For every 100 miners' inches which pass through the headgate, thirty are liable to be lost in percolation before the field is reached. Then in applying the remaining seventy inches, if the surface is uneven the greater part will flow into low places and be partially wasted while the high places may remain dry. In this way probably not more than fifty out of the seventy inches reach the land it is intended

During past years, observations have likewise been taken and records made of the rate of evaporation from the surface of soils of different character, but unfortunately for arid America these experiments have been carried on for the most part in the humid regions of Europe and America and can not be considered as safe guides in western practice. It may be said, therefore, that the investigation of the loss of water by evaporation from the standpoint of the irrigator is a new field concerning which little is definitely known. This being true, the question naturally arises as to its relative importance compared with other questions which demand consideration. Whether it is entitled to rank among the first is for you to determine. In my humble opinion the interests of western agriculture demand that it be given considerable prominence.

The loss of water by evaporation injuriously af-

View of Santa Clara Valley, California. [A Famous Irrigation District.]

to water. Now having moistened the soil with these fifty inches, the chances are that 40 per cent will pass off into the air without benefiting in the least degree the plans which it was intended to nourish. Thus of the 100 inches diverted only thirty may fulfill a useful purpose.

I have referred to this subject of losses by evaporation as a new field of inquiry. This is true only as regards irrigated agriculture. For at least fifty years men have observed and recorded the evaporation of water from water surfaces, but with the purpose of ascertaining the probable losses from reservoirs. Reservoirs, as a rule, impound large quantities of cool water on more or less elevated sites which may be surrounded by forests, while irrigated fields, on the other hand, are usually covered by thin sheets of warm water, and the rate of evaporation from them is far different.

fects both the Western farmer who irrigates and the one who cultivates the dry bench. All other taxes paid by the farmer are small in comparison to the one levied by the atmosphere in robbing the soil of its much needed moisture. The magnitude of this loss, which is borne by the irrigators, is enormous. Between seed time and harvest of each year there is sufficient water spread over the West to cover all of New England a foot deep. In some sections this water is still reasonably cheap; in others it is very dear. The annual cost to the farmers in applying so much water probably exceeds $25,000,000. Now if we assume that 40 per cent of this water which costs so large a sum each year is lost by evaporation it is equivalent to an annual tax of $1 per acre on every acre that is irrigated.

The loss to the dry farmer is caused by diminished yields. He is dependent on the natural rainfall and as a rule his crops are poor or good in proportion to the amount of moisture in the soil conserved from previous precipitation. Every acre-inch of water which is retained and prevented from passing into the atmosphere may produce an extra bushel of grain per acre. There is only water enough to irrigate a part of the fertile, arable land of the west, and so for every acre that is irrigated there will in time be several acres that must of necessity be farmed dry. How best to conserve the soil moisture over so vast an area, comprising the dry farms of sixteen States and territories, is a question which deserves the thoughtful consideration of every western farmer.

TANK IRRIGATION.

In attempting to give a brief account of our efforts in connection with this latest branch of applied irrigation candor compels me to state that our progress has been slow and that while a certain measure of success has been attained, we have also gained in experience through failures. We soon found that in work of this character it would not be wise to rely too much on experiments conducted in the laboratory or under more or less artificial conditions. We wished to find out what became of the water which was spread over cultivated fields and the only practicable way to obtain this information seemed to be to conduct experiments in the field. Some mistakes were made before we secured the right kind of vessels to hold soils. The single tanks which were first used were later converted into double tanks, water jacketed, in order to facilitate frequent weighings and to maintain a temperature substantially equal to that of the adjacent soil. All the tanks now used in California are double, having an annular space of about one inch between the outer and inner, and this space is filled with water. The double tank is placed in the field or orchard with its top a couple of inches above the surface. The equipment for weighing consists of a suitable derrick, differential pulley blocks and a scale. Each tank is raised by means of a bale, weighed and again lowered into the water of the outer tank.

EVAPORATION FROM A WATER SURFACE.

Much of the work done in California during the past two years being of a preliminary nature, it was thought best to study first the rate of evaporation from a water surface and the various factors which influence it, and to use the water surface as a standard to which all records pertaining to soil surfaces might be referred. Besides, in irrigation it is customary to flood the surface or to hold the water for a time in checks and basins and a knowledge of the rate of evaporation from such surfaces was necessary in order to compute the loss. The vessels used for this purpose were single tanks about thirty inches deep, and the amount which evaporated each week was determined by a small hook gage fastened to the edge of the tanks. The temperature of the water was observed and recorded whenever an observation of the evaporation was made.

The wide range of temperatures in California and the corresponding effect on evaporation induced us to ascertain, if possible, to what extent evaporation is influenced by temperature. Five tanks were placed in an open field at Tulare, in the San Joaquin Valley, last July, and filled with water, with the idea of maintaining in them temperatures ranging from fifty to ninety degrees Fahrenheit. By packing ice and sawdust around the cold tanks an average of 51.9° was maintained for the first and 61.3° for the second. Oil lamps were kept burning continually at the bottom of each of the hot tanks and average temperatures of 80.4° and 88.7° respectively were maintained. The results show that the evaporation from the surface of the hot tanks was seven times as great as from the coldest tank.

Average Temp.	Average Weekly Evap.
51.9 degrees.	7-12 inches.
61.3 degrees.	1 1-6 inches.
76.2 normal.	2 5-8 inches.
80.4 degrees.	3 inches.
88.7 degrees.	4 inches.

The range of temperature, between 50° and 90° F., is well within practical limits. The temperature of irrigation water taken from streams of the Sierra is frequently as low as 50°, while that of the irrigation ditches which furnish water to the cultivated portion of the Imperial Valley in southeastern California has been known to rise to 92°. As regards the temperature of the surface of irrigated soils, the range is much greater. Last July the temperature of soil in the orange orchards near Riverside reached 150° F. There is, therefore, in the case of the soils of the citrus regions of California a range of over 110°.

While experiments were being conducted to determine the effect of temperature on evaporation, an effort was made to include the effect of the remaining factors, such as wind, relative humidity. This preliminary work pertaining to evaporation from a water surface is now nearly completed and when the results are compiled they will furnish a guide to the more difficult task of ascertaining the rate of evaporation from soils.

EVAPORATION FROM SOIL SURFACES.

Evaporation from soil surfaces has been determined in connection with the work of growing crops of different kinds in double water-jacketed tanks in the open field. Oats, barley, wheat, alfalfa, corn, beans, sugar beats, potatoes and peanuts have been grown in this way by using from six to twelve tanks for each crop and varying the amounts of water applied to each.

THE RATE OF EVAPORATION IS DIRECTLY PROPORTIONAL TO THE AMOUNT OF MOISTURE IN THE UPPER LAYER OF SOIL.

The fact that a moist soil evaporates more than a dry soil has been known for some time. The chemists of several western experiment stations, in taking samples of soil at different depths, both before and after irrigation, have shown this to be the case. It is believed, however, that our experiments carried on in California were the first to demonstrate this fact by actual weighings of soils.

On June 14, 1904, twelve galvanized iron tanks were filled with soil of average quality and placed in an open field on a level with the surface of the ground. The soil at the start was fairly dry and contained less than 8 per cent by weight of moisture. The experiment was carried on in duplicate. Two tanks received no water and the remaining ten received quantities varying from 3.8 to 11.3 inches in depth over the surface. The water was applied on the surface and the day following the soil was finely pulverized to correspond to a soil mulch made by thorough cultivation. From the tanks which received no water an amount equal to one-half an inch in depth evaporated, while from the tanks that received a depth of 11.3 inches, 9.5 inches, or 84 per cent, was lost by the time the experiment was terminated in September. The losses in several tanks are shown by the table below:

No. of tank.	Amount of irrigation water applied over the surface.	Amount of evaporation over the surface.	Duration of experiment.
1 and 2	0.0	0.5	92
3 and 4	3.8	3.1	92
5 and 6	5.7	5.4	92
7 and 17	7.6	6.5	92
18 and 19	9.5	8.5	92
20 and 21	11.3	9.5	92

A similar test was made in the orchards of southern California during the present month with tanks years ago the citrus orchards of southern California were watered by means of shallow furrows. At that time no deep furrows were used. Now more than half the orchardists use a smaller number of furrows and make these deeper. This change has resulted in maintaining a drier surface, in deeper application of water, and in deeper root development. In light irrigation it is becoming common to make but one deep furrow, in which the soil may be loosened to a depth of fifteen inches midway between the tree rows, and immediately after irrigation this deep furrow is filled with dry soil. By this method there is practically no loss by evaporation. By the use of shallow furrows, spaced two and a half feet apart, the surface is moistened, evaporation is excessive,

Weiser Bridge, across Snake River, Weiser, Washington County, Idaho.

holding 1,200 pounds of soil and the results corroborate the test of the previous year.

HOW TO LESSEN THE WASTE FROM EVAPORATION.

Less Frequent Waterings.—In a brief paper like this the several practical ways of checking evaporation can only be suggested. Climatic conditions, crops, soils, quantity of available water, and other factors exert a controlling influence. In the performance of all labor toward this end, the main principle to be kept constantly in mind is that the rate of evaporation from the surface of soil is in direct proportion to the amount of moisture which it contains. Keep the surface of a field moist by continued or frequent irrigation and the greater part of the water will pass from the soil into the air. On the other hand, keep the surface dry, or wet it only at long intervals and cultivate often and thoroughly and the greater part will be retained. The first suggestion I have to offer, therefore, is to irrigate all deep-rooted plants less frequently and apply, if need be, larger quantities of water at each irrigation.

A smaller number of deeper furrows.—A dozen

and the fibrous rootlets are lured to the surface layer of soil, only to be withered and killed by the succeeding drouth.

Cultivate After Each Irrigation.—Whereved the nature of the crop will permit of cultivation, no time should be lost in pulverizing the surface when it is sufficiently dry. Keeping always in mind the fact that a moist surface soil in hot weather will daily lose a large amount of water by evaporation, the sooner a field can be cultivated after being irrigated the more water will be retained. This practice need not be confined exclusively to orchards, root crops, vegetables and corn. A thorough harrowing at the right time does not injure alfalfa and the yield from grain fields can frequently be increased by a like practice.

