FARM POWER

FARM POWER

Second Edition

International Harvester Company of America
(Incorporated)
CHICAGO U S A

Complete Index
will be found
on Pages 94 and 95

"THERE is no truth until the facts are put in order." Although no farm has ever existed without power, either animal or mechanical, no systematic attempt has so far been made to collect and classify the facts about farm power so that any farmer could use the information intelligently in studying this very important point. Much farm power literature has recently been issued which has centered generally around the experiences of individual farmers. A great deal of tractor literature also has been written from the point of view of the salesman rather than from the view of the man who would some day use the tractor. Both of these points of view are more or less misleading to the man who is looking for reliable information that will help him solve his power problems.

The Government has done some very thorough work in the collection of facts concerning certain phases of the horse's usefulness, and state experiment stations and agricultural colleges also have issued bulletins and figures on this same subject and on tractor use. These and the office and field records to which we have had access are the sources of information for the facts compiled and classified in this book. The result, we honestly believe, is an absolutely fair and impartial presentation of the truth concerning farm power as furnished on the one hand by horses and on the other hand by farm tractors.

In a matter so important as the changing of farm power from horses to a tractor basis, no man should make a decision without having gone carefully and fully over all the available evidence on both sides. So much of the evidence that has thus far come to our attention has been misleading and incomplete that we have deemed it our duty to present in this book all the available facts in the case. We offer it in the hope that it will have some real value to the thousands of farmers who we know are deeply interested in this vital phase of agriculture.

INTERNATIONAL HARVESTER COMPANY OF AMERICA
(Incorporated)

Farmers Must Meet Changing Conditions

The proportion of food producers to food consumers grows smaller constantly. In 1880, according to the Government Census, 70.5 per cent of the population of the United States was on the farm, or in towns of less than 2,500. Ten years later, the rural population was 63.9 per cent, or not quite two-thirds of the whole. This decrease continued steadily until in 1910, when, according to the last available figures, the percentage of people living in towns of 2,500 or less, was 53.7 per cent, or just a little more than half the total population.

The figures just given are based on a total rural population of over 49,000,000. Of this number of people only about one-eighth, or 6,000,000, are classified as farmers. This means that six million farmers are now producing food for one hundred million people, the present total population of our country. Compare this to the condition about a century ago, when almost the entire population, scarcely larger than the present number of farmers, was engaged in the production of foodstuffs.

Machine efficiency is largely responsible for this change. Machine efficiency, and that alone, has enabled a comparatively small percentage of the population to feed the remainder.

With land doubling in value and the insistent call for food from the cities, horses at $150 to $300 apiece, and with farm labor securing from $40 to $50 a month, the farmer must be on the job all the time. His land **must** produce crops, his stock **must** produce profits, his work **must** be planned and handled on schedule.

As we shall see, his most perplexing problem is that of power, for almost half his total production expense centers around his horses and their upkeep. The day has come when he must supplant horse power. He must substitute a highly organized, highly efficient form of motive and tractive power for that part of the horse form of energy which has grown too expensive to be profitable.

The magnitude of this power problem is astonishing. When we think of the wonderful industrial growth of this country with its vast manufacturing enterprises, we but vaguely realize the enormous amount of power required; and yet, according to

Phillip S. Rose, editor of The American Thresherman, the **farms of this country require more power than that employed in all our vast manufacturing industries.** Mr. Rose proves this statement in the following analysis:

"The last Government census of 1910 showed that there were a total of 24,042,882 horses and mules on the farms of the United States. Estimates of the Department of Agriculture, on January 1, 1914, placed the number at 25,411,000. If we assume that 80 per cent. of these animals are mature, there are now available for farm-work purposes 20,328,800 work-animals. On the basis that each animal will develop an average of seven-tenths of a horse-power, we find that the total available animal-power amounts to 14,230,000 horse-power expressed in mechanical units, or almost exactly three fourths as much power as was employed in all branches of manufacturing as shown by the 1910 census."

In addition to the power furnished by the horses and mules, the farmer has available mechanical power as supplied by steam engines, internal combustion tractors and engines, windmills, and water power. Very little water power is utilized, and windmill power is not large enough for most work. This leaves only steam engines and internal combustion engines using oil or gasoline, regarding which Mr. Rose says:

"A careful canvass of the States west of the Mississippi made last winter by Mr. A. P. Yerkes, a Government agent connected with the Bureau of Farm Management of the United States Department of Agriculture, shows that there are something like thirteen thousand tractors in operation. There are probably not to exceed one-quarter as many east of the river, making something less than 20,000 tractors in use in the entire country. These tractors vary greatly in size, but will doubtless average close to forty brake horse-power each."

Steam engines have long been used as a threshing power, and there are not far from 100,000 in use today. There are also in use probably a million portable and stationary gas and oil engines averaging 5 horse-power. The summary, then, of all the power used on the farms, according to Mr. Rose, is as follows:

Kind of Power	Number	Total Power
Horses and mules	25,411,000	14,230,000
Windmills	750,000	75,000
Steam-tractors	100,000	4,000,000
Gas-tractors	20,000	600,000
Gas-engines	1,000,000	5,000,000
		23,905,000

"The total power used in all manufacturing enterprises, according to the 1910 census, was 18,755,286 horse-power. Even allowing a large margin for possible error, it is thus seen that the farmer's power-problem is a big one and involves millions of dollars. Mechanical power, as yet, is much smaller in amount than animal-power, but it is rapidly increasing, and within a few years will doubtless assume first place."

PART I

PRICES OF LAND, LABOR AND POWER ARE THE DETERMINING FACTORS IN CROP PRODUCTION

1. Farm Land is so High in Value that only the Most Efficient Handling can make it Profitable

From 1900 to 1910 the average value of farm land practically doubled, according to the United States Census Reports. This is natural, for our constantly increasing population calls for more food; crop prices advance, and land becomes more valuable. But it requires the most efficient men, methods, and machines to derive a satisfactory profit from land of even average value.

2. Farm Labor Increasing in Cost

When farming was less complicated, manual labor was cheap. "$20.00 a month and keep" was formerly an acceptable wage.

But today wages of from $40 to $50 a month and the use of a tenant house put the farm on practically the running basis of a factory.

Though not overpaid, hired help is too big an expense in proportion to what it produces, especially on farms where the character of the operations are not arranged to keep help busy during the maximum time. December, January, February and March are inactive periods, with help more plentiful, because many farmers release their men at the end of the season. From April to October the demand is brisk, help scarce and wages high. The principal cause for the high wages asked is the fact that men are in demand in all industrial centers at good wages. The automobile industry which has developed in the past 15 years alone employs more than half a million men. Other industries have made additional calls for men, which has started a movement cityward at the expense of the farmer. To get men and keep them he must offer the same wages that these men could obtain in the cities.

The State of Illinois paid out for hired help in the year 1909, according to the last census, more than $36,300,000. This was an increase over the preceding decade of nearly 64 per cent. The sum which Michigan paid was an increase of 34 per cent, and for Ohio the increase was 77 per cent.

3. Price of Horses for Farm Work Higher Each Year

From 1895 to 1915 the increase in the number of horses in the United States was 33.3 per cent, while the increase in the value of these horses was 279.7 per cent. Prices advanced to such an extent that even with an increase of only 5,301,700 in the number of horses their value increased $1,613,372,000. We quote below the figures from the Census Bureau of the Department of Agriculture—

Year	Horses (not including mules)	Value
1915	21,195,000	$2,190,102,000
1895	15,893,300	576,730,000
Increase	5,301,700	$1,613,372,000

Per Cent Increase, $33\frac{1}{3}$.

The actual average price increase for all horses was from $36.20 in 1895 to $93.51 in 1906, and to $103.33 in 1915, a gain of 185 per cent. **Horses suitable for farm work now average from $150 to $250 apiece, according to the Chicago Live Stock World.**

These figures correspond closely with reports received from farmers, shown in tabulated form on pages 26 and 27. The average of almost one hundred farm owners reporting shows that the average price of horses replaced by an 8-16 tractor was $158. In the majority of instances the reports indicated that farmers always sold the poorer horses, keeping the better ones. This average price of $158 is what owners actually received for horses sold during the last six months of this year.

PART II

HORSES AS FARM MOTIVE POWER

4. Horse Labor is almost Half the Gross Operating Expense of the Ordinary Farm

We have become so used to seeing horses, reading of them, and thinking of them as a motive power for farm work, that we are inclined to question the statement that they can be dispensed with to great advantage. Sentiment, in a way, is responsible. The horse is an intelligent animal, and constant contact with him has prejudiced us against a cold blooded analysis of his usefulness, and yet the figures we shall give were prepared by unprejudiced men paid by the Government to help the man on the farm reduce his expenses and increase his production.

The figures are startling. **According to Extension Bulletin No. 15 issued by the Minnesota Farmers' Library, almost half of the gross cost of operating an ordinary diversified farm is made up of horse labor.** In spite of this, many farmers seldom consider the maintenance cost of their horses when they are attempting to arrive at some understanding of what it costs them to produce their crops.

5. Many Items Enter into the Cost of Horse Labor

Fortunately the United States Government some years ago made very accurate investigations into the cost of horse labor on farms. Experts who knew their business kept accurate record of the various cost items with a result that the Government is able to tell us how much horse labor costs per hour. The items which the Government took into consideration are the following:

Interest on Investment
Depreciation of Horse
Use and Depreciation of Harness
Shoeing
Feed
Labor
Shelter
Miscellaneous Expense

Illustration 1—Doing the heavy field work with horses is hard, monotonous, expensive work

6. Interest Charges

This is one item of cost which is not always considered but it rightfully belongs on the cost side. A horse at the average value of $150 costs his owner at least $7.50 or $9.00 a year on interest charges, depending on whether the interest is figured at 5 or 6 per cent.

7. Horse Depreciation

It is difficult to state the average life of a farm work horse. We are safe in assuming it to be from 10 to 15 years. On this basis there will be an annual depreciation on $150 horses of from $12 to $15. Some farmers might not think it necessary to include this, especially those who decrease these charges by the use of young horses, selling them when they become more valuable. Good horse traders also keep this charge down. It doesn't in any way, however, affect the general fact that the horse depreciates as it gets older.

Wayne Dinsmore, Secretary of the Percheron Society of America, says—"Work horses increase in value until they are six years of age. Depreciation begins at that time. Rapidity of depreciation depends entirely upon the class of horses and the manner in which they are handled. Pure bred animals frequently increase in value until they are nine or ten years old, but **depreciation usually begins at six years and amounts to about ten per cent a year.**"

8. Harness Use and Depreciation

Horses cannot work without harness. Harness costs money and it wears out so that it is only natural to include a cost for its use and depreciation. This, together with repairs and interest, averages from $1.50 to $2.50 per horse annually.

9. Shoeing Cost

Shoeing is another item that must be taken into account. It varies greatly in different parts of the country. In Minnesota, for instance, where the Government made its investigations, shoeing costs varied from $1.83 a horse in one section to 13 cents a horse in another.

10. Feed is the Heaviest Item in Horse Maintenance

Practically two-thirds of the annual cost of maintaining a horse is the feed cost. The total feed cost figures for the country are stupendous. Our 25,000,000* horses and mules consume feed to the value of almost $2,000,000,000 annually, or more than the total operating cost of all the 260,000 miles of railroad of the United States; 73,000,000 tons of hay are grown, harvested and marketed to feed them.

In determining the annual cost of maintaining a horse, as shown in the tables which follow, the feed prices were figured by the Government experts on the basis of market prices less the cost of transportation from farm to market.

11. Labor Cost

This includes the cost of labor in caring for and feeding the horse. There is no possible way of getting away from this charge or even reducing it, as it is an admitted fact that horses never receive any better care than they are entitled to; in fact, in the majority of cases they do not receive the care they should. In U. S. Bull. No. 73, to which we shall often refer, Table 1 indicates that this item during the period 1904 to 1907 amounted to $16.06 a horse. Since that time labor has increased 10 per cent.

12. Cost of Sheltering Horses

Shelter is an item which should enter into the cost of maintaining a horse, but it varies so greatly on different farms that it has not been taken into consideration by the Government in computing its horse maintenance figures. This item depends entirely upon the capital invested in buildings. The accepted basis of figuring this is 10 per cent of the amount invested. This 10 per cent provides for an interest on the investment, depreciation and repairs. Thus a barn which cost $40 a head sheltered would bring an annual cost of $4 against each horse. Some barns cost $100 a head sheltered. This would make the charge against each horse $10.