Deeper Soil Mulches.—The belief is current that a dry, well pulverized soil mulch, two inches in depth, will protect the moisture beneath from evaporating and that it would be a useless expenditure of time and labor to increase this mulch beyond four inches. This belief does not hold true for the warmer regions of California. There it requires a ten-inch covering to afford anything like complete protection. This was plainly indicated by an experiment conducted near Riverside, Cal., during the first week of August, 1905. Tanks to the number of fourteen were filled with soil and divided into four groups. The soil in group 1 was irrigated on the surface, that in No. 2 four inches below the surface, that in No. 3 eight inches below the surface, and that in No. 4 ten inches below the surface. In other words, the irrigated soil was covered by means of a dry mulch to depths of four, eight and ten inches, respectively, while the first group had no mulch whatever. In twelve days the losses by evaporation were in the proportion of 22, 6¼, 3 and 1. That is to say, while the tanks which were protected by a ten-inch mulch lost on an average of half a pound of water, the tanks that received no mulch lost on an average of eleven pounds, or in the ratio of 1 to 22. In determining the moisture content at different depths by means of a large number of borings on a ten-acre orange tract, the same fact was demonstrated. This tract was irrigated in the fall of 1904, received eighteen inches of rain water during the winter months, and was frequently cultivated, but in June, 1905, little or no free water was found in the upper ten or twelve inches of soil. Neither were there any roots in this layer. The bulk of the roots were found in the second, third and fourth foot, but a considerable number were also found as low as nine feet below the surface.

The Effect of Shade.—One should not underestimate the effect of shade in reducing evaporation. The effect of shade can most readily be observed in orchards. The loss by evaporation from tanks shaded by orange trees was much less than on those exposed to the rays of the sun. This difference is chiefly due to a difference in temperature. At noon on July 5, 1905, the temperature of shaded soil was 94½°, while that in the sun was 148° Fahr.

WINTER IRRIGATION.

In conclusion I desire to recommend the practice of winter irrigation as a means of checking evaporation. Many of the orchardists of the Santa Clara Valley in California irrigate during the rainy months of February, March and April, and by applying twenty-four inches of water over the surface in addition to the sixteen inches derived from rainfall, they manage to grow excellent crops of deciduous fruits without resorting to summer irrigation. Some may think that soil irrigated in March will become very dry in June, but the dry soil is confined to the top foot. Beneath there is moisture, which deeply rooted plants have no difficulty in securing. This practice of applying a heavy irrigation during rainy weather, or when the top layer of soil is moist lessens surface evaporation and permits a large part to be stored in the deep sub-soil.

Winters is paying 30 cents a pound for butter and 22 cents for eggs, both shipped here and from irrigated districts, even farmers are buying them, while they grow wheat at prices that may or may not pay expenses. Some of these farmers are opposed to the use of water. The United States Agricultural Experiment Department published the other day the results of irrigating barley land. Where six to ten sacks were a good yield, the application of eighteen inches of water resulted in twenty and twenty-two sacks to the acre. Another year the land will need less water to achieve the same result.—*Winters (Cal.) Express.*

NATIONAL IRRIGATION CONGRESS A SUCCESS.

C. M. Heintze, Editor of The Rural Californian, Expresses His Views.

Mr. C. M. Heintze, editor of *The Rural Californian,* who attended the Thirteenth National Irrigation Congress, has the following to say concerning it:

"It is indeed gratifying to record that the last session of the National Irrigation Congress, held in Portland, Ore., from the 21st to the 24th of September, inclusive, was remarkably successful and far surpassed any previous sessions, both in the work accomplished and the general ability and character of the delegates present. The resolutions passed are, as a whole, free from ambiguity. They are clean cut and to the point. In the one relating to Texas, however, many exceptions will be taken. The recommendation that that State be brought under the provisions of the national irrigation law can not be considered in any light other than absurd. And for the Secretary of the Interior to direct engineers of the United States reclamation service to examine and report upon feasible irrigation projects in Texas would be a greater absurdity if it were possible. The Government of the United States owns not a foot of land in that State. Therefore, how is it possible in the dealing out of equal justice to give Texas the benefit of the same service that is now extended to other arid sections? The national irrigation law, enacted for the benefit of the greatest number, must not be diverted to the interest of private individuals, as it surely would be if made applicable to the Lone Star State.

"The resolution relating to the reclamation service rings true, as does also the one commending experiment work by the United States Department of Agriculture. Of equal clearness and force is the following resolution which we print in full:

"'Believing that too much capital, public and private, can not and will not be invested in the reclamation of arid lands, it is the sense of this congress that Government, as well as private enterprise should both be extended to the utmost, and that Government enterprise should not unnecessarily interfere with prior private enterprise actually engaged in a particular field, nor should subsequent private enterprise interfere with nor prevent government enterprise from reclaiming arid lands.'

"But most significant of all, and the one that will attract attention in all parts of the country, and more particularly in southern California and Arizona, is the one that struck at the devious methods of the Maxwell-Boothe combination. It reads:

"'Resolved, that there is not now nor has there been any connection whatever between the National Irrigation Congress and the incorporated company known as the National Irrigation Association; and it is hereby announced that no person, corporation or company has been or is authorized to solicit or collect money for or in behalf of the National Irrigation Congress.'

"Thus the National Irrigation Congress formally divorced itself from and renounced all conections with the 'National Irrigation Association'—sometimes referred to as the 'Maxwell-Boothe combination,' and which, in our opinion, is the appropriate title.

"The introduction of the above resolution precipitated a warm debate. McAlpine, of Minnesota, stated that in his own State 'several thousands of dollars had been collected by the so-called "irrigation association" in behalf of the National Irrigation Congress.' "

"Senator Carter, of Montana, stated that the funds of the 'irrigation association' were largely secured by personal solicitation by letters written by George H. Maxwell as executive committeeman. Scipio Craig, of Redlands, Cal., came to the support of Maxwell, but he was not at all effective in lessening any of the bitterness manifested against that gentleman. If he accomplished anything it was to increase it. But Scipio was not to blame. He knows, as every one in this section at least knows, that the 'Maxwell-Boothe' corporation has not for a long, long time enjoyed the confidence of the public.

"Then followed a heated controversy between Senator Carter and C. B. Boothe, a member of the 'irrigation association,' and chairman of its executive committee. He said that no member of congress would dare impugn the motives of the association, and that while its books were open to inspection, he denied the right of the congress to criticise or investigate its operations; and then declared, with a voice vibrating with anger, that any assertion that moneys collected by his association had been wrongfully applied was simply a lie. By his display of anger Boothe lost what few friends he might have had, for Senator Carter's report on the subject was adopted by a practically unanimous vote.

"It will be observed that Mr. Boothe did not offer to submit his books to any body or set of men for investigation, and it is exceedingly doubtful if he would under any circumstances. In this turn of affairs Mr. Boothe is left in a sad plight, and we extend him our sympathy. Now that the declaration has gone forth that there is no connection whatever between the National Irrigation Congress and the Maxwell-Boothe corporation —'irrigation association'—the collections of funds will be small and much more difficult than formerly. And this being true, what will poor Boothe do? It may be said, 'the world owes him a living,' but what has he to give in return? Unquestionably he has been industrious and energetic in the interests of the Maxwell-Boothe corporation, but a divorce having been procured by the National Irrigation Congress, it is not unfair to assume that the poor jade, 'the irrigation association,' is left in a somewhat helpless position.

"But while greatly sympathizing with poor Boothe, we must not forget to be just to the merchants and business men of Los Angeles and southern California. They must be informed that the National Irrigation Congress does not solicit funds from individuals or corporations for carrying on the work of reclaiming arid lands. Any subscriptions of cash therefore to Maxwell and Boothe will revert to the Maxwell-Boothe corporation, or, in other words, the 'irrigation association.'

"The attempt on the part of Boothe and his few followers to use Tom Richardson, ex-secretary of the National Irrigation Congress, and now the popular manager of the Portland Commercial Club, proved a dismal failure. Mr. Richardson would have nothing whatever to do with Boothe. He knew him.

"It is fitting here to remark that to Tom Richardson's good judgment and untiring energy must a great part of the success of the congress be attributed. All the delegates had nothing but words of praise for him, and he deserved them.

"With the divorcement of the Maxwell-Boothe elements from the National Irrigation Congress we naturally expect greater success and better results in the future than have been achieved in the past."

QUEEN OF THE YELLOWSTONE — BILLINGS, MONTANA.

Great Openings For Farmers, Manufacturers And Investors.

"To Montana's hills and their dimpling rills,
Our vision is turned today."

To one who has gone through to the Pacific Coast without seeing Montana, a stop-over and even cursory examination of its resources, climate and possibilities is a revelation. The writer has often passed through this wonderful State en route to the coast, but has only recently gotten into the way of stopping off at the many points of interest within its borders. After one or two stops the habit grows on one until it soon becomes fixed, and later a desire to remain creeps in, so that it is difficult to keep that delightful State and its many attractions out of one's mind. On a recent visit, considerable time was spent in and around the Queen City of the Yellowstone Valley, Billings.

One writer has said that Billings admits—nay, even asserts—its greatness, and a close examination of this thriving city and a study of the surrounding agricultural and stock-raising territory, with a knowledge of the vast area to be drawn upon in a commercial sense, leads one to accept all it claims.

Billings enjoys the distinction of being the home of a number of red-hot boosters, and every one, from the school boy to the promoter, is working overtime in advertising its prosperity and prospects.

Billings is the county seat of Yellowstone County and is situated on the main line of the Northern Pacific Railroad, nearly midway between St. Paul and Seattle, at the gateway of the Yellowstone Valley, the Egypt of Montana. It is the most important railroad center of eastern Montana, being the western terminus of the Burlington system, with its branches running into the famous Big Horn Basin country of Northern Wyoming, and two branch lines of the Northern Pacific running to the great coal mining districts of Bear Creek, Red Lodge, Bridger and Gebo, with eight passenger trains daily, and more miles of yard and side tracks than any other station on the line of the Northern Pacific between St. Paul and the coast. The heaviest freight traffic (tons per mile) on the Northern Pacific being between Billings and Logan. It has a population of nearly 6,000 people. While the excellent open ranges tributary to Billings makes it easily one of the most important live stock shipping and receiving points in the State, it is to the irrigated farms of the Yellowstone Valley that it owes its phenomenal prosperity.

It is the center of the largest and most favorably located agricultural territory in Montana. To alfalfa, "the king forage plant of the agricultural world," is due the credit of subduing the sage-brush plains and paving the way to diversified farming. The soil of the valley is a rich alluvial deposit along the river bottoms, with a sandy loam on the uplands. Water is supplied from the Yellowstone River through four large systems of irrigating canals aggregating in length more than one hundred miles, and it is the boast of the farmers that they have on the average three hundred days of sunshine every year. With this combination of soil, sunshine and water, the elements of uncertainty in farming operations are minimized or eliminated entirely.

All farm products common to the middle and West-

BOOSTERS OF BILLINGS.

A. L. Babcock. Col. H. W. Rowley. Chief Booster Moss. W. T. Clark. Paul McCormick.

ern States are raised here in profusion, and in quantity and quality surpass those raised where the farmer is dependent upon natural rainfall for his soil moisture.

Alfalfa yields three crops a year, with a total yield of from five to seven tons to the acre. This crop is all disposed of at home, creating one of the valley's most important industries, that of sheep feeding, both roughing through the winter and fitting for market. More than 250,000 head of sheep were fed in the Yellowstone Valley during the last winter. Many cattle are also fed. The hog industry is yet in its infancy, but the few who have so far given it a trial have demonstrated the fact that Montana pork raised on alfalfa and finished on soft wheat and corn will afford the farmer a handsome profit on his feedstuff at a figure below that paid for packers' stock and at the same time furnish to the consumer a very superior article.

No part of the great Northwest affords greater inducements to the small grain farmer than does the Yellowstone Valley. Hard wheat yields from twenty-five to fifty bushels to the acre, while soft wheat runs from fifty to seventy-five, barley from forty to sixty bushels; oats yield from forty to one hundred standard bushels of thirty-two pounds, that weigh out from forty to forty-five pounds to the measured bushel. Corn from fifty to one hundred pounds.

Potatoes yield an average of from 250 to 300 bushels to the acre, with numerous instances of verified yields running near 1,000 bushels. Rutabagas, twenty to thirty tons. Sugar beets fifteen to twenty-five tons to the acre, running from 15 to 22 per cent saccharine matter, with a purity coefficient of from 80 to 85.

Apples, pears, cherries, plums and small fruits of all kinds yield well, attain a size and flavor unsurpassed and command a large advance over the imported article.

A special advantage to the agriculturist in the Yellowstone Valley is that the home demand for farm products of every nature far exceeds the supply, insuring a cash market and high prices.

Billings is noticeable for its business activity, its progressive citizens, and its beauty of environment, and in these combinations it is unexcelled by any city of twice its size in Montana, and probably not anywhere in the Northwest.

The streets are laid out in squares, avenues 100 feet wide and streets eighty feet, flanked by cement and plank sidewalks, beautiful shade trees and neatly kept boulevards. The homes of the people show tidy and tasteful surroundings, neatly kept lawns and beds of flowers being seen on every hand.

Its social and educational status compares favorably with cities many times its size in the East, and its climate is healthful and pleasant.

To the farmer, the business man, the homeseeker, or the investor, Billings offers opportunities worthy of consideration.

It is our intention to devote space in several of the forthcoming issues of The Irrigation Age to the Yellowstone Valley and give data concerning the possibilities of home building in this section. This will be done so that our many readers who contemplate locating in the West, where agriculture may be followed under irrigation, may secure a good idea of what can be accomplished with given sums of money so that they may thereby know in advance just what is necessary in the way of funds as well as the results to be obtained. With this end in view, the editor of this journal has spent a good part of two months visiting farmers who are established near Billings and much valuable data has been secured concerning their experiences, what induced them to locate in the West, their financial condition when they first landed in Montana, and a lot of other facts, which, it is hoped, will prove of interest and value to those contemplating a change. The following answer, which was recently received from an inquiry by mail, will give a fair idea of the results of the first year's crop and what is necessary in the way of equipment. Our correspondent fails to state that his land, with a perpetual water right,

MORE BOOSTERS.

W. B. George. Christian Yegeo. Austin North.

which insures sufficient water each season for all crops, cost about $35 per acre. We are informed that the company from whom this land was purchased has recently made a slight advance in the price of land. We give

Loading Alfalfa, Hesper Farm, west of Billings, Montana
[Hesper farm is owned by Hon. I. D. O'Donnell, Billings.]

herewith letter from settler, and it should be borne in mind that the land on which these crops were produced was what is known as barren sage-brush or desert land one year ago:

"In replying to your question as to how much it will cost a man to get started on a forty-acre farm, I

Home of Settler Near Billings. [See letter.

purchased forty acres of the Billings Land & Irrigation Company on the Billings Bench in 1904, and from my experience will say that a comfortable, plastered house of four or five rooms will cost about $600, and a fair barn could be built for $150. The fencing required on a forty-acre tract would cost about $150. The settler will need

"In addition, the settler ought to have $300 to $500
three horses, which will cost him $375, and harness would be worth $75. One cow would cost $50, two dozen chickens $12, a good wagon $85, plow $15, harrow $18, cultivator $5.
in cash to cover his living expenses until he gets returns from his crops.

"As to results I have obtained this year, I will say that I have sixteen acres of beans, which will yield 640

Schroeder's Ranch in Lake Basin of Yellowstone County, Montana. One of the big sheep ranches of eastern Montana.

bushels. I shall be able to sell these beans this year for 4 cents or better, which will bring me $1,536; twelve acres are in oats and will pay me $134; four acres are in potatoes and will yield 800 bushels or better. Fifty cents per hundred is about the lowest price that potatoes sell at in the fall. This would bring me $240.

"The balance of my farm is in young orchard, garden stuff and some used for house and barn yard.

Very respectfully,

"————————."

Mouth of 1,800-foot Tunnel carrying water through rock cliff near Billings.

An illustration is given in these columns of the home spoken of. It can readily be seen that our correspondent is well housed and has everything about the place in good ship-shape order. Will some of our city readers not agree with us that this method of living with an assured income is not preferable to a salaried position in town? What would three hundred days of sunshine mean to your children? Why not write to some of the Billings boosters and learn if they can start you out on the same plan?

In future issues will be given the story of some of the older settlers near Billings, who reached that country as laborers on the then new railroad and who are today prosperous and influential, nay, even wealthy citizens.

Temporary Home of Settler near Billings, Montana.

zens. There are hundreds of cases of this character in and around Billings, men who went into debt for land, lumber, farm machinery, household goods—in fact, everything—who are now rated as wealthy, retired farmers.

Many illustrations shown in connection with this article were secured through the courtesy of the Billings Booster Club, while a lot of other photographs were secured from Mr. Nicholas Sinelnicow, special representative in America of the Minister of Agriculture of Russia, who made the trip from Chicago to the Pacific Coast

Trestle carrying Flume of Billings Land and Irrigation Co.'s Canal. This Flume receives water soon after it leaves tunnel shown elsewhere in these columns.

with the editor of THE IRRIGATION AGE, visiting all of the important irrigation districts en route.

Our November issue will contain a more detailed description of many of the Yellowstone Valley farms.

FROM DESERT TO FARM.

Changes Wrought In Arid Waste By Irrigation Veritable Miracle.

Were all of arid America fit for the living it could be occupied by a third of the entire population of the

Concrete Outlet from Main Canal of Billings Land and Irrigation Co.'s Canal which forms Lateral shown in another view

United States. Go into the foothills of Colorado and Nevada. There the sagebrush springs from the sand as it does on the sun-baked mesas of Arizona and New Mexico, away to the south. The statistician estimates that even in Kansas, Nebraska and the Dakotas fully 75,000,000 acres will produce only a scanty herbage—just enough to keep range cattle alive a few weeks during the grazing season—yet these states are not considered a part of the desert.

Already a modern miracle has been wrought. The one who has not visited the oasis created by irrigation may scout this assertion, but should he chance into the valley through which the Rio Pecos flows, or in Colorado along the Poudre River, the landscape of field, orchard and garden which nature has created in a literal wilderness will convince him beyond the shadow of a doubt. In the southwest fruits and grains, both of the tropic and temperate zones, are to be seen growing in luxuriance where yesterday only greasewood, sagebruth and cactus existed.

Yet the soil is unchanged, save for the application of water. It is that of the desert—without moisture, almost incapable of supporting life. When moistened, however, these particles of sand, even alkali rock, contain properties so fertile that from them springs vegetation more abundant and luxuriant than the crops that are gathered from the rich black loam of Indiana and Illinois and the fertile valleys of New York itself.

Though less than 10 per cent of the available area for irrigation has thus far been reached, in Colorado itself no less than 75 per cent of the lands available for cultivation depends upon the artificial water supply. These farms aggregate 750,000 acres. The South Platte valley, the most extensively irrigated region in the United States, including portions of Colorado, Wyoming and Nebraska, has 2,000,000 acres which are artificially watered. Farms in Utah thus supplied aggregate 300,000 acres, Arizona contains 100,000 acres, New Mexico 150,000 acres, Nebraska 100,000, while some of the most productive valleys of California, which send their fruit and vegetables by the carload to all parts of the United States, as well as the principal cities of Europe, are nurtured entirely by wells and canals. Yet the average size of an irrigated farm is not over forty acres, which gives an idea of the millions of people who today depend upon these great waterworks for their livelihood.

THE IRRIGATION PLANT AT CONRAD, MONT.

A Montana exchange says the great irrigation plant installed in Teton county through the broad-minded and far-sighted business enterprise of Hon. W. G. Conrad, of Great Falls: This enterprise is the largest in the state up to date and nearly equals some of the government's proposed irrigation schemes. It is assured that Mr. Conrad is even now busy with plans that will result in this great tract of land, which he has redeemed from an arid desert and made available for farms and homes, being cut up into individual tracts and settled with thrifty farmers who will own their own homes and become producing and prosperous citizens of the state. Only by such transformation is it possible for him to realize profit or interest on his investment, and he has steadily kept this object in view through no little misrepresentation and envious comment by those

One of Laterals from Canal of Billings Land and Irrigation Co. East of Billings.

who, unable to accomplish such beneficent results themselves, would yet put any obstructions possible in the way of others who could and would bring the project to a successful issue. It is not too much to expect that in a very short time a thousand families will find profitable work and a prosperous living on land which only a few years ago furnished nourishment only for a few bands of sheep, work for a score of herders and profit for their half dozen owners.