*January 1, 1914, estimate Department of Agriculture is 25,411,000.

13. Miscellaneous Expenses

The miscellaneous expenses include veterinary services, medicines, liniments and many other small items that are required in the care of a horse. The Government found that during the years 1908 to 1912 these averaged 54 cents a year a horse.

14. Yearly Maintenance Cost of Horses from 1904 to 1907 was $79.80. (U. S. Dept. of Agr. Bull. No. 73.)

Table I

Interest on investment	$ 4.90
Depreciation	4.84
Harness depreciation	1.55
Shoeing	.68
Feed	51.39
Labor (Not incl. drivers' expense. See ¶ 11.)	16.06
Miscellaneous	.38
Total	$79.80

15. From 1908 to 1912 the Yearly Maintenance Cost was $96.21. (Ext. Bull. No. 15, Minn. Farmers' Lib.)

Table II

Interest on investment	$ 6.73
Depreciation	2.54*
Harness depreciation	2.30
Shoeing	.80
Feed	65.72
Labor (Not incl. drivers' expense. See ¶ 11.)	17.58
Miscellaneous	.54
Total	$96.21

*Note this item of depreciation is too low—due to abnormal conditions existing in the horse market where tests were made.

16. The Maintenance Cost for 1914 was $129.23

The prices of horses, feed, labor, in fact, almost everything, has gone up since 1912. In order to determine what it cost to maintain a horse during 1914, figure first the difference in feed cost. From 1908 to 1912, as we have just shown, feed cost an average of $65.72 annually. Uncle Sam says that this was the cost of feeding 4,686 pounds of grain and 6,346 pounds of hay. What did this feed cost in

1914? (The price figures of hay and grain quoted are taken from U. S. Farmers' Bulletin No. 645.)

3 tons of hay at	$11.12	$33.36
53 bu. of oats at	.43	22.79
53 bu. of corn at	.63	33.39
Total Feed 1914		$89.54

The item of depreciation, $2.54, in Table 2 is not high enough. The depreciation in this case has been affected by abnormal conditions prevailing in the territory where the tests were made. In these horse markets the prices of horses have jumped rapidly enough to offset depreciation which has accrued. A fair figure for depreciation would be from $10.00 to $15.00 annually. Let us say the smaller figure—$10.00.

Assume that interest, harness depreciation, shoeing and miscellaneous expenses are the same. Labor since 1912 has increased ten per cent, so that the labor cost now is $19.33. The yearly maintenance cost for 1914 will be as follows:

Table III

Interest on investment	$ 6.72
Depreciation	10.00
Harness depreciation	2.30
Shoeing	.80
Feed	89.54
Labor (Not incl. drivers' expense. See ¶ 11.)	19.33
Miscellaneous	.54
Total	$129.23

The maintenance cost for 1914 therefore is $129.23. For the sake of easy figuring hereafter, we shall assume the expense to be $125.00 annually.

This cost is verified by a test made by a Division of Farm Management during the past summer on thirty farms in Catawba County, West North Carolina. On these farms were ninety-two horses and forty-five mules and the average cost per animal for a year was $125.60.

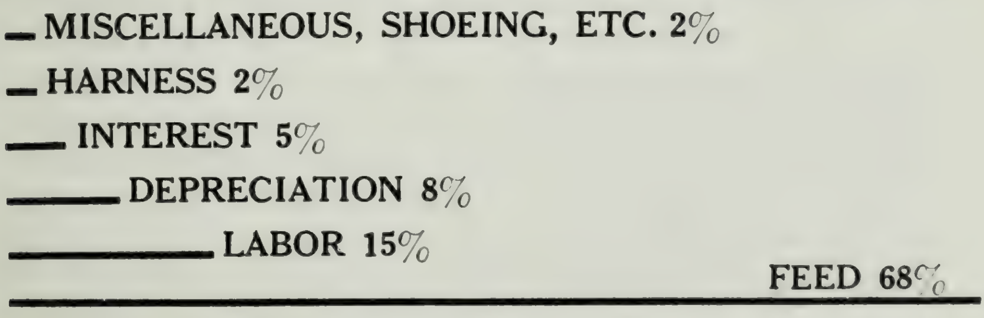


Chart 1. Horse maintenence costs in percentages

17. A Horse Works only Three Hours Per Day

The average number of hours worked per day by each horse as determined by a six-year test—1902 to 1907, inclusive, was 3.15 hours. Counting 313 days in the year, omitting Sundays, indicates that a horse averages 985 hours per year. Let us say 1,000.

Very few men could make a living working so short a time—only 3 hours a day.

18. Horse Labor Now Costs 12.5 Cents Per Hour

How much does horse labor cost an hour? This cost is determined by dividing the average annual cost of maintenance by the average number of hours each horse works. Fortunately, the Government kept an accurate check on this when it made the tests referred to on the preceding pages with this result.

From 1902 to 1907 the annual cost of maintenance was $80.00, so that horse labor an hour cost 8 cents. From 1908 to 1912 it was $96.00, or 9.6 cents an hour. For 1914 it was $125.00, or 12.5 cents an hour. (Table III, Page 11.)

Mr. Fred R. Taylor of Warren County, Ill., has kept accurate records during the past three years and he finds that the average cost an hour of horse labor during 1914 was 13.6 cents.

19. It Requires the Products of Five Average Acres to Feed a Horse

Uncle Sam says that the horse eats annually three tons of hay. The U. S. Census Report for 1910 says that the average crop is 1.3 tons per acre, so that at this rate it will require 2.3 acres of hay. Uncle Sam also says 4,686 pounds of grain are fed annually, let us say half oats and half corn. This would be 53 bushels of oats and 53 bushels of corn. The average oat yield is 28.6 bushels and the corn yield 26 bushels per acre, so the horse requires 2 acres of corn land and 1.8 acres of oat land, or a total of 6.1 acres. To make these figures as favorable as possible to the horse, let us say that he eats annually the products of only 5 acres.

In 1914 there were 25,000,000 horses and mules on our farms, and these **require the products of at least 120,000,000 acres to feed them.**

20. One-Fourth of all Tilled Land Farmed for Horse Feed

Now, there are only 478,000,000 acres of improved land in the 6,361,000 farms in this country, therefore, to feed our horses and mules we use 25 per cent of all our productive land (U. S. Census Report 1910). Think of the waste! **One acre out of every four under cultivation is farmed for the benefit of horses that give only three hours' work a day.**

We seldom realize how many acres we are cultivating for horse feed, but we even more seldom think of the fact that one-fourth of our entire investment in farm equipment, in buildings, and in land must be charged up against the cost of horse maintenance.

Could we take this 120,000,000 acres of land now used to feed the horses and mules, and raise crops for the world's population, **we might double our corn crop, the biggest money-maker we have, and also add 50 per cent to our wheat yield.**

21. Every Farm has from One to Three Unnecessary Horses

Uncle Sam in Bulletin No. 73 says this: "On many farms from one to three unnecessary horses are kept mainly that they may be available during the few days when the crops are being harvested."

Minnesota Farmers' Extension Bulletin No. 15 on page 10, says this:

"Upon many farms more horses are kept than are necessary to perform the work. Frequently this is because the owner does not realize the annual cost of keeping them; or he retains them for sentimental reasons. If the working animals so kept were brood mares, raising a foal each year, this would not be objectionable, as they would bring in some income. Often they are geldings and there is little excuse for retaining the extra horses. It is essentially unbusinesslike. Often an extra horse or two is kept through the year, in comparative idleness, for possible use in seed time and harvest.

Illustration 2. Good brood mares bring an income

22. Horse Feed Turned into Butter or Beef Makes a Big Profit

If there are today from one to three horses more than necessary on each farm, every farmer could make from $50.00 to $150.00 more by feeding to cows the feed given the unnecessary horses. If, in addition, a cheaper power than horseflesh is used, so that additional horses could be disposed of, a farmer might make from $100.00 to $250.00 more profit without cultivating any greater acreage.

For example, according to the Iowa Dairy Test Association, a test of 1,400,000 Test Association cows showed that feed for one cow cost $37.00 per year. Each cow returned 217 pounds of butter fat at $0.32, a total of $69.44, showing a profit of 85 per cent or $32.44. (The skimmed milk and calf pay for the labor charge.) The $89.54 it costs to feed a horse one year (Table III, Page 11) would feed two cows, and these could bring a net profit of $64.88.

In the Pennsylvania State Experiment Station Bulletin No. 102, it shows that in feeding steers, 100 pounds of gain cost $9.75 for feed. Then the $89.54 worth of feed consumed annually by the horse would, if fed to steers, produce almost a thousand pounds of beef.

The Indiana State Experiment Station in 1913 found that the cost of feed per hundred pounds gain varied from $7.74 to $9.34.

It will be readily seen that horse crops if fed to cows or steers would bring a handsome profit every day, either in butter fat or beef, whereas, this same feed

given to the horse goes to keep up a head of steam that is never utilized more than 12 per cent of the time, and in the case of unnecessary horses is utterly wasted.

23. Four Good Reasons Why Horse Labor is Expensive.

If horse labor is so expensive, we naturally inquire the reasons. The principal ones are as follows:

First, because of the horse's low efficiency as a motor.

Second, because of the fact that he is a small power unit which cannot work in combination with more than three other units at the most.

Third, because every unit requires man labor to operate and control it.

Fourth, because the work for which he is adapted is seasonal, and then in volume far beyond his capacity.

24. The Horse is a Very Low Efficiency Motor

The horse eats 10 pounds of feed for every hour that he works—10,000 pounds a year. For all this feed he returns a surprisingly small amount of work at the traces. Seventy per cent of what he eats is lost somewhere in his mouth, stomach and intestines. This delivers 30 per cent to his muscles, which sounds promising until we learn that the greater part of this must be reserved for his own use—body maintenance, carrying his weight and propelling himself about the field. **He has left, after he has taken care of himself, not more than 7 per cent efficiency for actual work. Edison says his efficiency is only 2 per cent.**

In comparison with other prime movers, the horse is the lowest of all—a triple expansion steam engine has an efficiency of from 8 to 10 per cent, and a kerosene engine from 15 to 18 per cent. At best, out of every five acres of feed, he turns not more than half an acre of it into useful work. What is worse, the most of this is feed that easily could be put in available form for human sustenance—corn cakes, corn flakes, hominy, and rolled oats, or it could be turned readily into pork, mutton, milk, butter, or beef, and sold at good prices.

25. Horse Labor Must Always be Used in Small Power Units

In the days of the cradle, the sickle and the spade, the horse was big enough, but today he has been dwarfed by the big units on every side. This is the day of big things—big cars, big boats, big engines, big dynamos, big farms, big elevators, everything in fact is big. Agriculture alone has attempted to thrive and grow with a power that long ago proved entirely inadequate for other important work. Man muscle and horse muscle cannot possibly fill the bill. The horse at best cannot work with more than three or four other horses. This is the largest workable unit, so at the most a farmer does not have over three or four horse power of energy to put onto any one job. The rate of travel is slow—hardly over 1.6 miles per hour. When it is faster than this the horses tire out rapidly, in fact, at this rate they cannot put in more than ten hours of work in twenty-four with rests and breathing spells in between. If eight horse power is required on a job, it means two units of four horses each, or more likely four two horse teams.

26. Horse Power Requires Expensive Man Labor

It is hardly practical to use more than four horses in a team. For field work farmers frequently use four horses on harrows and plows and binders, but when it comes to road work, rather than use four horses on a load a man divides up the load and uses two teams, each team requiring a driver. This is one of the points that makes horse labor so expensive. Every team, whether it be two, three, or four horses, requires the service of a driver. On a farm where it is necessary to put a large number of teams into the field to do the work on time, this requires a great deal of hired help, more than it is sometimes possible to obtain.

27. Farm Field Work is Confined to Short, Active Periods

There are practically two seasons on every farm—the active season and the inactive season. The Government made very careful investigations and found that during the

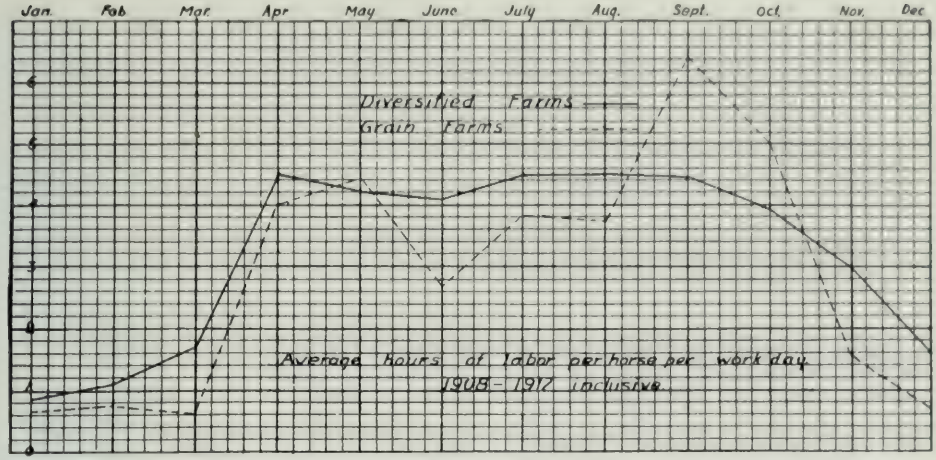


Chart II—Showing the average hours of labor per horse per day by months: (Ext. Bull. No. 15, Minn. Farmers' Lib.)

inactive season, that is, the winter months, the horse seldom averages more than one hour of work a day. During the active season, the crop growing period, the work averages from three hours a day on some farms to as high as eight or ten on some others.

Note that on grain farms the "peak load" occurs during the three months culminating in October; spring work touches the high point in May. During November, December, January and February the work is very light. The diversified farm, on the other hand, gives steadier employment, although there are months of very little activity. The number of horses a farmer keeps are determined by just a few months' work. **Sufficient horses must always be carried to take care of the work during the most pressing season with the result that most of the horses are idle the greater part of the time.**

28. Horses Are Seldom at their Greatest Efficiency when They Should Be

After a winter of idleness in a barn the horses are soft and not in a condition for the severe strain of spring work. Yet when spring opens up there is plowing, disking and dragging which must be done on time in order to insure maturity of the crop. Rather than push the horses to the limit, the job, whatever it may be, is slighted or less acreage is put under cultivation. In either case, there is a direct loss to the farmer. At harvest time the work is again severe. The sun scorches and the flies bite. Nevertheless the crops must be harvested when they are ready. After a season's field work the horses cannot be in best condition to stand the hard drive and long hours sometimes necessary to save the crop.

29. How Much Power Does a Horse Deliver

This is a point that is not always clearly understood. We rate all prime movers in horse power terms, assuming the power delivered by a horse in one hour to be a standard. As a matter of fact the power per hour delivered by a horse is a very uncertain quantity. It depends on its size, muscular development and speed. **Experiments indicate that the horse exerts a pull on its traces equal to one-eighth to one-tenth of its weight for a working day of ten hours.** The speed at which he is able to do this work for ten hours is from 1.6 to 2 miles per hour.

30. Definition of a Mechanical Horse Power

Jas. Watt, inventor of the steam engine, concluded from experiments with heavy English dray horses, **that the power of the average horse was equivalent to 33,000 pounds raised one foot in one minute. This was adopted as the standard for measuring power and is known as a mechanical horse power.** Figuring on this basis, a 1,500-pound horse traveling at $2\frac{1}{2}$ miles per hour and pulling one-tenth of its weight would be pulling exactly one mechanical horse power.

$\frac{1}{10}$ of 1500 = 150 lbs.
150 × 13200 ft. ($2\frac{1}{2}$ miles) = 1,980,000 foot pounds in 60 min.
1,980,000 ÷ 60 = 33,000 lbs. 1 ft. per minute = 1 Horse Power.

If this horse traveled only 2 miles per hour, he would deliver four-fifths of a horse power; if he traveled 1.5 miles per hour, he would deliver three-fifths of a horse power.

Animal power, however, is an elastic power and the maximum effort which a horse may put forth for a short time may greatly exceed his own weight. In actual test a draft horse has been proved to exert an effort of about half his weight while walking at a speed enabling him to develop, for a short time, from 4 to 5 mechanical horse power. Such trials, however, are always of short duration and must be followed by periods of rest.

This elasticity of the power as delivered by the horse has led to some confusion in comparing the actual horse power delivered by an animal with the mechanical horse power delivered by a machine. A machine's horse power is not elastic. It may be safe to assume, however, that day in and day out, week after week, and month after month, a mechanical horse power will be equivalent to an animal horse power in actual work performed.

Illustration 3
Horses are idle the greater part of the year

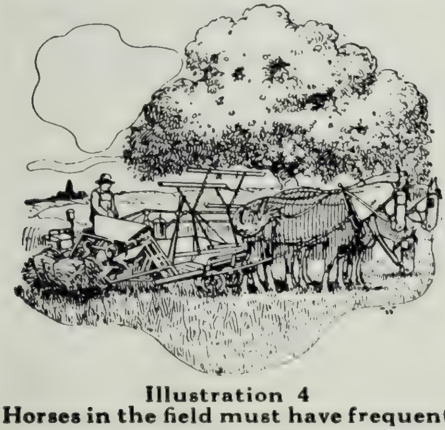


Illustration 4
Horses in the field must have frequent rests

31. A Summary of Farm Horse Labor

1. Eats products of 25 per cent of all cultivated land.

2. Works only 3 hours per day, or 1,000 hours per year, or 10,000 hours during its working life.

3. Costs about $125 a year for maintenance, or 12.5 cents for every hour that it works.

4. Inactive during four months of each year.

5. Must be used in small units, each unit requiring a driver.

Illustration 5
Horses cannot work in bad weather but must be cared for just the same

Illustration 6
Horses are tired out before the day is finished

Illustration 7
Horses must be taken in from the field and fed and watered

Illustration 8
Horses must be cared for in the winter. They eat but do not work

6. Increasing in cost each year.

7. Subject to disease, sickness and injury.

8. Duration of his efficient effort limited to only a few hours a day. Must have long periods of rest.

9. Not capable of much emergency work as in case of rush harvests.

10. Seriously affected by climatic changes.

11. Not always a safe power, especially in the hands of a boy.

12. Needs thoughtful and constant care to insure proper feeding and good condition.

13. Requires expensive shelter — so does its feed.

14. A very low efficiency motor, delivering from 2 to 7 per cent in work.

15. Its continuous working pull is small, only from one-eighth to one-tenth of its weight.

PART III

THE TRACTOR AS A FARM MOTIVE POWER

32. Farmers Must Adopt a Cheaper Power

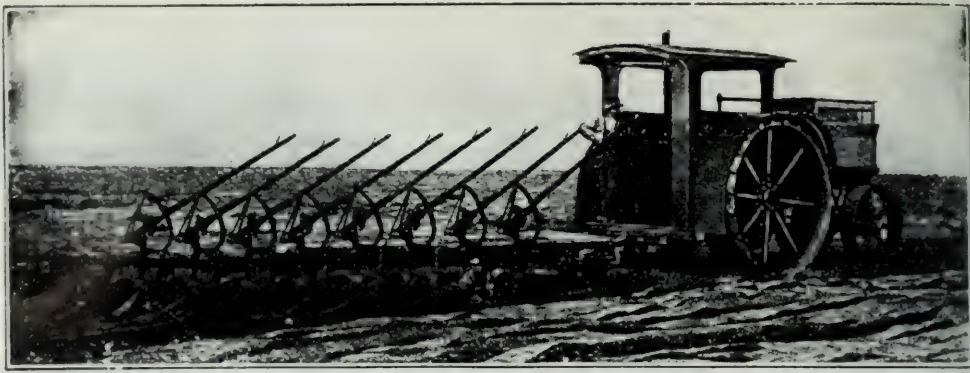
The problem of a cheaper power for the farm is such a serious one that not only the United States Department of Agriculture but many of the State Departments have issued bulletins emphasizing the necessity of giving this careful thought. In Bulletin No. 15 issued by the Minnesota Farmers' Library we find this—

"On the modern farm where business organization and a high type of skill are required, the cry is for efficiency. This is especially timely when the costs of production are high and the farm manager must soon be prepared to investigate in detail the costs of production in order that economies may be instituted. On most farms the possibilities of more economic forms of production are apparent. The point of maximum returns for labor or capital expenditures is still far beyond us. **Upon many farms the first step toward more economic production must be in cheapening the power used in operating farm implements.** A **tremendous loss** is possible in the one item of horse labor alone, and when it is considered that this cost represents about 40 per cent of the cost of farm operation, its importance may be realized. The man who handles his horses at a high cost per hour of labor is handicapped in every enterprise on his farm in comparison with the man operating at a low cost. * * * * The cost of horse labor is essentially a business problem for the man who operates his farm by business methods."

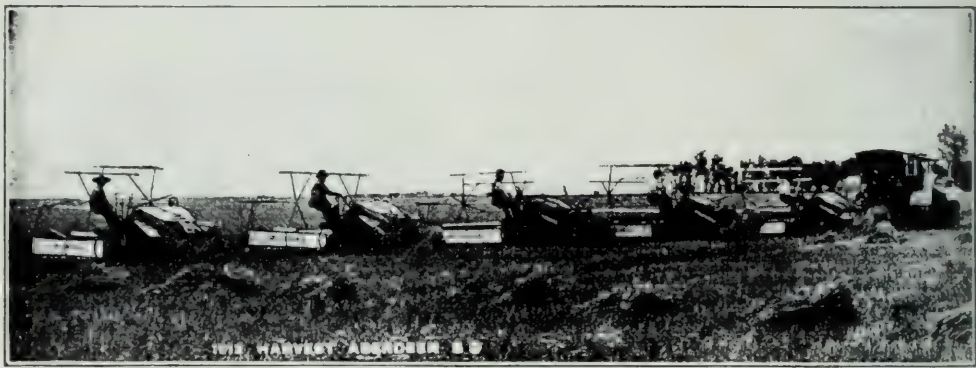
There are several ways of approaching this problem of horse power expense. It may be possible to change the cropping or rotation system so as to distribute the work for the horses as evenly as possible through the year. In numerous instances economies can be affected by decreasing the number of horses kept. In either instance it may be possible to give more attention to the question of feeding to reduce this to the minimum cost without impairing the horses' efficiency. Any or all of these methods are desirable, and we would urge every farmer, no matter how many horses he feeds, to put them into effect.

But the most practical method of reducing this power cost on the farm is to substitute a cheaper power.

This cheaper power, cheaper in initial cost, cheaper in maintenance, cheaper in operation, is oil tractor power. The tractor is the logical outcome of the attempts which have been made to reduce power costs.



Plowing 30 acres a day



Harvesting 100 acres a day

Taking the crop to the elevator

Illustration 9
For years the small farmer lived in hope that some day he, too, could have cheap oil power to do his work

33. Big Farm Tractors were the First to be Developed

The development of the farm tractor has just been the reverse of the automobile. The first automobiles were small, light weight affairs—the first tractors were big, powerful and rather heavy machines. They were of enormous tractive capacity, and suited to extensive harvesting, seeding, threshing and hauling operations. Undoubtedly the man with 10,000 acres found the help and power problem more acute than the small farmer because of the limited time in which to accomplish his big work. This man eagerly accepted the large tractor outfit as a solution of his troubles.

On these large grain farms oil tractors accomplish their purpose. With the tractor plowing, double disking, and seeding 25 acres per day—work that formerly would have taken one man and a team two weeks to perform—and with a tractor waiting to harvest, thresh, and haul to market, it is small wonder that the tractor has taken the place of the horse on large farms.

Illustration 10
The largest plowing outfit ever assembled—three International Harvester Mogul Tractors and a 55-Bottom Engine Gang which plowed an acre in less than four minutes

But how about the man on the small farm? He, in the meantime, had been left to curry, water and feed, to mend harness, and use gall cure, in fact, to travel the same monotonous round of horse duties that has ever been the farmer's lot. He was left to solve his power problem as best he could until a tractor should be developed with unrestricted application to small farm needs. Of all our six million farms, more than five million are small farms—174 acres or less—and so 80 per cent of all our farmers were kept waiting for the small farm tractor, a power that would put them on a par with the big producer.