One has but to look at the land above this ditch, brown and bare, and not worth a dollar an acre, and compare it with the smiling fertility of the land below, which has had irrigation, to realize what a great increase in the wealth of Teton county and its agricultural resources has been wrought by these ditches. The man who makes a million or two of dollars in Wall street but transfers wealth from others to his own coffers, but the man who digs mineral wealth from the soil and puts it into circulation or the man who multiplies the productive value of an acre of land increases the sum total of wealth in the world instead of changing the distribution of wealth already produced. Every man who adds to the total of wealth in the world by production deserves well at the hands of his fellow men. Among the list of these in years to come the name of W. G. Conrad will rank high, and of all the productive enterprises in which he has engaged in the past with profit to himself and advantage to the state, none will reflect greater credit on his name, or be a source of more pride to his posterity, than the land and irrigation project at Conrad, which will change 100,000 acres of desert into the sites for happy homes and waving fields of grain.

View of Beet Sugar Factory, Billings, Mont.

TO TEACH IRRIGATION.

Washington State College Will Take Up A Timely Study.

The State College of Washington will teach irrigation as a special subject. The program for the coming year will cover the entire subject, including the building of reservoirs and ditches; the measurement and distribution of water; time to irrigate and best methods of application.

Another view of Main Lateral from Billings Land and Irrigation Co.'s Canal

Prof. O. L. Waller, who has had charge of much government work in this connection, says to the *Inland Farmer* of Spokane:

"The state of Washington is now entering upon an era of agricultural settlement and development which is destined to make it one of the foremost irrigated commonwealths in the United States.

"The completion of this development will involve the expenditure of millions of dollars in canals and ditches and still a greater number of millions in leveling and grading the land for the application of water. To tens of thousands of people who do this work the problems of irrigation will be entirely new, and to leave them to learn all its lessons by experience will involve the loss of large sums of money in mistakes and in the inauguration of wasteful and improper methods of distributing water, which will tend to retard both present and prospective development of the state."

VAST INCREASE IN LAND VALUES.

Section That Sold Decade Since at $11,000 Now Worth $760,000.

KENNEWICK, Wash., Sept. 18.—Frank Dudley says he purchased section 36 here ten years ago for $11,000. The land is now worth $760,000; in fact, it could hardly be purchased at this figure. The comparison of actual figures is one of the most remarkable demonstrations of the wonderful advance in land values that has yet cropped up in the Kennewick district.

Mr. Dudley lives at Niagara Falls, N. Y., and is here on a visit. He was heavily interested in the old canal company that failed in the panic of 1894 and started to build the town of Kennewick. Section 36, on which the principal garden tracts are now located, was purchased by him at $11,000, and after the company's failure the tract was acquired by the Northern Pacific Railway Company, which completed the irrigation canal and sold lands at $75 per acre. This was less than three years ago, and the garden tracts are now selling at $400 to $800 per acre. About 400 acres are embraced in the garden section.

Mr. Dudley is an expert fruit man, and his opinion is that the garden lands will be worth $1,000 to $1,500 per acre within three years. He was astonished at the wonderful fertility evidenced.

THE DUTY OF WATER IN CALIFORNIA.

BY FRANK ADAMS.
Office of Experiment Stations, U. S. Department of Agriculture.

There is no single question of irrigation of more fundamental importance than the amount of water necessary to most successfully and most economically raise crops. This is true whether irrigation be viewed from the standpoint of the court which settles water rights, the engineer who constructs canals, the superintendent who divides and distributes water, or the farmer who uses it. Nevertheless, although accurate studies to determine the duty of water have been carried on to a considerable extent in all of the Western States for a number of years, the data available for California, at least, are comparatively meager. This is unfortunate, because not only is the United States Government undertaking irrigation in a large way, but hundreds of individuals, co-operative companies and private corporations are now planning, constructing, or operating irrigation systems, and some 35,000 farmers are already irrigating, in most cases with too much water, approximately 2,000,000 acres of orchards, vineyards and field crops.

It is in no way surprising that, in spite of the efforts that have already been made, so little is known about the duty of water in California, because what might be a sufficient quantity of water for a given crop in one locality might be either too much or too little for the same crop in a locality where conditions are different. In other words, the duty of water must be studied locally rather than generally, and California is so large a State, and has such widely varying conditions of soil, rainfall, plant adaptability, water supply, and, what is most perplexing of all, has so many farmers, with such varying ideas regarding how much water plants need that with all resources that seem to be available, years of study and careful practice will be required before we can be said to know the duty of water in California.

To begin with, there is not even a general agreement as to what the term "duty of water" means, or how it should be expressed. The term "duty" used in connection with water would seem to indicate what service it *should* perform, yet the term is taken to mean the service it *does* perform. Probably the misnomer will not be eliminated until the service water should perform in irrigation and the service it does perform are one—a result so far attained in few, if any, localities in California. While the inaccuracy of the term is perhaps of little consequence, the wide variation in the way it is expressed is of consequence, because it leads to misunderstanding. At present the duty of water is expressed in the area of land a given unit of running water will irrigate, the size of stream necessary to water a given area, or the total depth of water applied to the surface of land during the season. If either of the first two expressions are used, no definite idea is conveyed unless the length of time the stream of water is flowing be

A CALIFORNIA IRRIGATION CANAL IN THE FOOTHILLS
With a high duty of water running in the canal should irrigate 50,000 acres.

given, and it is most often the case that this is not given. Consequently the form of expression now generally accepted as the best is the last one named. Of this form of expression there can be no doubt and no misunderstanding, for it means the same wherever it is used. What adds further value to it is the fact that it is the same form as that used for expressing rainfall, and irrigation is simply artificial rainfall, applied in the quantity and at the time best suited to the needs of plant growth.

As most generally considered, then, the duty of water is the amount that is used in growing crops, expressed in the total depth applied during the season. It may be different with different soils, different rainfall, different crops, and different practice.

Since 1899 the Office of Experiment Stations of the United States Department of Agriculture has been making measurements of the amount of water used under different canals throughout the West. The measurements since 1901 have not been grouped, but for the water diverted by the many canals measured was each three seasons of 1899, 1900 and 1901, the amount of season sufficient to cover the land irrigated to an average depth of 4.45 feet. In 1903 approximate data regarding the amount of water diverted were collected from twenty ditches in Northern Colorado, from thirty-two ditches in Wyoming, and from five large ditches in Western Nebraska. Expressed in depth over the surface of the land irrigated, the average under the Colorado ditches was 3.27 feet, under the Wyoming ditches, most of which were small individual ditches, was 8.52 feet, and under the Nebraska ditches was 3.60 feet. Under one small ditch enough water was diverted to cover the land irrigated under the ditch to a depth of 21 feet.

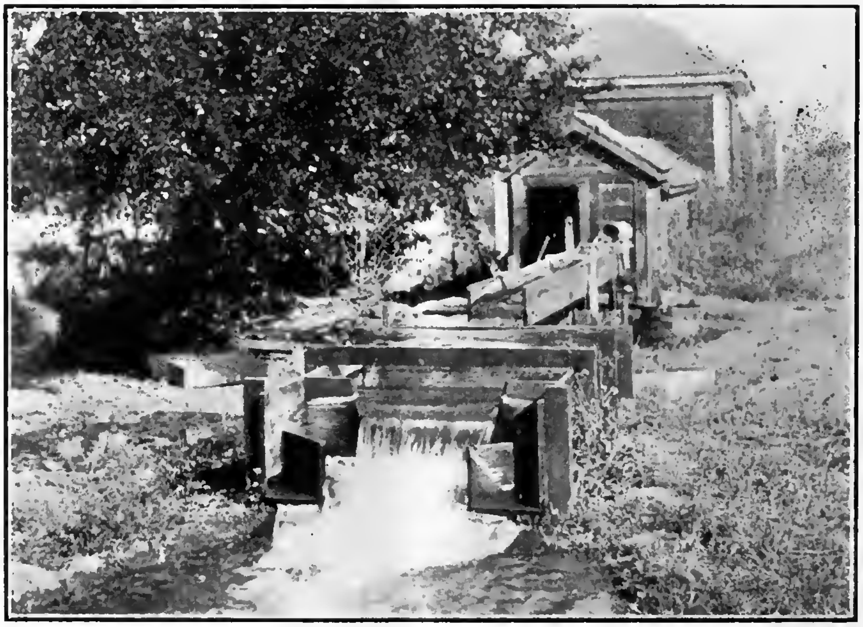
Through seepage and other avoidable or unavoidable waste, much of the water entering canals is lost before reaching the land to be irrigated. These losses vary so greatly with different canals that no useful purpose would be served by attempting to average them. In some cases, as where canals are cement lined, they are insignificant; in others, they include as much as 75 per cent or more of the water entering the headgates. While engineers constructing canals must take these losses into consideration, they really have nothing to do with the duty of water, and to be a definite guide to farm practice, measurements should be made where the water is used. A large number of measurements have been so made by the Office of Experiment Stations. The average depth of water applied during 1899, 1900 and 1901 on some fifty farms in eight Western States was found to be 3.98 feet, not including rainfall, the crops watered ranging from alfalfa, which requires a considerable amount of water, to oranges and lemons, which are successfully grown with a much smaller supply. In 1899, the average depth applied on five selected orange orchards at Riverside, Cal., ranged from 1.67 feet to 2.95 feet, including .47 foot rainfall. In 1901 the average depth applied to twenty-one farms under Pioneer canal on Tule river, also in California, most of the farms being planted to citrus fruits, ranged from 1.26 feet to 4.83 feet, the mean for the twenty-one farms being 2.37 feet, including .37 foot rainfall. Measurements kept during the four seasons 1898 to 1901 on twenty-five farms at Lindsay, Cal., showed a mean depth of water applied for the four seasons of 1.00 foot, 1.63 feet, 1.50 feet and 1.14 feet, respectively. This water was measured carefully, because it was pumped from wells and paid for by quantity delivered. The rainfall for these years was .47 foot, .60 foot, .85 foot and .84 foot, respectively. In 1904 measurements of the amounts used under sixty pumping plants in Santa Clara valley, Cal., were made, an agent of the Office of Experiment Stations doing the work with a current meter, a carefully constructed stationary weir, or a small weir board inserted in the field ditch being measured. The average depths of water being applied were found to range from under one foot to nearly five feet, and averaged 1.13 feet, not including rainfall. With rainfall added the depth was 2.00 feet. All of the land considered was planted to deciduous fruits. The duty was high be-

MEASURING A SMALL FLOW.
Measuring the duty of water with a small weir board inserted in field ditch.

cause the water had to be raised from depths ranging from 22 to 140 feet, at an average cost of $4.38 per acre-foot.