34. The Small Farm Tractor is now a Reality

The small tractor finally came. From big, heavy machines with huge belt power and tractive ability have been developed lighter engines with graceful lines and capable of delivering a half or more of their rated engine power at the drawbar, where it takes the place of horses. Designs have been standardized, unnecessary weight eliminated, mechanism simplified, until now a farmer of 160 acres can purchase a safe, simple, cheap motive power that will make a big hole in the producing cost.

Illustration 11
The popular one-man small-farm kerosene-burning tractor

35. Oil Tractor Rating

The terms "brake" or "belt" horse power are used to denote the total amount of power which the engine will develop and transmit to a belt for stationary work such as threshing. This amount of power may be computed or ascertained by actual measurement with proper apparatus.

The "drawbar" horse power is the belt power minus the amount of power required to propel the weight of the tractor. Most tractors require approximately 50 per cent of the total power developed by the engine to move their own weight, leaving the remainder available for pulling other implements. The amount of power which is actually exerted on the drawbar varies, of course, with the weight and construction of the tractor. Tractor ratings are ordinarily expressed by writing the "brake" horse power after the "draw-bar" horse power, thus 8-16 or 10-20 would indicate a tractor having a pull of either 8 or 10 horse power on the drawbar, and developing 16 or 20 horse power for belt, or stationary, work.

36. The Tractor does not Entirely Supplant the Horse

With all its wonderful utility, we do not assume that the tractor will entirely supplant the horse. The horse is more mobile; it can go places a tractor cannot. **Some horses will always have to be kept, especially on corn belt farms, but in most cases sufficient horses can be sold to pay for a tractor and still have enough horses on the farms to do the light jobs.** The money that has been spent in horse feed can be turned into butter, mutton, or pork and the money invested in huge barns—"horse hotels"—can be turned into blooded stock, into productive machines, fences, better roads and more comforts for the home.

37. Good Horses will Always be in Demand

This is what Chas. E. Snyder, Assistant Editor of the National Stockman and Farmer says:

"If every farmer owned an oil tractor, as he will some day just as he owns a binder now, we would still have room for more **good** horses. The general adoption of oil power is not going to drive the horse out of the country nor take the possibility for profit out of him. No one who understands agricultural conditions expects any such thing to happen. When steam power replaced the horses used to drive the old-time threshers many felt that the horse industry was going to be hurt badly. It was not. There is endless work for the horse that can do it well and always will be. We have altogether too many of the kind of horses that fill no market demand. They are the result of crossing, indiscriminate breeding—the little pacing mare to the grade drafter, the chunky mare to the crooked-legged spavined little trotter, etc.—the product a non-descript of the dunghill type that nobody wants. If the oil tractor will put this kind of horse out of business—and it will—we shall all be better off. The misfit horse never made his grower any money, anyhow. Let us breed straight and let us breed the best, sound, pure-bred or high-grade mares to pure-bred stallions of their kind. The offspring will always be needed and bring good prices. But at the same time we need the cheap and efficient power that oil or kerosene will furnish us to supplement our good horses. It is the only money-winning, sensible, business-like plan to follow—**more good horses, fewer bad horses, and more farm tractors.**"

TABLE IV

38—Tabulated Reports from Farmers who have purchased an International Harvester 8-16 H. P. Mogul Kerosene Tractor, showing size of farm, acres under cultivation, number of horses before and after buying a Tractor, their value, fuel consumed and prices paid therefor.

TOWN	STATE	Acres in Farm	Acres Under Cultivation	HORSES: No. Before Buying Tractor	HORSES: No. After Buying	HORSES: No. Horses Replaced	HORSES: Total Value of Horses Replaced	HORSES: Value Horses Per Head	KEROSENE: Gallons Used Daily	KEROSENE: Price Per Gallon —Cents	GASOLINE: Price Per Gallon —Cents	LUBRICATING OIL: Gallons Used Daily	LUBRICATING OIL: Price Per Gallon —Cents
Elmo	Kan.	320	160	6	4	2	$300	$150	20	5.5	8.5	½	35
Galva	Ill.	210	180	10	6	4	600	150	20	6	9.5	1	40
Gladstone	Ill.	176	120	6	...	...	...	150	17	5.5	8.5	...	...
Stanley	N. Y.	140	130	7	3	4	800	200	17	7.5	...	1¼	30
Garber	Okla.	320	260	8	4	4	600	150	20	4	...	⅔	30
Zearing	Ia.	295	205	11	6	5	705	140	16	5.5	14	1	35
Bessie	Okla.	240	170	6	6	...	...	133	16	6	13	...	38
Minneapolis	Kan.	320	240	10	4	6	650	108	20	4.6	...	½	29
Greenville	Ala.	1200	600	18	18	...	...	166	10	10.5	17	½	30
Salina	Kan.	240	230	7	7	...	...	160	20	6	...	1	40
Rocky Comfort	Mo.	350	330	10	2	8	800	100	16	5	12	1	28
Cross Timbers	Mo.	200	150	6	6	...	...	100	15	5	...	1½	30
Hays	Kan.	960	450	10	10	...	...	150	20	5	8.8	1	45
Columbus	Neb.	234	150	4	1	...	...	125	20	6	12	1	50
Soso	Miss.	147	75	3	2	1	200	200	30	6	...	1	...
Lyons	N. Y.	113	107	6	6	...	...	...	17	8	...	½	65
Prairie du Rocher	Ill.	230	230	8	6	2	300	150	20	6	12	½	22
Nash	Okla.	160	140	6	6	...	...	116	30	6.5	15	2	...
Massaponax	Va.	300	200	8	2	6	800	133	20	8.5	15	½	40
Morris	Ill.	320	275	13	8	5	400	80	20	6.5	10.5	1	30
Chittenango	N. Y.	164	140	5	3	2	400	200	12	7	16	¾	33
Moville	Iowa.	240	160	8	4	4	800	200	13	5.5	9.2	1½	48
Clarksville	Tenn.	480	400	9	4	5	875	175	20	8	...	¾	38
Osborne	Kan.	40	35	2	2	...	...	200	20	5.5	12	1	26
Waynesville	Ohio.	215	140	6	2	4	900	225	15	7.5	11	¾	25
Cuba	Ohio.	302	250	12	6	6	900	150	12	8	...	½	40
Montrose	La.	200	150	6	6	...	...	166	12	8	12.5	¼	43
Allensville	Ky.	348	265	8	4	4	600	150	...	...	...	...	...
St. James	Minn.	130	100	4		...	...	120	18	8	16	½	40

New Baden	Ill.	240	150	8	4	4	600	150	15	6.25		1½	24
Hastings	Neb	160	160	6	2	4	700	175	20	6		¾	40
Easton	Md	141	125	7	4	3	600	200	25	9	18	1	55
Fairview	Mo	165	165	4	2	2	400	200	27	4		1	35
Watkins	N. Y.	340	300	8	6	2	400	200	12	8	16	1	37
Edna	Kan	480	240	8	8				10	3.5	8	1	34
Hallowell	Kan	200	150	6	4	2	300	150	19	5.2	9.6	¾	23
Bowling Green	Mo	281	240	12	7	5	625	125	20	5.9		¾	29
Ligonier	Ind	230	190	3	3			166	15	6	9	1	22
Glenburn	N. D.	600	600	12	8	4	600	150	15	10	15	½	35
Delavan	Wis.	280	200	7	5	2	320	160	12	7		½	40
Fredonia	Wis.	180	170	6	4	2	300	150	15	5.9	10	½	11
Clarkshill	Ind	270	260	10	5	5	750	150	16	6.5	10.5		40
Cornell	Ill	233	203	14	6	8	1,000	125	12	6	9.5	⅛	30
Maywood	Neb	None		6	1	5	900	180			11	1	36
Buechel	Ky	340	200	12	7	5	550	110	15	6.5	10.5	¼	30
Sutherland	Iowa	350	245	10	8	2	300	150	20	5.8	10	½	45
Shabbona Grove	Ill	320	300	12	8	4	600	150	15	6		1	50
Logansport	Ind	287	275	16	8	8	1,475	184	20	6	8.5	½	23
Meridean	Wis.	140	100	5	4	1	150	150	18	8		1	35
La Grange	Ind	190	140	6	3	3	600	200	15	5		½	22
Weston	Me	280	220	8	8				25	6		1	55
McDonogh	Md	865	560	16	12	4	400	100	30	7	12	⅛	
Clifton Springs	N. Y.	130	110	6	4	2	360	180	20	8.5	14	¾	35
Union City	Tenn	330	320	12	6	6	1,200	200	22	8.5	15	1½	60
Sycamore	Ill	100	90	5	3	2	400	200	20	6	10	½	40
Amsden	Ohio	170	170	6	4	2	490	200		8	11		30
Pawnee Rock	Kan	320	250	10	5	5	750	150	20	5.4	12	¾	28
Brookville	Ind	365	250	8	5	3	600	200	20	6.5	10.5	¾	29
Rogers	Neb	200	140	5	4	1	150	150	25	6.5	12	1½	60
Salina	Kan	240	200	10	6	4	800	200	20	5.9		½	
Saranac	Mich	184	120	5	2	3	225	75			9.5	1	28
Green Bay	Wis.	160	90	4	2	2	400	200					
Guymon	Okla	480	325	10	6	4	600	150	18	6		1	34
Coats	Kan	320	265	7	7			150	20	6.3		1	30
Newton	Kan	160	140	8	4	4	550	137	12	6.5		¾	45
Jasper	Mo	163	130	4	3	1	150	150		7	9		25
Collinsville	Ill	320	200	8	4	4				6	15		23
Waukee	Iowa	250	230	8	4	4	750	187	20	6.3		¾	24
Waupun	Wis.	80	62	3	2	1	200	200	15	5.9	9.25	½	35
Medicine Lodge	Kan	800	600	8	5	3	600	200	23	4.9		½	27
Poynette	Wis.	200	175	7	4	3	450	150	24	9		½	30
Colfax	Ill	360	320	14	10	4	450	112	18	6.5		¼	33
	Average	292.7	222	7.9	4.9	3	$474	$158	18.3	6.47	11.75	.8	35

Note: Where figures are omitted owner failed to make a report. These reports obtained in September 1915.

39. How Many Horses can be Sold from the Average Farm?

This is always a perplexing question, and can only be answered in a general way. **Substitute oil power for animal power where the time saved and the increased amount of work done will result in a profit. Sell all but enough horses to do the light work. Keep preferably brood mares that will help pay for their keep in the colts they produce.** Some farmers maintain that a tractor would pay for itself even if all the horses were retained. We do not think this is wise economy. Unnecessary horses should be sold, and in addition, others the tractor will replace also should be disposed of.

A concrete illustration, with an average 160 acre farm as a basis, has been very carefully analyzed below. This analysis shows the number of days of field work the horses do, the amount it costs, the work the tractor can do, and the number of horses it will replace.

40. Field Work with Horses on 160 Acre Farm

According to the U. S. Census Report, an average Illinois diversified farm of 160 acres would be approximately as follows:

50 acres of corn,
30 acres of oats and wheat.
20 acres of hay,
60 acres of rough land, pasture, orchard, building and feed lots.

This average farm supports six work horses or mules and one colt. Let us see how many days' work with horses are required to seed and harvest these crops.

Illustration 12—The average 160-acre corn belt farm supports six Work horses and one colt

Illust. 13—This scene was taken on the farm of the Good Hope Farm Company, Mentor, Ohio, of which B. J. Ruetenick is manager. Mr. Ruetenick, in an article contributed to the October 2nd, 1915 issue of The Country Gentleman, states: "The tractor and three disk harrows kept ahead of three 11-hoe drills. Nine horses would be needed for these tools." These would have required three drivers, so the tractor also displaced 2 men

40. Field Work with Horses on a 160-Acre Farm (Continued)

(Figures of work done per day are taken from reports submitted by Central States farmers.)

TABLE V

50 Acres of Corn Land

Plowing—4 horses–16″ gang	4	acres per day	12½ days
Disking—4 horses–8′ disk harrow	15	acres per day	3⅓ days
Harrowing—(3 times) 3 horses, 3 sec. har	30	acres per day	5 days
Planting—2 horses–check row planter	12½	acres per day	4 days
Cultivating—(4 times) 2 horses, 1 row cult	10	acres per day	20 days
Harvesting—3 horses, corn binder	8	acres per day	6¼ days
Total	51.08 days or 1450.5 H. P. hrs.		