The most complete data regarding the duty of water in California relate to the Gage Canal system at Riverside. Records have been kept for the Office of Experiment Stations on this system for six years, beginning in 1898. The depth of water used has been exceedingly uniform, ranging from 2.62 feet to 2.93 feet and averaging 2.74 feet, all of the figures including the light rainfall of the Riverside district. These figures should be applicable to nearly all of the region devoted to citrus fruits south of the Tehachapi. There the orange and lemon orchards are irrigated every month in the year, although in winter the irrigation requirements fall off because of rainfall, as well as because of decreased evaporation from the soil and decreased transpiration from the trees. Other records are available for Southern California, although not exclusively for citrus fruits. The best available data for the region around San Diego, at the average rate of 5.42 acre-feet per acre, which included a light rainfall, but made no allowance for seepage losses. Coming north, most of the data available do not show any widely different use. Measurements, somewhat incomplete, under five ditches on Tule River, show an average depth of water used, including rainfall and allowing for seepage losses, of 2.75 feet. Under four important ditches in Santa Clara Valley the total depth received by the land in 1904 was 3.09 feet. On the other hand, 3,250 acres in Modesto and Turlock districts received in 1904 an average depth of 7.69 feet. It should be added, however, that the land in Modesto and Turlock districts was newly irrigated, and that the irrigators were mostly getting their first experience in the use of water.

Ten years ago it was not at all uncommon for engineers to plan and construct canals on the theory that all necessary precaution would be observed if the canals were made large enough to carry water at the rate of one-acre foot of water, i. e., a depth of one foot for each

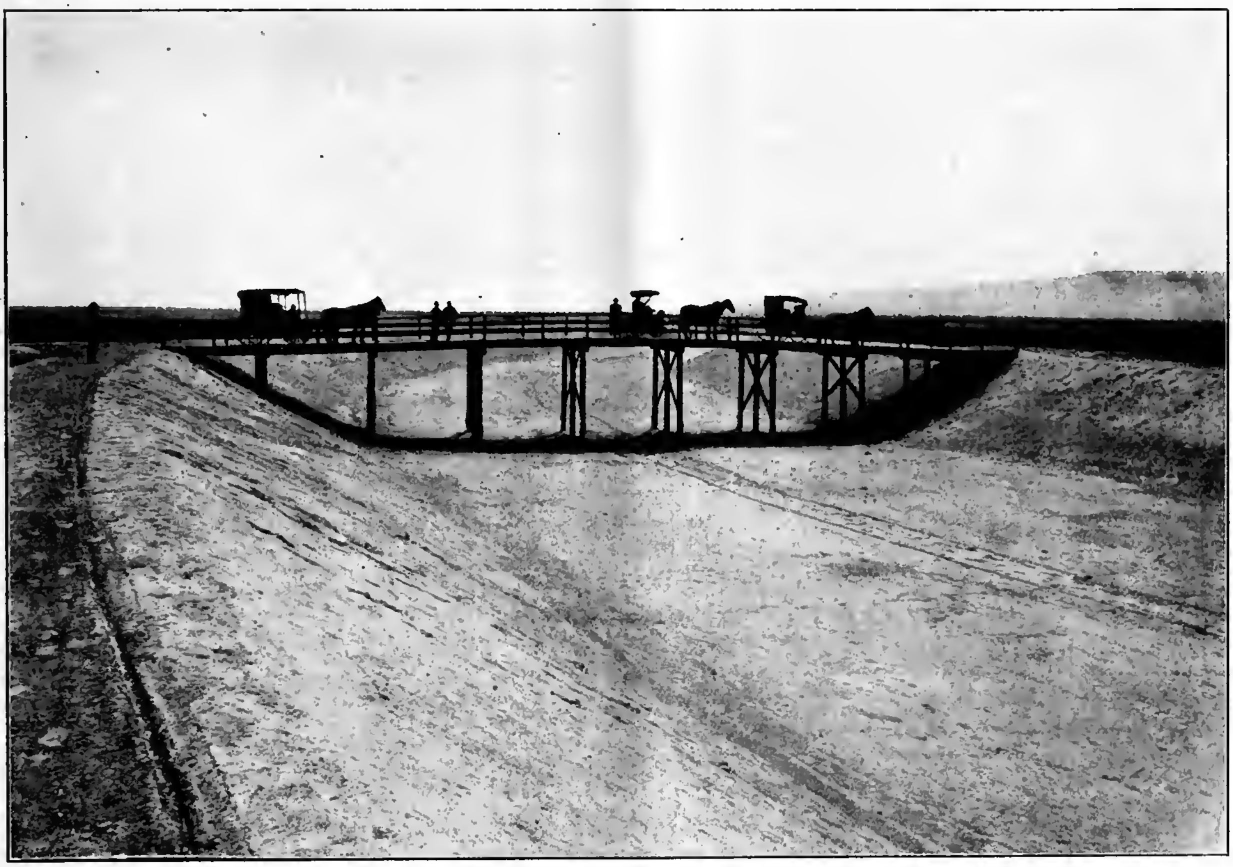


A MEASURING WEIR.
Measuring the duty of water with stationary weir at source of supply.

tem, shows that the average depth to which water is used, including rainfall, is approximately 2.50 feet. The records kept by the California Development Com- particularly for the district under the Sweetwater sys- pany for the Imperial settlements show that in 1904 a total of 280,000 acre-feet of water was delivered to the canals of the various mutual water companies. The area irrigated was not far from 85,000 acres, so that with rainfall, and not allowing anything for seepage or other losses, the average depth of water used was 3.59 feet. In Imperial water district No. 1, 166,800 acre-feet of water was supposed to have been used on 61,000 acres, making an average depth, including rainfall, but not allowing for seepage, of 3.03 feet. In both cases the seepage and other losses must have been considerable, so that the real duty of water was undoubtedly above what the figures indicate. At Yuma, not far from the Imperial settlements, data kindly placed at the disposal of the Office of Experiment Stations by Mr. J. B. Lippincott, of the Reclamation Service, show that in 1904 water was run for 4,650 acres planted to mixed crops acre to be irrigated. While the data now available hardly give more than a suggestion of the real duty of water, they are sufficient to show that unless extraordinary favorable conditions prevail, canals should be planned on the theory that at least four acre-feet of water will have to be diverted for each acre of land to be irrigated. Yet this is only roughly true, because of the difference in practice and crops and requirements. Measurements made on one well irrigated farm in San Joaquin Valley in 1904 showed that a single irrigation of alfalfa was satisfactorily accomplished with a depth of .54 foot, yet Mr. W. L. Dixon, of the Kern County Canal and Water Company at Bakersfield, is authority for the statement that under the Kern County system it is not at all uncommon, but quite usual, for a depth of 2 feet of water to be applied to alfalfa at one time. The difference in the use in these two cases is not a difference in requirements, but a difference in practice. Where the smaller quantity was used, the irrigator was careful and the checks in which the water was applied were practically level and not over one acre in area. Where the two acre-feet per acre is used, not only are the farmers apparently not careful—although they ought to be, because they pay for the water used or wasted at the rate of 37½ cents an acre-foot—but the checks they endeavor to irrigate are as large as fifteen or sixteen acres in area and frequently far from level.

The only way to increase the duty of water in California is for farmers to use more intelligent care than they have in the past in the use of water. It is probably true that few farmers would use what they do if they had any conception of its quantity. If this is the case, one of the first practical steps is for farmers to measure the water they use, which is in many cases a very easy matter. The small weir shown in one of the accompanying photographs is a simple device which nearly all farmers can adopt, and by the use of which, with such instructions as are readily available on application to the University of California or the Office of Experiment Stations, quite satisfactory results can be obtained. A more carefully constructed weir, intended for permanent use in one place, is also shown. The burden of water measurement should, however, be on those in charge of canal systems as engineers or superintendents, yet it is a fact that water is measured to irrigators in but very few cases in California, and then practically only in Southern California. Another means of increasing the duty of water, and the most effective means, is for water to be paid for by quantity used rather than at a flat acre rate. Until water is so paid for the duty will remain low. Canal companies throughout the West which sell water and which formerly charged a flat acre rate have learned that they can nearly if not fully double the duty of water by charging for the water actually used. With such a plan of distribution measurements will be necessary, so that it will be doubly efficacious.

One of the first endeavors of the Office of Experiment Stations in the co-operative irrigation and drainage investigations in California is to gather additional data on the duty of water, in so far as the means at hand will permit. For two years it has been measuring the amount of evaporation from cropped and uncropped soil surfaces with the idea of determining as best it can by somewhat artificial means how much water would be needed by different crops if losses by percolation through the soil and by evaporation from the soil surfaces could be eliminated. In other words, it has been endeavoring to learn something of the amount of water plants themselves need and use. Also along the line of the duty of water, the Office is endeavoring to learn more definitely than is now known what becomes of the water that is applied; in other words, how much of it sinks below the point of availability in the soil, how much is lost by surface evaporation from the soil, and how much seems to be utilized by the trees or other crops irrigated. Although this is a matter any energetic farmer could himself learn much about by digging holes in his field after irrigation and watching how deep the moisture applied sinks, very little is now known about it. In the work now in hand the interest and assistance of the soil experts of the Agricultural Experiment Station at Berkeley have been enlisted. The field of present study is some of the orange orchards of the region around Riverside. Until the sources and character of the waste of water in irrigating are known, no intelligent efforts can be made to end them.