30 Acres of Wheat and Oats

Disking twice—4 horses, 8′ harrow	15	acres per day	4 days
Harrowing—3 horses, 3 sec. harrow	30	acres per day	1 day
Drilling—3 horses 12 x 8 drill	15	acres per day	2 days
Harvesting—4 horses, 8′ binder	15	acres per day	2 days
Total	9 days or 330 H. P. hrs.		

20 Acres of Hay

Mowing—2 horses, 5′ mower	10	acres per day	2 days
Raking—2 horses, 8′ side del. rake	15	acres per day	1½ days
Loading—2 horses, 6′ loader	10	acres per day	2 days
Total	5½ days or 110 H. P. hrs.		

The total horse power hours of field work required for these three crops is 1890.5 At 12.5 cents an hour the horse cost is $236.30. This does not include any expense for man labor.

41. Field Work with an Oil Tractor on a 160 Acre Farm

Let us suppose that this farmer sold four horses at an average price of $150. (See paragraph 3 for prices of farm work horses.) These four horses should bring $600.00, almost enough to buy a kerosene-burning tractor rated at 16 horse power on the belt and 8 horse power on the drawbar. What would the same work cost when done by this tractor? In the first place, the tractor will do all of the operations mentioned above with the exception of planting and cultivating the corn, and perhaps operating the side delivery rake, and for this work and other light horse jobs we have kept two horses and the colt. (Figures based on 10-hour day.)

FIELD WORK WITH HORSES ON A 160-ACRE FARM

Illustration 14

Plowing

Disking

Harrowing

Seeding

Mowing

Loading

Harvesting grain

Corn harvesting

TABLE VI

50 Acres of Corn Land

Plowing—8-16 tractor and two 14″ plows, 5.6 acres per day....	9 days
[If pulling three 14″ inch plows, 8.4 acres per day, 6 days]	
Disking and harrowing in one operation:	
8-16 tractor—8′ disk harrow with 2-sec. peg, 20 acres per day..........	2½ days
Harrowing twice—8-16 tractor with 3 sec. harrow, 35 acres per day..........	3 days
Planting—Use the team and planter.	
Cultivating—Use the team and cultivator.	
Harvesting—8-16 tractor and corn binder, 8 acres per day	6¼ days
Total..........	20¾ days

30 Acres of Oats and Wheat

Double disking and harrowing in one operation:	
8-16 tractor with 8′ tandem harrow and 2-sec. peg, 20 acres per day..........	1½ days
Drilling—8-16 tractor with 12x8 drill, 20 acres per day.......	1½ days
Harvesting—8-16 tractor with 8′ binder, 20 acres per day....	1½ days
Total..........	4½ days

20 Acres of Hay

Mowing—8-16 tractor with two 5′ mowers, 20 acres per day..	1 day
Raking—With 2-horse team.	
Loading—8-16 tractor with windrow loader, 13 acres per day..	1½ days
Total..........	2½ days

Here is 27¾ days' work with a tractor which will require 15 to 20 gallons of low grade kerosene at 7.7 cents per gallon, and one gallon of lubricating oil at 35 cents—total fuel per day $1.89. (See Note.) Adding to this a liberal amount for depreciation and repairs, interest at six per cent, and a day's operation (counting 100 days' work per year) will cost about $4.00, total for 27¾ days is $111.00. The horse labor for planting, cultivating and raking amounts to $63.75, which added to $111.00 makes a total of $174.75—or—the tractor does for $111.00 work which, when done with horses, costs $172.55. There is a clear saving of $61.55, and the crops were put in in 12⅓ days less time.

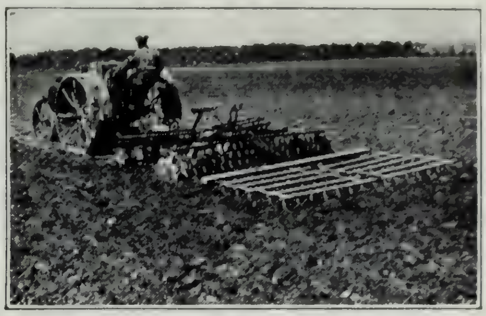
This, however, does not indicate the difference in profit in handling the job with a tractor rather than with horses. Selling four horses leaves the farmer with $375.00 worth of feed to put into butterfat or beef. This amount will keep ten cows, which can return a net profit of $324.00 (see paragraph 22). Take out of this $324.00 profit, the $111.00 which it costs to operate the tractor, and there is still left

Note: These are January, 1916, average prices—kerosene 7.7 cents, gasoline 16.9 cents. The cost in any particular territory may be obtained by using local prices.

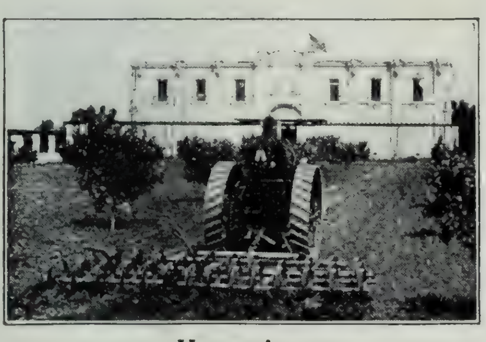
FIELD WORK WITH AN OIL TRACTOR ON A 160-ACRE FARM

Illustration 15

Plowing



Disking and Smoothing



Harrowing

Seeding

Mowing

Loading hay

Corn Harvesting

Grain Harvesting

a net profit of \$213.00 a year in cash, and a saving of $12\frac{1}{3}$ days of man labor.

Farm labor is worth at least \$1.50 per day including board. Here is a saving of \$18.50, a total of \$231.50 for the year not including the saving in belt work.

Add to this the profit which can be made by having available belt power at about 2 cents per horse power hour for all the miscellaneous work that comes about almost every day in the year, and it is apparent that a good tractor burning kerosene could pay for itself long before it is worn out.

42. With a Tractor the Work can be done in Season

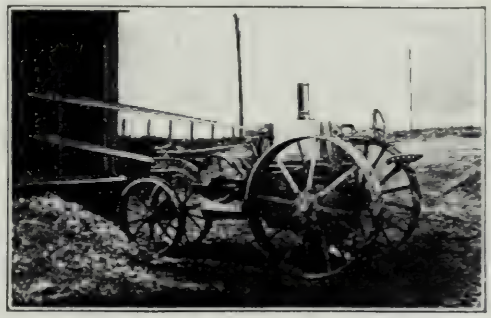
The saving of $12\frac{1}{3}$ days of labor which were figured at \$1.50 per day can be made far more profitable. On any farm, even with ample horses to take care of the work, seasons are sometimes against the farmer. Good spring plowing or seeding weather may be of short duration, with a result that not all the acreage planted is cultivated. Again, a day gained in the harvest is oftentimes of far greater importance than \$1.50 in labor saved. With a tractor on the job you can work twenty-four hours a day if necessary to take advantage of the weather. Besides this, the days gained may give the farmer an opportunity to do work for the neighbors at a good profit. A member of the United States Department of Agriculture recently stated in a speech that he regarded this side of the tractor business the most important. In his opinion **farmers lose millions of dollars annually because their plowing, tilling and threshing cannot be done just when it should.** There is a right time for every work and a tractor enables the farmer to take up this work in its order, to complete it in a short time, and do everything in its proper season.

BELT WORK WITH AN OIL TRACTOR ON A 160-ACRE FARM

Illustration 16

Husking and Shredding

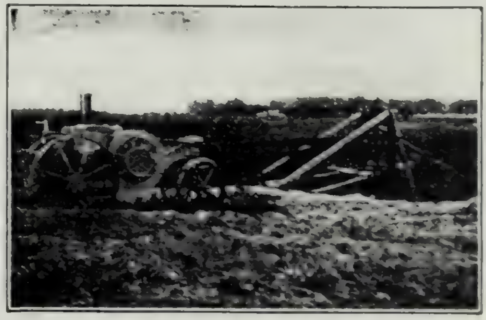
Filling the silo



Grinding feed

Threshing

Baling hay



Pumping water

PART IV

ADVANTAGES OF KEROSENE-BURNING TRACTORS

43. Tractor Horse Power versus Animal Horse Power

In Bulletin No. 174, United States Department of Agriculture, issued April 15, 1915, appears this—"The term horse power denotes an amount of power equivalent to that developed by a 1,500 pound horse moving at the rate of 2½ miles per hour, and exerting a pull equal to one-tenth of his own weight, or 150 pounds. This represents a power output capable of raising a weight of 33,000 pounds to a height of one foot in one minute, and these figures are commonly used in computing the power developed by an engine. A pull equal to one-tenth of his weight is considered a normal load for a horse. As most farm horses weigh less than 1,500 pounds, it is apparent that they do not ordinarily furnish full horse power. **Thus an engine delivering 20 horse power at the drawbar would be exerting a stronger pull than twenty horses (averaging less than 1,500 pounds in weight) normally do hour after hour.** It should be borne in mind, however, that the engine is capable of delivering at the drawbar in an emergency but a fraction in excess of its rating of 20 horse power, while twenty average horses are able for a short time to pull several times their normal load, that is, the engine must be overloaded to deliver 25 horse power, while the twenty horses can be so urged as to deliver 30, 40, 60 or more horse power for very short periods of time."

A tractor rated at 8-16, that is, 8 at the drawbar and 16 on the belt, will, according to the figures above, exert as strong a pull at the drawbar as eight average horses normally do hour after hour and week after week. A man who purchases a tractor of this size sometimes expects it to go out and do just as much work at a day's plowing as could eight horses. As a matter of fact, these eight horses may be doing 16 horse power work for a very short time. The real test is, how much work can these eight horses deliver day after day, week in and week out? In a test of this kind eight horses will not deliver more than 8 horse power, consequently a tractor with a rating of 8 horse power at the drawbar should be considered the equal of eight average farm horses.

44. What is the Difference Between Kerosene and Gasoline?

To the user or prospective user of an internal combustion engine, there is only one difference of any importance between kerosene and gasoline—**the price.**

Gasoline and kerosene, with benzine, naphtha, distillate, and lubricating oils, are all obtained by distillation from one product—crude oil. Until recently, from 4 to 10 per cent of gasoline and from 44 to 50 per cent of kerosene were obtained. This small quantity of gasoline, compared with the large amount of kerosene, naturally made gasoline more expensive. Along came the automobile designed to utilize nothing but gasoline, and up went the price of this fuel. Oil refiners immediately turned their attention to getting larger quantities of gasoline, and today, by a new method of distillation, they can obtain as high as 30 per cent of this fuel and 30 per cent of kerosene. This increase in the production of gasoline has not been nearly large enough to supply the 1,500,000 gallons used daily by stationary engines, and the 4,500,000 gallons required daily by the 2,225,000 automobiles now in use. As a consequence, there is still a big spread in price, with gasoline from 50 to 100 per cent higher.*

45. Oil Refiners are Facing a Shortage in the Production of Gasoline

Every indication points to a continued shortage of gasoline. The automobile industry is turning out hundreds of thousands of cars each year, and gasoline engine factories are adding other hundreds of thousands. Meanwhile, the oil wells are producing less. If the increase in the number of motor cars and engines and decrease in the oil supply continues, there can be only one result—**a shortage of gasoline which might prove serious.** An unimpeachable authority states that the next five years will bring the oil refiners face to face with a crisis which they will find it difficult to meet—a demand for gasoline which cannot be furnished from the supply of crude oil.

* January 1916 prices show gasoline 119% higher than kerosene

How about kerosene? It is being produced in larger quantities each year as the production of gasoline increases, but the demand shows no decided change. There is always an ample supply, with the result that **gasoline averages 67 per cent higher in price, as shown by reports received from twenty points throughout the country. In a recent Government Bulletin it is stated that the price of gasoline is 50 to 100 per cent higher than kerosene.**

Reports from farmers themselves shown on pages 26 and 27 indicate a difference of about 5 cents a gallon between kerosene and gasoline—or gasoline 82 per cent higher than kerosene.

46. Does Gasoline Produce More Power than Kerosene?

The fact that gasoline is more expensive and more easily evaporated and ignited than kerosene has led many to think that it produces more power. A gallon of gasoline weighs 6.18 pounds, while a gallon of kerosene weighs 6.8 pounds. They both contain the same number of heat units per pound, about 19,000, but as kerosene weighs more per gallon than gasoline, it contains more heat units.

47. Why Doesn't Every Engine Operate on Kerosene?

There is one very good reason why every motor won't operate on kerosene—BECAUSE THE BUILDERS OF THE MOTOR HAVEN'T DISCOVERED THE SECRET OF HOW TO BURN KEROSENE SUCCESSFULLY. Years ago the designers of International Harvester tractors turned their attention to this problem. They saw the handwriting on the wall—gasoline going up and up. They realized that if the man on the farm was to have cheap power it must be **kerosene** power, not gasoline. These men—the keenest minds in the inventive field—had ample funds and equipment at their disposal and only one instruction—**to design an engine that would burn kerosene economically and just as satisfactorily as any other engine will burn gasoline.**

AND THEY DID IT. EVERY INTERNATIONAL HARVESTER OIL TRACTOR WILL BURN KEROSENE AND DELIVER THE SAME AMOUNT OF

POWER ON 20 GALLONS OF THIS FUEL THAT ANY OTHER ENGINE WILL ON 18 GALLONS OF GASOLINE.

48. A Kerosene-Burning Tractor Saves Money

This difference in the price of kerosene and gasoline means a saving which is a whole lot greater than one would imagine. An engine burning 20 gallons of kerosene a day at 7.7 cents a gallon, would save its owner $1.50 a day over the same engine burning 16.9 cent gasoline, assuming that it burned two gallons more of kerosene than gasoline. A hundred days' work on this basis would mean a saving for the kerosene engine of $150.00, which makes it very evident that there is no economy in buying a gasoline engine when a kerosene engine is available.

A farmer contemplating the purchase of an engine or tractor should make it a point to investigate the kerosene-burning feature. There are many so-called kerosene-burning engines on the market. It is possible for these engines to run on kerosene, but when it comes to doing actual work, the fuel tank is usually filled with gasoline.

49. Kerosene is Safer to Handle and Store than Gasoline

There is another point which it is well to consider. With a kerosene-burning engine on the farm, there is greater safety than in storing the gasoline needed for most other tractors. Farmers who use kerosene for lighting purposes will find it necessary to carry only one tank of oil. This can be filled very easily whenever the tank wagon comes around, and every time it is filled there is a saving of 4 cents or more in every gallon of fuel put into it. With kerosene instead of gasoline on hand, there is less danger of violating many of the very strict rules of the insurance companies. Gasoline evaporates easily, while kerosene does not.

Don't take anybody's word that the engine will burn kerosene satisfactorily, but see it do actual work with this fuel.

50. What Uncle Sam's Experts Find in Favor of the Kerosene Tractor

In a recent Bulletin of the Department of Agriculture, which is a very exhaustive treatise on farm experience with the tractor, we find that in all the tests made kerosene tractors made a better showing than gasoline tractors. To quote from the Government's own experts—

"From the comparison made it will be seen that the figures were slightly in favor of the kerosene tractor in almost every case, the most important difference being in the estimated life and the cost of repairs required annually, but the percentage of replies, days used annually, hours lost, horses replaced, and percentage finding custom work profitable, all of which are favorable to the kerosene tractor, are worthy of note. * * * * * The hours plowed per acre, the depth plowed, width of plow and width of harrow are all greater for the kerosene than for the gasoline tractor. The amount of fuel consumed is greater for the kerosene tractor, but the cost is less on account of the lower price per gallon."

According to the Government experts, any man who contemplates buying a tractor will do well to buy a kerosene rather than a gasoline tractor, because it will last longer, costs less to keep up, requires less fuel, and does more work.

51. First Cost of a Tractor is Less than Horses

Assuming that an average farm horse is worth $150, the first cost of an oil tractor capable of delivering on a continuous pull, day after day, an equal amount of power is considerably less. For instance, a tractor capable of delivering 8 horse power at the drawbar will cost about $725, which is at the rate of about $90 a horse power, just a little over half of the cost of a horse capable of delivering the same power.

52. The Pulling Capacity of a Tractor is Greater than that of a Horse

The best authorities agree that the horse is capable of pulling on a continuous pull about one-tenth of his weight.

A 5,000 pound oil tractor, for instance, will pull from 1,500 to 2,000 pounds, which is from one-third to two-fifths of its weight. It is this greater pulling capacity, in other words, g ater efficiency, of the tractor which permits it to produce power at a much lower cost per unit.

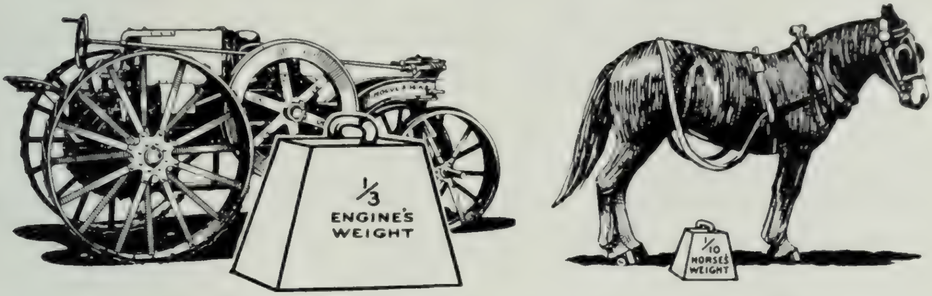


Illustration 17. The comparative pull of horses and a tractor

53. How Much does it Cost to Operate a Small Farm Tractor

As an illustration, let us take an 8-16 oil-burning tractor, which delivers 16 horse power at the belt and 8 horse power at the drawbar. This engine, in a ten-hour day on a full load, will consume 15 to 20 gallons of low grade kerosene at 7.7 cents a gallon, worth \$1.54. It will also require one gallon of lubricating oil at 35 cents, a total of \$1.89 for fuel and oil only. (See note bottom of page 32.)

Fuel consumption figures verified by farmers' reports shown in table IV on pages 26 and 27.

54. A Tractor Horse Power at the Drawbar Costs 3 to 4 Cents Per Hour

At a fuel cost of \$1.89 per day, the tractor delivers a horse power at the drawbar for about two cents per hour for fuel only, in striking contrast with 8½ cents, which is the feed cost for an animal horse power.

If we add to this fuel cost a liberal amount for depreciation and repairs, and interest at 6 per cent, the cost will be from 4 to 5 cents per hour. This is against 12½ cents per hour for an animal horse power. The greater number of days the tractor is used and the better care it gets the lower its total operating cost, because in the figures given above there have been very liberal allowances made for depreciation, all of which have been charged up against the tractor on the basis that it works only 100 days a year. The longer the tractor lasts the less depreciation per year, and the more days it works the less to be charged up to each day.

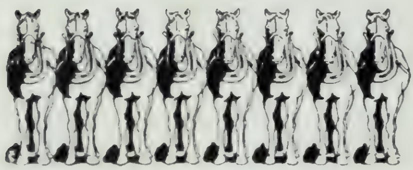
55. A Horse Power at the Belt Costs About Two Cents Per Hour

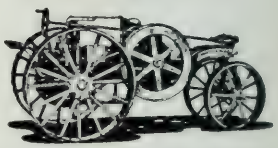
The tractor referred to in paragraphs 51 and 52 will deliver easily 16 horse power at the belt. At a total operating cost of $4.00 per day (page 32) the tractor will deliver 160

CHART III

8,000 Horse Power Hours are Delivered by

8 Horses in one year — **8-16 oil tractor in 100 days**





Cost with Horses		Cost with Tractor
53.76	Interest on Investment	$ 43.50
80.00	Depreciation	145.00
18.16	Harness Depreciation	
6.32	Shoeing or Repairs	36.25
701.76	Feed or Fuel	154.00
	Lubricating Oil	35.00
156.56 (Feeding and caring for)	Labor (Supplying oil and fuel)	25.00
4.24	Miscellaneous	
1020.80	Total	$438.75

$582.05 SAVED BY USING AN OIL TRACTOR

horse power hours in ten hours, so that the cost per horse power hour is about two cents.

56. Tractors Always Ready for a Hard Pull

Quoting from The Country Gentleman of September 18, 1915, a prominent horse breeder recently said—" 'I think too much of my good brood mares to work them during the heat of the summer on the binder or on that horse killer, the gang plow.' It is too much to ask of a brood mare to raise a big colt and perform heavy labor in summer and fall, but they can advantageously be used for cultivating and the lighter work about the farm." Another authority says:

"Thus we find generally that mares have the preference and comprise a majority of the horse stock on most farms, the gelding going to the cities, where they are preferred.

"But not all is smooth sailing when brood mares comprise the major portion of the farm horse power. Too often mares heavy in foal must be employed in doing work that no brood mare in such condition should perform. Necessity and the absence of sufficient number of other horses to do the work at a critical time demand it. Particularly is this true in the spring near foaling time. The gravest danger follows pulling a mare to her limit, backing heavy loads or backing at all over rough ground, working on slippery ground or traveling far or working hard on a hot day either before foaling or too soon after foaling. Lost foals, dead mares or mares so weakened as to be long unfit for service are likely consequence. Also when mares have colts at side the spring rush of work often demands that they do too heavy work. They come in intensely hot, perhaps the rush has prevented stopping between meals to allow the colts to nurse, and too often the colts are found off feed, constipated or dysenteric—and all good horsemen know that every check in a colt's growth likely means many dollars off his market value when grown. So the man who breeds mares upon which he must depend for a lot of work has plenty of trouble on his hands unless he place the welfare of his mare and colts above his crops and it is not always possible to tell just what it is best to do in a critical time."

Here is another phrase of the farm power question which again emphasizes the desirability of mechanical motive power. The tractor is always ready for a long, hard pull. It will work under full load for twenty-four hours just as easily as it does for an hour. It will work on the coldest day in winter and on the hottest day in summer. Flies cannot bite it, nor can the dust choke or blind it. It can be driven to the absolute limit—you can't tire its muscles nor break its heart. As long as it gets fuel, it gives power, and during the stress of a busy season you know the feeling of security and preparedness which comes to the farmer who has ample power to take advantage of every favorable hour.

Again, no time is lost in getting under way. In the morning you have full power available in a moment—no time is lost in feeding, watering, and hitching up.

If you are doing field work, merely shut down your engine at night and leave it there. You can go out to it again in the morning knowing it is just where you left it and have it started under full load in a minute or two. This contrasts very strongly with what the horse can do.

57. The Oil Tractor is a One-Man Outfit

The oil farm tractor is essentially a one-man outfit, and its utility to the farmer lies partly in the fact that with it one man controls a large amount of power. One man can hardly handle more than four horses in a team in the Corn Belt, but he can easily handle an oil tractor that delivers 30 horse power at the drawbar. It is very evident from this that the larger the tractor the greater the saving in man labor. One man and a small tractor may easily handle three plows. This work done with horses would require probably two teams and two drivers. One man and a large tractor can possibly handle eight or ten plows. In this instance the one man takes the place of the four or five drivers that would be needed for the teams.

Whether the job be drilling or disking, harrowing or seeding, it is seldom necessary to have more than one man with the outfit. If the tractor for plowing is equipped with a self-steering device, the operator has practically nothing to do except to watch his plows, and these require very little watching.

58. Time Spent in Caring for a Tractor

When compared with what a horse expects, the tractor surely does not ask much of its owner. It requires no valet service, does not have to be watered and fed three times a day, curried and rubbed, nor does it require its stable to be cleaned each morning. Its feed, in striking contrast to what the horse eats, can be stored anywhere without attention. As for itself, when it stops all attention and care stops, while the horse, through the long winter months of idleness, requires feed, feed, feed, and care all the time. All the tractor asks is an occasional overhauling, and surely there is nothing disagreeable about this work when compared with the services which the horse requires.