Bridge across Twin Falls Land and Water Co.'s Canal, near Reservoir at Dry Creek, Cassia County, Idaho.

Nothing has thus far been said about the duty of water as it varies for different crops. To mention this is but to suggest a wide range of the most interesting and beneficial studies, in which every farmer and irrigator can himself take part. Measurements already made by the Office of Experiment Stations give some data, but many more are needed. The average depths found to have been received, including measurements from nearly all of the Western States, are, for potatoes, 3.94 feet; for alfalfa, 3.39 feet; for orchards, 2.76 feet; for sugar-beets, 2.15 feet, and from grain crops, from 1.40 feet to over 2.00 feet.

The agricultural future of California will depend less upon the number of acres of land under irrigation than upon the care with which the farmers of the State irrigate. If too little water is used, land falls far short of producing its maximum yield. If too much is used, both the crops and the land are injured; the farmer who uses the excess is poorer by the cost of the excess, and other land which might be irrigated remains wholly or partially unproductive for want of water. It is safe to say that a large majority of the irrigators of California now use far too much water. Deficiencies of rainfall of irrigated over unirrigated districts are often made up several times over in single irrigations, and it is seldom the case that, where water is applied at all, only one irrigation is given. It was part of Aristotle's philosophy to use only so much of the world's goods as the attainment of the specific purpose in view required. The same philosophy needs to be applied by the irrigators of California. When it is, the duty of water will be far higher than it now is. We must learn that too little water applied is deficiency and that too much water is waste. It is, of course, true that before we can give this philosophy its full effect in irrigation, we must learn just what is deficiency and what is waste; yet pending the determination of these facts, we might well remember that the majority of us at least shall need to apply less water to our fields long before we shall need to apply more. In other words, we should remember that our task in California is in increasing the duty of water rather than in decreasing it.

CORRESPONDENCE

Scottsbluff, Neb., Sept. 15, 1905.

Editor Irrigation Age—Resolution No. 1 offered at the National Irrigation Congress, at Portland, by your correspondent, was inspired by the fact that I am a homesteader under the projected Interstate (Government) Canal, and eventually I will be compelled to pay my pro rata of expense incident to watering the lands. The unfortunate policy of delegating to engineers duties with which they are unfamiliar, has already cost our water users several dollars per acre. One error which entailed much of this loss lies in a contract made with H. D. Lingle, involving the Whalen Falls Canal. One year ago Mr. Lingle was offering this canal, with all its water rights, priorities and privileges for $150,000 and no takers. The Government engineer, Mr. John E. Field, was in position to exact terms, and instead of closing a contract on a reasonable basis, he was bickering, and meanwhile pressing some doubtful and probably untenable claims against the Tri-State Land Company. A rumor went around that Heyward G. Leavitt, president of this company, was negotiating for purchase of Mr. Lingle's canal, and had offered $200,000. Mr. Leavitt publicly denied this, stating he had been approached by Mr. Lingle and after examining the project had declined to make an offer for it. Engineer Field evidently believed Mr. Leavitt was after the Lingle holdings for he hastened to complete a contract on the following basis:

Mr. Lingle retained his priorities and exclusive privileges on 270 inches of water and 20,000 acres of select lands in Wyoming. The Government is to construct the canal and convey the water to the Lingle headgates, for forty cents per acre per year. In return the Government secures a right of way over the Whalen Falls route. Whether or not this is a good bargain from either standpoint, is illustrated by the fact the Continental Trust Company has since guaranteed first mortgage bonds on Mr. Lingle's holdings to the extent of $300,000, twice the amount they were previously valued at. Soon after this contract was approved by the interior department, Mr. Lingle secured from the Wyoming State Land Board privilege to charge $30 per acre for a water right and 50c per acre annual maintenance fee. Twenty thousand acres at $30 per acre makes a product of $600,000 for something which was offered a few months before for $250,000, $450,000 loss to water users of the other 100,000 acres under the Interstate Canal, and a perpetual drain, for 40c per acre is an wholly inadequate payment for maintenance.

Realizing the cost of this one error, also hoping engineers might hail creation of a business commission as a relief from duties extraneous to their professions, I offered resolution No. 1. I endeavored to place it in the light of "relief" out of charity to those who committed the error. The resolutions committee ask Mr. Newell his opinion, and he pronounced it "a direct slap at the President." The author, having considerable admiration for our chief executive, had no desire to be placed in such an attitude, and withdrew the resolution.

After deliberation, however, I am convinced that Dr. Newell is unduly sensitive, and did not speak advisedly, because I have an abiding faith that the executive ear is upon the ground, welcoming suggestions for increased efficiency in Governmental service.

The rapid growth of the reclamation has brought from obscurity numerous lieutenants, and it is to be expected that mistakes will occur. Some have been promoted who are unworthy, and others that are worthy and conscientious may err because of inexperience, and errors may be ovelooked even if expensive, if they who commit them do not seek to discipline the individual who has the temerity to rise and remark. Contumacy is unbecoming in trustees, and this regrettable attribute on the part of Dr. Newell and Mr. Field is creating apprehension, and unless financial details are given more consideration, and plans adopted looking to selection of skilled business specialists, it will be impossible to satisfy existing doubts, short of investigation. The detail of grades, excavations and embankments has sufficient scope for master minds, but it does not develop financial genius essential for combatting superior business abilities of this utilitarian age.

Engineers Newell and Field have a happy faculty for uniting any one possessing independent ideas with those antagonizing federal reclamation, ostensibly to weaken their representations. To endeavor to subdue and discredit complaints by erroneously associating critics with affected interests is as useless as it is unfair, and is not honest.

G. L. Shumway.

Hailey, Idaho, Sept. 15, 1905.

Editor Irrigation Age:

S. D. Boone left recently for the head of Fish Creek, expecting to be away four or five days. He goes to look over the site of an irrigation reservoir that he and Charles Hernsheim propose to construct next year.

This reservoir will be so situated on Fish Creek as to conserve the water from that stream and its tributaries, and it will afford a supply of water sufficient to irrigate 75,000 to 125,000 acres of land even in the driest years. This land will be within ten to twenty miles of Carey, and, therefore, directly tributary to that town. It being lava soil, it is very fertile, and will produce almost any crop of the temperate zone.

While the water will be sold with the land, it will hardly be upon as great a pro rata as has been done heretofore, as too much water has generally been used in irrigating in this region. Better crops could have been gotten with less water. If the company follows present plans it will collect in its reservoir a sufficiency of water to irrigate 250,000 acres.

Mr. Hernsheim is in the East interesting a few friends in the enterprise. In this he will doubtless succeed. The reservoir is therefore almost a certainty.

BOWEN.

LEWISTON, IDAHO, Sept. 15, 1905.

EDITOR IRRIGATION AGE:

Through filing of condemnation proceedings in the District Court here today for land on Craig Mountain, news became public of a big irrigation project that is under way for this section of country.

The project is of vast importance to this community and involves the expenditure of a large sum of money. Hartman, Thompson & Powers, well-known investment bankers of Portland, are at the head of the enterprise. Suits just filed involve the condemnation of lands which will be the initial reservoirs of the project, and plans for early work on canals and laterals which will bring water over land comprising 40,000 acres south and east of Lewiston are being rapidly pushed.

Mr. Powers, who has been looking after the enterprise, has been in Lewiston many times, but his plans have been worked out so quietly that up to this time no statement has been issued by him or by his associates. With Mr. Powers are strong capitalists of Portland, San Francisco and Lewiston, and no stock is being sold nor any company organized to handle the project, the financing of the same remaining in first hands. F. D. Warner, of Portland, is manager here for Mr. Powers, but could not be seen today relative to plans of the enterprise.

There is perhaps no finer body of land in the entire Northwest than that which lies in the district south and east of Lewiston, and while these lands are semi-arid in nature, there has been no year when a crop failure has been recorded.

The promoters have quietly secured a large area of land. The plans are understood to be to convert the lands into orchard tracts, making it the largest irrigated district adapted to deciduous fruits in the entire Columbia and Snake River Basins.

BOWEN.

GREELEY, COLO., Sept. 14, 1905.

EDITOR IRRIGATION AGE:

J. H. McColl, a member of parliament from Victoria, Australia, was in the city today looking up irrigation methods in this section with a view to applying them to Australia. McColl's father was the father of irrigation in that country. He is traveling at his own expense, but expects to apply his newly acquired knowledge for the benefit of Australia. He leaves for Fort Collins tomorrow.

Mr. McColl comes from the Murray River Valley, where, he says, there are 20,000,000 acres of land that is readily irrigable. They have some physical difficulties to overcome that are not found in Colorado. There the streams have only three to four inches of fall to the mile, while here it is several feet in most instances.

Another peculiarity of the country, he says, is that the water would flow away from the river through the canals instead of toward the river, as in Colorado. The reason for this, said McColl, is that the greater part of Australia was at one time an ocean bottom, there being simply a range of mountains extending in a semi-circle clear around the island from 100 to 180 miles from the coast. The erosion of these hills gradually filled up the shallow ocean.

IRRIGATION DITCHES.

Uncle Sam is taking hold of several pretty big projects just at present. The Panama canal, which is destined to become the most important waterway in the world, is talked of more than any other owing to its magnitude. Engineers predict that it will take twelve or fifteen years to complete the canal and that it will cost in the neighborhood of two hundred millions of dollars.

But while this great American work is going on, or rather its preliminary surveys and excavations, Uncle Sam is doing another engineering work which promises even greater results than the Panama canal. The truth of this becomes manifest to the most unthinking upon a little reflection. The Government has now under consideration—one is already completed—seven great irrigation projects in the west involving the reclamation of some million and a quarter acres of desert land, at a cost of about thirty million dollars. A half dozen more are in the course of survey and commencement of work.

The fund for this work is constantly growing from the receipts of all the sales of public lands; moreover as every dollar expended by the Government must be returned to the fund by the settlers taking the land, the fund becomes a revolving one and is capable of use over and over again for building new works.

It is estimated that there are over seventy million acres of irrigable land in the west and it is admitted that an intensively cultivated irrigated agricultural community would people the western half of the United States with nearly the present population of the entire country.

The cost of this great work would amount to two billion dollars—a work the vastest ever entered into by any country in any time, yet costing the Government not one dollar, for every dam and canal constructed is paid for by eager settlers who flock upon the rich, irrigated desert lands.—*Missoulian,* Missoula, Mont.

EXPERT ENGINEER GIVES RULES FOR PRACTICAL USE.

The Twin Falls, Idaho *News* has the following to say:

Professor Rashbacher, who is making a study of irrigation here for the benefit of settlers on the government tracts, has spoken before a number of farmers' associations recently on the method of measuring water, to ascertain whether each irrigator is receiving his proper allowance. Following is a condensed report of his address:

There are three different units used in the measurement of water, the unit used depending upon the amount of water to be measured, the miners' inch used to measure the smaller quantities. According to the laws of the state of Idaho a miners' inch consists of the amount of water flowing through an orifice an inch square under a constant head of four and one-half inches over the center of the opening.

If an irrigator wishes to measure the actual number of inches of water flowing through he can do so very easily by constructing a board dam across the ditch and cutting a slot an inch high and extending nearly across the dam.

If a well fitting slide be put into the slot and drawn out until enough of the slot is left free to allow all of the water in the ditch to flow through with the water level standing above the center line of the slot four and one-half inches, then the length of the slot in inches is the number of inches flowing through the ditch.

The cubic foot per second or second foot is used for measuring both large and small quantities of water and is being generally used in place of the miners' inch. A second foot is simply the flow of water which will fill a box a foot square and one foot deep in a second of time.

It is generally measured by means of a weir set in the ditch with some sort of recording device for registering the height of water flowing over the weir, each different height corresponding to a flow of a certain number of second feet; this flow is computed with tables which are worked out for weirs of different sizes.

The acre foot is used for measuring extremely large amounts of water.

It is the amount of water required to cover an acre one foot deep and is equal to 43,560 cubic feet. This unit is mainly for determining the capacity of reservoirs and determining the amount of water applied to the land during the irrigation season.

By duty of water is meant the number of acres irrigated by a second foot of water. Thus if an irrigator is allowed a second foot and irrigates eighty acres with that amount the duty of water on his field is 80. The higher the duty of water the more skillful and intelligent the irrigating. The average duty in the arid states is close to 80 at the present time.

There are several easy ways for a farmer to measure the amount of water flowing down his ditch. About the easiest way is to dig a hole about ten feet square and a foot deep and notice the time it takes to fill. Divide this time in seconds into 100 and the result of the number is the number of second feet of flow. Multiply this result by fifty and we have the number of miners' inches.

Another way is to measure some distance, say fifty feet, in a straight stretch of ditch and notice the time required for a chip to float this distance. Get the average width and depth of the ditch somewhere on the fifty feet stretch.

Multiply the average depth in feet by the average width also in feet, and multiply the result by fifty. Divide the result by the time taken to pass through fifty feet and the final result is the number of second feet flowing through the ditch.

IRRIGATION BOOMING IN WYOMING.

So Says Nebraskan.

Irrigation is making great strides in Wyoming, according to J. C. F. McKesson, of Lincoln, Neb., who returned recently from a trip to Cody. The land which is under ditch has a good market value, and some within a few miles of Cody can not be purchased for $100 an acre. Along the line of the Burlington there is an area of 200,000 acres which will be watered from the government project and a considerable portion of it has not yet been homesteaded. The settlers have taken the land close to the towns, but many tracts, which will make productive farms when the government project is completed, are open to entry. The settler must sleep on the homestead, but at the present time nothing is raised on the land, so that it is simply a waiting game for the entrymen. The Shoshone dam will make a reservoir which will hold more than enough water to irrigate the land. Much of the area which is susceptible to irrigation has been covered with private projects which will utilize the flood waters of the stream. Because of the necessity of residing on the land to secure a homestead, acquisition by purchase is preferred by some settlers, who calculate that the completion of the canals will make the land valuable.

Still another project will add to the irrigable area. A large section of the Crow Indian reservation is to be thrown open for entry under the provisions of the reclamation act and will provide thousands of irrigated farms. This land is to be allotted to settlers in small tracts. The water will be taken from the Yellowstone River about forty miles above the point where it will be first turned on the land.

Cody is enjoying a boom because of the development of the surrounding country which is in prospect. Many new buildings are being erected.

McKesson says that the irrigated lands of western Nebraska and Wyoming will find a market for their products toward the Pacific coast, so that any difference in the freight rates demanded by the eastern Nebraska and Iowa farmers as compared with those of the irrigated country will not cut much figure. He believes that it is the policy of J. J. Hill to encourage this western traffic and that assistance is being given in developing the irrigated region in the hope of building up a great shipping business with the coast. Large shipments of live hogs have been made recently to Seattle from as far east as Aurora. The Seattle packing house is not associated with the trust.

One great advantage which the settlers on the irrigated lands have compared with eastern Nebraska entrymen is the cheapness of coal and lumber. Coal can be had at the railway mines for $1 a load and lumber costs about one-half of the price demanded of eastern Nebraska farmers, while slabs for fencing can be had for a song. In many places throughout the northern part of Wyoming there are outcroppings of coal, so that the prospect for a continuance of the cheap fuel supply is considered good. The much higher prices demanded from Nebraska purchasers of coal is due to the cost of transportation, he says.

The gold boom at Kerwin, south of the national park, appears to be gaining strength, according to McKesson. A lively camp has been established and it is claimed that pay ore has been found. The development is awaiting railway construction. The outlook for a considerable copper production is said to be satisfying.

The Lancaster county man saw several farms owned by Crow Indians. The wheat crop appeared to be very good. In one place he saw two brand new up-to-date threshing machine outfits in operation in charge of Indians. A peculiar thing about these workmen was the fact that they kept their coats on, although they appeared to feel the heat. Some of the men wore high-heeled cowboy boots and appeared very awkward. Tied to nearby fences were the cayuses ridden by the bucks to the scene of their activities.

IRRIGATION MACHINERY NOW NEEDED.

For Development In South Africa.

Among the many agencies now being employed for the development of South Africa, one of the most important is irrigation, which is absolutely indispensable in many regions for the proper and profitable cultivation of the land. In this connection it is interesting to note that the irrigation department of the Transvaal has recently completed a ten-mile irrigation canal on the White river, in the northern part of the Barberton district. The irrigation settlement is between 3,000 and 3,200 feet above sea level, and is about fifteen miles north of Nelspruit Station, on the Delagoa Bay line, which is 222 miles by rail from Pretoria.

The canal, when running to its full capacity, will carry twenty-five cubic feet of water per second, or 13,456,800 gallons per twenty-four hours, which at a low estimate should be sufficient for the irrigation of 2,500 acres. The original canal, ten and one-eighth miles long, has just been completed and the contractor has entered into another agreement with the Irrigation Department to construct an extension about four miles in length. The total amount of land commanded by the canal will be about 2,500 acres.

Should this scheme prove a financial success, the irrigated area can be very considerably extended. The expenditure on the ten miles already constructed works out at about £9 14s per acre, which is considered an extremely moderate price for the Transvaal. It is hoped that the government will extend their operations and construct many other small works—canals and reservoirs—in various parts of the colony.

Increasing attention is now being given to the subject both by the government and big private concessionaire companies, the benefits to be derived being considerable. For instance, unirrigated land valued at £1 per acre will command from £30 to £80 per acre when irrigated—a margin of betterment profit which is sufficiently large to attract and reward the keenest enterprise. There is every probability that the further extension of irrigation works throughout the country will provide manufacturers with increasing opportunities for supplying pumping machinery, excavators, dredges, piping, fittings, gutters, connections and other appliances.

WILD HORSE ROUND-UP.

Montana's Prairie Ponies Give Indian Cowboys an Exciting Race.

ON THE CROW RESERVATION.

The Intrepid Red Men Are Anything But Lazy When Rounding Up The Ponies From The Corral.

Once a year, when the rains of spring have turned the brown plains of the Crow reservation into a vast carpet of green, the great round-up of wild ponies is held.

There are round-ups and round-ups in the great range country of the Absaraka, but the wild horse round-up is not to be confounded with any other. Nothing like it is to be found anywhere in the West, for the reason that one can look in vain for wild ponies on almost any other Indian reservation. The Crows from time immemorial were the great horse owners among the Indian tribes. No tribesmen were their equals at stealing ponies, and no Indians could equal the Crows in keeping ponies when once they had been stolen. In the days of its glory, when the tribe boasted 30,000 warriors, the Crow nation numbered its tens of thousands of ponies. Today this slender nation of 1,500 people owns more ponies than any other western tribe, but under the encouragement of the government the Crows are selling their stock and turning to agriculture. Carloads of Indian ponies are shipped from the reservation every month, in the spring and fall, most of them going to St. Louis and other southern points, and it is for purposes of sale that the Indians round up the wild horses that roam the great ranges in Montana.

The ranges on the Crow reservation are for the most part just as innocent of fence as in the days of old Arapooish, the greatest chief of the Crows, who lived in the time of Lewis and Clark. For miles and miles one can travel across rolling prairies, which for generations have been ideal feeding grounds for ponies. Here the wild horses roam—small-boned, shaggy-coated creatures, with long flowing manes and tails, and with deep lungs and sound forelegs that would make the eyes of a polo player light up with joy. The brand of the cowboy they have never known, nor have they felt the touch of the lariat. Whole bands of these maverick ponies sweep across the level stretches, plunge into the arroyas, and clamber up the heights with the agility of mountain goats. There is always a stallion with a herd, exercising a patriarchal watch over the mares and colts in his care. Sharp-cut against the sky this sentinel can be seen constantly on the watch for danger.

Wolves are the especial terror of the wild horses. Let a wolf appear in sight and instantly the band is called together and stands in a circle, hind legs outward. Mr. Wolf is too wise to approach within kicking distance, and he merely circles the bunch at a safe distance, licking his chops at the sight of the tender little colts in the center of the squealing, snorting bunch of ponies. The Indian pony is as free with his heels today as he was before the white man cut up the great ranges. Those hind hoofs have always been his only means of defense, and terrible ones they have ever proved to be in time of danger.