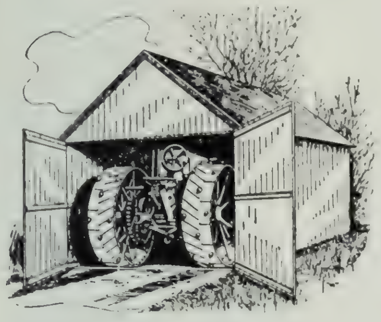


Illustration 18
Winter quarters for the tractor

59. Cost of Housing a Tractor

A tractor needs only a shed for protection just large enough to permit the outfit to be run in. This is in striking contrast to the expense of barns required for horses. On the basis of 750 cubic

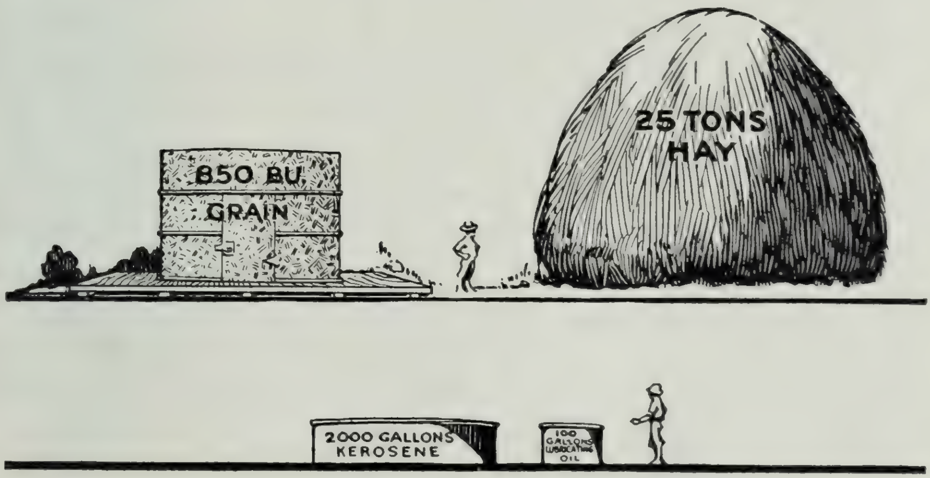


Illustration 19
Note the difference between storing the feed for eight horses and an 8-16 oil tractor

feet of space, which it requires to correctly stable one horse, eight horses would require 6,000 cubic feet. A tractor of about the same working capacity would only require one-eighth as much space. Feed for each horse requires about 1,400 cubic feet, 100 feet for grain and 1,300 for hay and straw, or 12,000 cubic feet for eight horses. The feed, that is, fuel for a tractor, is merely a tank and some cans placed wherever convenient. This item in favor of the tractor is frequently overlooked, though in dollars and cents it is a decided saving in tractive power over horse power. This is more readily appreciated when we realize the vast amount that the American farmer has invested in his horse barns.

60. Does the Tractor Pack the Soil?

With the early steam tractors, the packing of the soil by the tractor wheels often caused serious injury to the crop.

This feature of the early tractor was much advertised, and sometimes caused considerable prejudice in the minds of many farmers against all tractors, both gas and steam. Government experts looked into this matter very thoroughly, and here is their verdict as shown in a recent Bulletin.

"While some gas tractors under certain conditions have injured the crop by packing the soil, this is not ordinarily the case. The answers of one hundred and thirty-five tractor owners who were personally interrogated on this point have been compiled. These men were located in various states in the northwest. In answer to the question 'Does the packing of the soil by tractor wheels injure the crop?' only nine state that the packing of the soil is injurious, while one hundred and one say that it is not, twenty-two of this number declaring it to be beneficial. It may be safely stated that on most soils, when they are in fit condition to be worked satisfactorily with horses, **the modern gas tractor will cause no injurious packing.**"

The small farm tractors now being offered have been reduced very materially in weight when compared with the power they deliver, with the result that now there is practically no liability of packing, in fact, an 8-16 tractor puts about 10 pounds pressure per square inch on the soil.

A man weighing 170 pounds, wearing No. 8 shoes, creates a pressure of 14 pounds to the square inch of surface where he steps. A horse weighing 1,400 pounds creates a pressure of approximately 18 to 33 pounds per square inch under his hoofs while pulling a working load.

61. Life of an Oil Tractor

The life of a tractor cannot be properly expressed in years alone. The tractor is a machine, and like all machines, its life depends on the amount of work it does and on the care taken of it.

This life can be shortened by lack of proper care and by abuse in operation. The number of years a tractor will be available for work on a farm, therefore, depends only partly on the hours it will be required to work each year, but if the machine is given proper care, both when idle and when in use, the amount of work done per year will be the principal factor in determining its length of useful life.

The life of a small tractor properly handled and properly taken care of when not in use should be sufficiently long to more than pay for itself and leave its owner a good profit in dollars and cents and in time saved.

62. Tractors have a Double Use

The tractor will do practically everything on the farm for which horses or engines are used, that is, all drawbar and belt work. Of course, there are some exceptions, such as the planting and cultivating of corn. All the operations on the grain farm from plowing to hauling to market, all the operations in corn growing with the exception of those mentioned, and all the work of hay making with the exception of drawing sweep rakes and operating stackers are profitable jobs for the tractor to handle. It will also pull stumps, haul lumber, and work the roads.

But the field work is only half the story. Everything that has a pulley attached to it can be operated by the tractor —feed grinder, pump, saw, silo filler, thresher, shredder, hay hoist, corn elevator, concrete mixer, dynamo, and so on. This work the horse cannot do at all.

Due to this double use it is not necessary for the tractor to supplant a great amount of horse power in order to pay for itself.

63. Jobs for Which a Tractor can be Used

Clearing the Land
Pulling up trees
Tearing out hedges
Pulling stumps
Grubbing
Pulling stones

Preparing Seed Bed and Seeding
Plowing
Listing
Disking
Crushing clods
Smoothing
Rolling
Packing
Drilling

Harvesting
Mowing
Hay loading
Hay hoisting
Pulling grain binders
Pulling corn binder
Pulling potato digger

Belt Work
Hay baling
Corn Shelling
Irrigating
Pumping
Grinding feed
Sawing
Threshing
Husking and shredding
Silo filling
Clover hulling
Stone crushing

Road Work
Grading
Dragging
Leveling
Hauling crops
House moving

Miscellaneous
Elevating corn
Loading logs
Stretching wire
Ditch digging
Spraying
Spreading
and many other jobs

Clearing the Land

Illustration 20


Pulling up trees with a large oil tractor


Pulling out a hedge with a small oil tractor


Oil tractors are good stump pullers


A 12-25 oil tractor pulling a grubbing plow

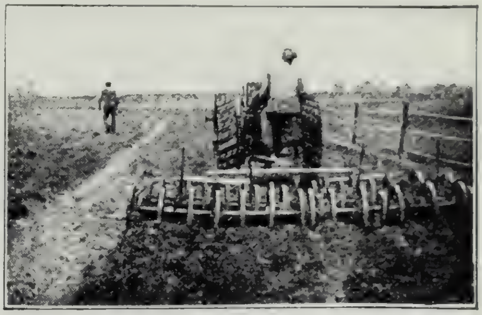
Preparing the Seed Bed and Seeding

Illustration 21

The oil tractor makes easy work of a difficult plowing job

A small-farm oil tractor pulling three disk harrows

Crushing clods and smoothing the field



The small oil tractor handles the spring-tooth harrow in good shape

Some farmers disk and smooth at one operation with a small tractor

Pulling three grain drills with a small tractor

Harvesting

Illustration 22

The small tractor easily pulls a potato digger

This small tractor is pulling one hay loader, although some farmers hitch two loaders to the machine

Harvesting (Continued)

A 12-25 tractor pulling four binders

Pulling a corn picker

Belt Work

Illustration 23

The ideal threshing power

Filling the silo

Husking and shredding the corn crop

Operating a rock crusher

Furnishing power for the feed grinder located in the barn

Pumping water

Belt Work (Continued)

Operating a large corn sheller

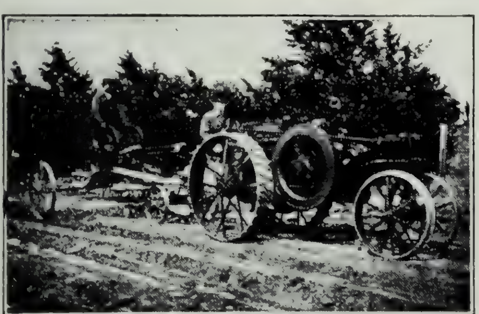
Baling Hay—The press is in the barn

Ideal power for a concrete mixer

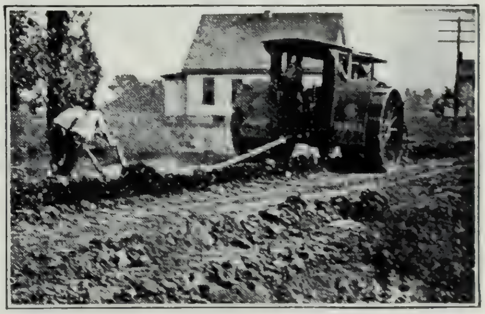
Sawing the wood is part of the winter work

Road Work

Illustration 24



The small-farm tractor handles a grader with good results



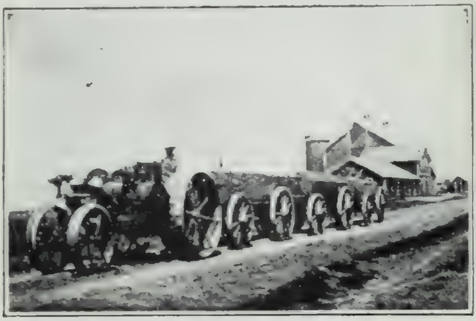
Plowing up an old roadway with an oil tractor

A large oil tractor operating an elevating grader

Leveling the roads with a tractor as the power

Miscellaneous

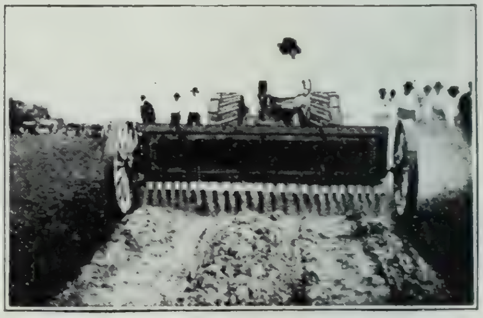
Illustration 25



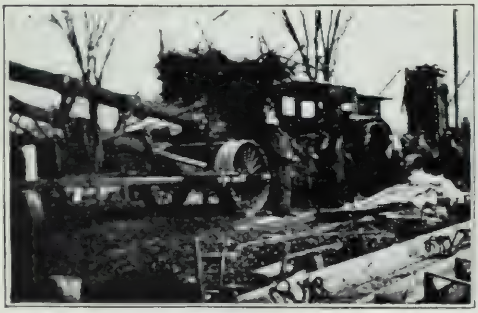
Hauling the crop to market

Loading logs

Pulling a spreader



Drawing a lime sower



Hauling trees on a country estate

Pulling a hop sprayer

Moving a house

Ideal power for a portable saw mill

PART V
PLOWING WITH AN OIL TRACTOR

64. Plowing is the Hardest of All Farm Work

The first gasoline tractors built were intended primarily for belt work to take the place of steam tractors. Their work here was so entirely satisfactory that the farmers immediately attempted to put their outfits at work in the field, and the first work they tried to do was plowing. This is only

Illustration 26. A striking picture of old time and present methods of plowing

natural, because of all the jobs on the farm, plowing is the hardest on both man and beast. This is the basic operation of all farm work, and it should always be done at the right time. To plow one square mile, or 640 acres, a man and team must walk 5,280 miles. The gang plow has always been considered a horse killer, and when farmers discovered that they could put oil power in the field and save their horses, many did not hesitate to make the change.

65. Cost of Horse Labor to Plow an Acre is $1.25

It requires approximately 10 horse power hours to turn an acre of land. At a speed of two miles, a team with one plow in ten hours will turn two acres. To deliver the 2 horse power required to do this work, they must travel 176 feet per minute and exert a continuous pull of 375 pounds or 187.5 pounds per horse.

1 horse power = 33,000 pounds, 1 foot per minute.
2 horse power = 66,000 pounds, 1 foot per minute.
2 mile speed = two times 5,280 or 10,560 feet per hr., or 176 ft. per min.
66,000 ÷ 176 = 375 pounds pull per minute.

We have seen that horse labor costs, according to Government figures, 12½ cents per hour per horse. On this basis ten hours' work will be $1.25, which is the average horse cost of plowing per acre.