To capture strong, fleet animals such as this would seem to be an impossibility, but your Indian cowboy does not regard it so. In fact, nothing is impossible to an Indian when he has made up his mind to accomplish it. Nobody could follow an Indian horse round-up and call the red man lazy. When the call for the round-up goes forth the best riders on the reservation, or in the district to be covered, are called into service. This year the round-up fell to the charge of a slender youth named Felix Bear-in-the-Cloud. His name is not a more startling mixture of the civilized and savage than is Felix's costume. He has on a white man's hickory shirt and handkerchief, and a white man's felt hat with the inevitable high, pointed crown which the Indian affects. To the rim of the hat is fastened the eagle feather—the Indian's "good medicine." Felix's hair is braided and tied with bright bits of ribbon, and there is a dash of paint on either cheek bone. His chaps might be worn by any white cowboy, being plain leather affairs, with fastenings of nickel discs down either seam. His boots are of the conventional cowboy spurs, and Felix sits in his saddle with the ease of the star rider of a wild west show.

Felix has the great mess wagon brought up to the agency storehouse, and soon it is loaded with tents, boxes of provisions and bedding and is started out with instructions to the driver to meet the cavalcade on a certain creek, ten or fifteen miles from the agency.

The round-up is near the country hallowed by the blood of General Custer and his men. In fact, the round-up wagon proceeds up Talluc creek, the very stream which Custer was supposed to be scouting when he disobeyed orders and pushed on to the point on the little Big Horn, where he and his men lost their lives. The creek has dwindled to a mere thread of silver, winding between rolling hills. In midsummer the creek bed is as dusty as any part of the plain is.

After a quick journey over a fine road the wagon driver comes in sight of a corral, where he is met by a cavalcade of horsemen, some fifteen or twenty Indians, all clad much like Felix Bear-in-the-Cloud and each man with his best horse under him, his best rope at his saddle and ready for the work of the horse drive. With the men is the herd of extra horses, known as the horse cavvy. Each man has five or six horses for use in the rough work of the round-up, as there is no more wearying task than bringing in the mavericks of the plains, and saddle horses quickly drop under the strain. And, by no means the least important feature of cavalcade, one sees the camp cook, Edith Bear-in-the-Cloud, the pretty wife of the round-up boss, and Fannie On-Top-of-the-Tepee, a slender Indian girl who is wearing black to show that she is both widowed and childless.

Camp is made in a hurry. The Indians have lost all the slowness of movement which characterizes them at the agency or in their hours of ease about their villages. Each man works quickly and deftly. The tents are up in a hurry, the bedding is put under the wagon and two beds are unrolled for the night herders, who must snatch their sleep as best they can in the daytime, and the cooks are soon supplied with wood, chopped from the big pieces of timber dragged in at the end of a lariat. Dinner over a few minutes are given to story telling and smoking at the camp fire, but the thunder of hoofs tells that the day herders are coming up with the horse cavvy. Every man jumps to the saddle, unfastens his lariat and makes ready to pick his fresh horse from the bunch that is brought in.

The saddle horses are more than half wild. To use a cowboy's expression, their breakers merely "took the top off them." They would soon put an unskilled rider on the ground. Kicking, squealing and snorting they are bunched into a solid mass and a rope corral is deftly thrown about them. No western horse that has been broken will try to break out of a rope corral. The very touch of a rope teaches him to be cautious. The cowboys gather about the corral and one after another picks out his mount and ropes him. It requires expert roping to get a horse from the dodging, milling mass of ponies, but in an incredibly short time each man has led out his mount and has it saddled and bridled. When the last horse is taken out the horse cavvy is driven away again in charge of the day herders to the feeding grounds.

There are a few directions from the foreman and then the cowboys are in the saddle and the picturesque cavalcade starts out on the actual work of the round-up. The men "ride circle"—that is, they spread out in fan shape, constantly widening the distance between the riders. Soon a bunch of wild horses is sighted and the chase begins. Instead of pelting after the horses the cowboys so place themselves on the prairie that they can ride in relays. A few of them keep directly after the horses, while others ride over the plains in such a manner that they will be able to intercept the flying ponies a few miles ahead. They arrive at the point of interception with their horses comparatively fresh. Those who have been chasing the ponies are "all in." Their mounts have blown and a run of a few more miles would exhaust them. But the cowboys who have made the cut-off take up the work of the chase, never giving the wild horses an instant's rest.

A third bunch of pursuers cuts in a few miles ahead, having made another short cut across country. The wild horses are beginning to show the effects of the terrific pace. They are as badly winded as are the heavily mounted ponies of the cowboys. Some of the bunch begin to lag and the swifter ones will not desert them. The little colts, some of which are but a few weeks old, keep up with the herd in surprising fashion. But now the riders have gained the rear of the herd, and a few of the cowboys work around to the sides and eventually to the front. Then the herd is turned until it is headed back toward camp. The ponies are running heavily and much of their spirit is lost. Soon the camp is reached and the "wild bunch" is run into the corral—not the rope affair, but the stout inclosure of logs, several of which are scattered about the range and where the work of rounding up is always carried on.

USE TOO MUCH WATER.

The editor of the *Twice-a-Week Spokesman-Review,* Spokane, attended the irrigation congress and has the following to say:

Among the attendants at the National Irrigation Congress in Portland were Samuel Fortier, irrigation engineer for California, and Arthur T. Stover, irrigation engineer for Oregon. These engineers are under the direction of the offices of experiment stations in the United States Department of Agriculture. Their duties are to make investigations in irrigation and drainage. They are called upon largely to aid individual farmers and private irrigation enterprises.

A representative of the *Twice-a-Week Spokesman-Review* chanced to meet Mr. Fortier and Mr. Stover together on the Lewis and Clark exposition grounds. In conversation with these men something was learned of the work under their charge. They investigate leaky ditches, faulty methods of water distribution, unskilled ways of preparing land for irrigation, surface evaporation from soil and like difficulties encountered by farmers in putting water on their land.

It was the pronounced opinion of these experts that there is a prevalent use of altogether too much water in irrigation. This overuse is carried to such an extent that water logging ensues. Water logging may result from the application of too much water or from the necessity of drainage, or from both causes. In some cases as much of thirteen acre feet of water are applied to the land. An acre foot is one solid cubic foot of water applied to a square foot of land surface. While there is a difference in the amount of water required by different lands, yet that difference is not nearly as large as might be supposed by those unacquainted with scientific irrigation. On the average only four acre feet are needed for a season's irrigation.

In some of the investigations made by these irrigation and drainage experts 80 per cent loss has been found from seepage of water in the canals and ditches. As a rule only 30 per cent or 40 per cent of the water in irrigation is saved for the growth of the farm products.

Disastrous results may follow from the use of too much water, especially when the water table terminates within a few feet of the surface. In such cases, when the water put on the surface meets the natural body of water under the surface, water logging follows. Then as the underground water rises to the surface it brings with it considerable alkali and the land becomes less and less valuable. There is a district in the San Joaquin Valley of California where this overuse of surface water has ruined a considerable acreage of land. Nothing but salt marsh hay will now grow on it.

It is not only in connection with the duty on water, that is, the proper amount of water needed on any given section of land, that the irrigation and drainage engineers are employed. Naturally they are led into the study of the soils, especially as to the conservatism of moisture in the soil. It is fast becoming as important a subject in farming to know how to save the rainfall and snowfall of the winter months as to provide means for applying water from artificial ditches during the summer months. Water may be stored in the ground as well as in reservoirs. This subject of dry farming is assuming larger proportions every year.

Then there is the matter of winter irrigation. It is found that irrigation works which are sufficient to supply a quantity of water for a given amount of land during the summer months may also be used for supplying water on additional sections of land during the winter months. Of course, winter irrigation requires that the soil shall be prepared to receive and store the water for summer use. It is found that water for irrigation may be obtained at a cost of from $2 to $5 per acre. This winter irrigation is carried on mostly during the months of February, March and April. On Butter Creek, in northeastern Oregon, eighteen farmers on the stream each produce $9,000 worth of crops by means of winter irrigation. Each farmer has about 220 acres, and alfalfa is the chief crop grown.

While Eastern people have had rather dim ideas regarding the resources of the arid and semiarid sections of the United States and the enormous increase in production which may result from irrigating these lands, the Western people are largely blind to the progress of irrigation in the Eastern part of the country, where the annual rainfall has been supposed to furnish all moisture needed for growing crops. At present $12,000,000 worth of rice is being produced in Louisiana largely under irrigation. Among others, the New Jersey Experiment Station is making a thorough investigation of the subject of irrigation.

In many parts of the East it has been found of great advantage to have water to apply to the land when it is needed and in quantity that is needed. As President James J. Hill, of the Great Northern Railway, said in his letter to the irrigation congress at Portland: "Certainty, abundance and variety are to be found where irrigation prevails."

An Estimate of the Cost of Applying Water to Crops.

The cost of applying water to crops varies greatly according to the skill of the irrigator, the contour of the fields, and the available head of water. A skilled irrigator commands higher wages than a man of less experience. The land on one farm may have a sloping surface well adapted for the application of water, and on another a rolling, broken surface over which much time and labor must be spent in properly applying the water to the crops. One farm may be supplied with a full head of water sufficient to enable the irrigator to spread water over his fields between laterals quickly and thoroughly, while another farm may have so poor a head of water that a greater amount of labor and more time must be spent in irrigating the same area. The method used in irrigating different crops must also be taken into consideration. It takes much more time for one man to irrigate an acre of potatoes by the furrow system than an acre of wild or native hay by the flooding system. In the first instance the potatoes may be irrigated by running water through every other furrow, which is often done in the first watering of potatoes. On the other hand, to irrigate an acre of wild or native hay requires only the few moments necessary to turn enough water from a lateral to cover the entire acre. It is therefore difficult to state even approximately the cost of applying water to crops.

From information on the subject derived from farmers in southern and middle Wyoming it is inferred that one man can irrigate from five to ten acres of grain or alfalfa in a day. This estimate is qualified by the preceding remarks. An ordinary farm hand is paid $1 per day with board. Considering this as equivalent to $1.50 a day, the cost per acre of applying water to crops is from fifteen to thirty cents an acre.