66. Tractor Cost of Plowing Less than Horse Cost

The cost of plowing with a traction engine depends upon so many factors that it is difficult to make any definite statement. It depends upon the condition of the ground, size of the tractor, the number of plows pulled, the amount of fuel used, etc. An 8-16 horse power tractor, for instance, burning from 15 to 20 gallons of low grade kerosene per ten-hour day and using one gallon of lubricating oil, costs $1.89 for 10 hours work. (See page 32.) Pulling two 14-inch plows and traveling 20 miles per day, the tractor will plow 5.6 acres at a fuel and an oil cost of about 30 cents per acre. Pulling three 14-inch plows, it will turn 8.4 acres at a cost for fuel and oil of about 20 cents an acre. The kind and condition of soil is an important factor in determining the tractor cost of plowing. At that, the comparison between the lowest possible horse cost and the highest tractor cost shows a very interesting difference.

67. Uncle Sam Might Save $200,000,000 on His Plowing Bill

Think of the cost of maintaining 25,000,000 horses and mules. Last year it was $3,000,000,000, not including one cent for shelter.

The Census Report for 1910 shows 478,451,000 acres of improved land in farms, of which 65 per cent is put into crops that require plowing. This would be a little over 300,000,000 acres to plow every year. Let's assume that only 250,000,000 acres are plowed. One horse can't plow more than one acre in a day of ten hours, for which the farmer pays $1.25 for horse labor alone. Just think what Uncle Sam's yearly plowing bill is—$312,500,000, and he hasn't paid a cent yet for man labor. He might have had the same work done for $125,000,000, thereby saving $187,500,000, almost enough to build a Panama Canal every year.

68. Tractor Plowing Saves Man Labor Expense

The saving of three-fourths in the fuel cost is not the only one made by the tractor. In addition, there is a man

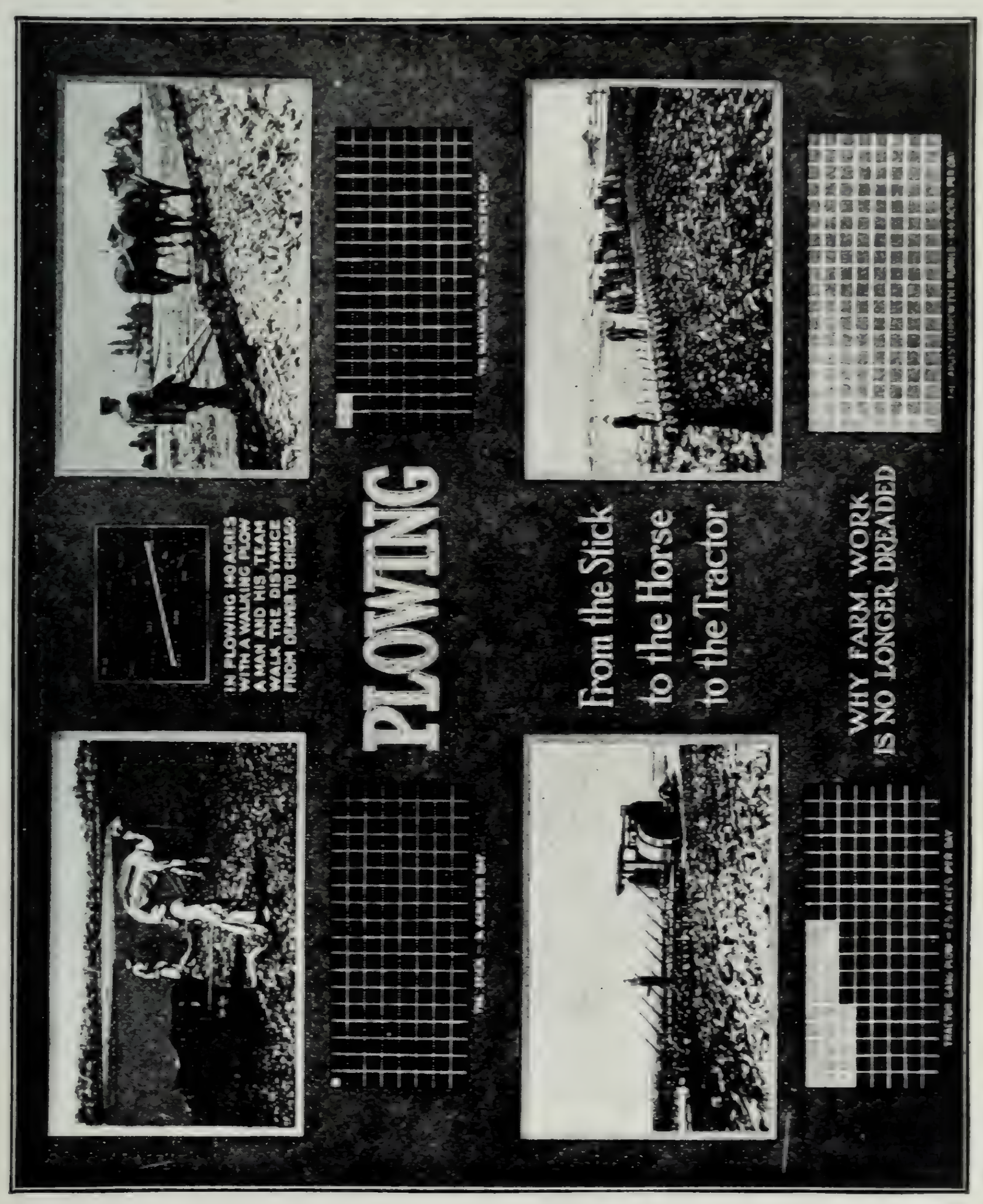


Illustration 27—Reproduction of Plowing Chart shown at the San Francisco Exposition, 1915

labor saving which amounts to considerable where one man and a tractor with a number of plows take the place of several drivers needed to work the horse teams.

69. Tractor Plowing Insures a Better Job

No horse gang can possibly do the quality of work that can be accomplished by an engine gang. Anxiety to spare the team has cut a big slice off the profits of many a farmer. For the sake of his horses he has plowed three or four inches deep when his judgment as a farmer said "Go deeper." He has often plowed late on account of hard ground, and he has many times allowed a field to remain unplowed on account of worn-out teams. Under normal conditions, late plowing never produces as good results as early plowing. Many a farmer has fed and harnessed by the light of the lantern, gone to the field and worked his team hard to take advantage of the cool of the morning. With the approach of the hot hours of mid-day, with vicious flies sapping the vitality from his faithful team, he has eased up on the work or quit the job. In using the tractor for plowing, there are none of these distressing conditions to be taken into consideration, nothing to think of but the quality of work done. It is possible to plow deep without thought of the added burden.

Deep plowing may generally be taken as an indication of good farming. In any normal community the farmers who plow deeper than the average of their neighbors may be safely considered the best managers. These farmers usually have the best crops, because by deep plowing they have been able to use a larger quantity of the natural resources of the soil. Deep plowing, especially in heavier soils like clay and those which tend to take on a hard pan character, loosens up the ground and permits easier root penetration and a greater absorption of rain water.

70. The Draft of Plows

To estimate on the work to be done with a tractor, one must figure on the nature of the soil. Numerous tests show the following table a good basis for figuring:

Illustration 28

A good job of deep plowing with an International Harvester Mogul 8-16 Kerosene Tractor

Table VII

Draft per Square Inch of Cross Section of Furrow

In sandy soil	2 to 3 pounds per square inch
In corn stubble	3 pounds per square inch
In wheat stubble	4 pounds per square inch
In blue grass sod	6 pounds per square inch
In June grass sod	6 pounds per square inch
In clover sod	7 pounds per square inch
In clay soil	8 pounds per square inch
In prairie sod	15 pounds per square inch
In virgin sod	15 pounds per square inch
In gumbo	20 pounds per square inch

Example:

Suppose a plow rig has two 14-inch bottoms, and the depth to be plowed is 6 inches. A cross section of each plow is therefore 14 x 6 inches, or 84 square inches. Twice this for two bottoms is 168 square inches. Since, in sandy soil, the pressure per square inch is three pounds:

Then 168 x 3 lbs. = 504 lbs.—draft in sandy soil.
Likewise 168 x 7 lbs. = 1,176 lbs.—draft in clover sod.
Likewise 168 x 8 lbs. = 1,344 lbs.—draft in clay sod.

71. How to Determine the Approximate Drawbar Pull of a Tractor

To find the approximate drawbar pull of a tractor traveling 2 miles per hour, multiply the rated drawbar power by 180 lbs. For instance, a tractor rated at 8-H. P. at the drawbar (at a 2-mile speed) must have a pull of at least 1,440 lbs. to make good on its rating. This should be a conservative estimate of its pull.

72. To Find the Number of Bottoms Which Can be Pulled

To figure the number of bottoms which can be pulled, divide the drawbar pull by the cross section of one furrow, multiplied by the draft per square inch of cross section of the furrow.

Example:

An 8-16-H. P. tractor to be used on the basis explained in paragraph 71, must have a pull of at least 8 x 180 or 1,440 lbs. to make good its rating. Plowing is to be done in clover sod, 6 inches deep, and the pressure per square inch on the plow is 7 lbs., according to the figures given in paragraph 70. Thus, the cross section and depth of plowing (14 x 6) multiplied by 7 (draft per square inch) equals 588 lbs. 1,440 lbs. divided by 588 lbs. equals 2.4. Thus, we can safely estimate on two bottoms.

73. Conditions Affecting Work of Plowing

Each one per cent of rise in grade—rise of 1 foot in 100 feet—adds one per cent of the weight of the tractor and plows to the draft. An engine plow gang with two bottoms weighs about 650 lbs., and the 8-16-H. P. tractor about 5,000 lbs. Thus, in the example shown under the heading "The Draft of Plows," the two 14-inch plows plowing at a depth of 6 inches, the draft on a 5 per cent grade would be as follows:

In sandy soil—504 lbs. plus 280 lbs. = 784 lbs.

It can be readily seen that the number of plows that can be pulled will depend largely upon the elevation and condition of the land. The footing of the tractor, weight of the plow gang, the elevation above sea level, and other points should be taken into consideration in figuring on tractor outfits.

74. Plowing Continuous Furrows from Center of Land

There are several ways of laying out and plowing land with tractors. It must be remembered that plows will not always cut the same width in tough land as in easier plowed land, and therefore it requires some experience and judgment on the part of the operator in order to lay out and plow a field and do a clean job. Local conditions must always govern the manner of laying off "lands" and they can be narrow or wide to give more dead furrows for drainage in wet localities and fewer dead furrows in dry countries where it is desirable to conserve all rainfall in the soil. Herewith are given two ways of proceeding to lay out and plow:

One method quite often used in plowing rectangular fields is by means of a continuous furrow. Down through the center of the field, stakes are set 10 or 15 steps closer to the ends than the sides, to allow for the narrowing of the furrow in turning the ends. Plows are started at the left end and pulled to the right, in the direction of the arrows shown in Chart IV. When the opposite stake is reached the plows are lifted and the tractor turned around as indicated by dotted lines, and swung in on a curve so as to round up the ends. It is necessary at the outset to make this loop at the ends on account of the short turn on the return furrow. When the land is wide enough the plows are left in the ground for a continuous furrow around the entire land. When the field is finished nothing will remain except small corners which can then be finished. From the standpoint of saving time this is the most approved method, because the plows are working continuously. Curve plowing, however due to an uneven distribution of the load is hard on the tractor gears.

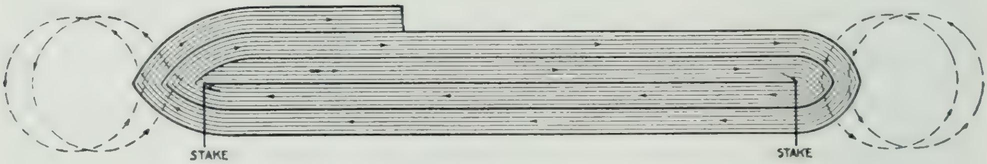


Chart IV—Plowing continuous furrows.

75. Back Furrowing and Dead Furrowing

This method is an exceptionally efficient method of plowing, because with it it is not necessary to make a double turn with the tractor. The only turns it makes are in a half circle. While it may pack the head lands to some extent, we do not think that packing is at all serious. When the head lands are plowed with a tractor, the entire field is plowed without any wheel tracks, and with ample back furrows and dead furrows. This method is clearly shown in Charts V, VI and VII.

To proceed with this method, leave about 15 steps (45 feet) all around the field on which the outfit can turn. With one bottom only in the ground, plow a furrow AO fifteen steps from the fence. Also MN fifteen steps from the op-

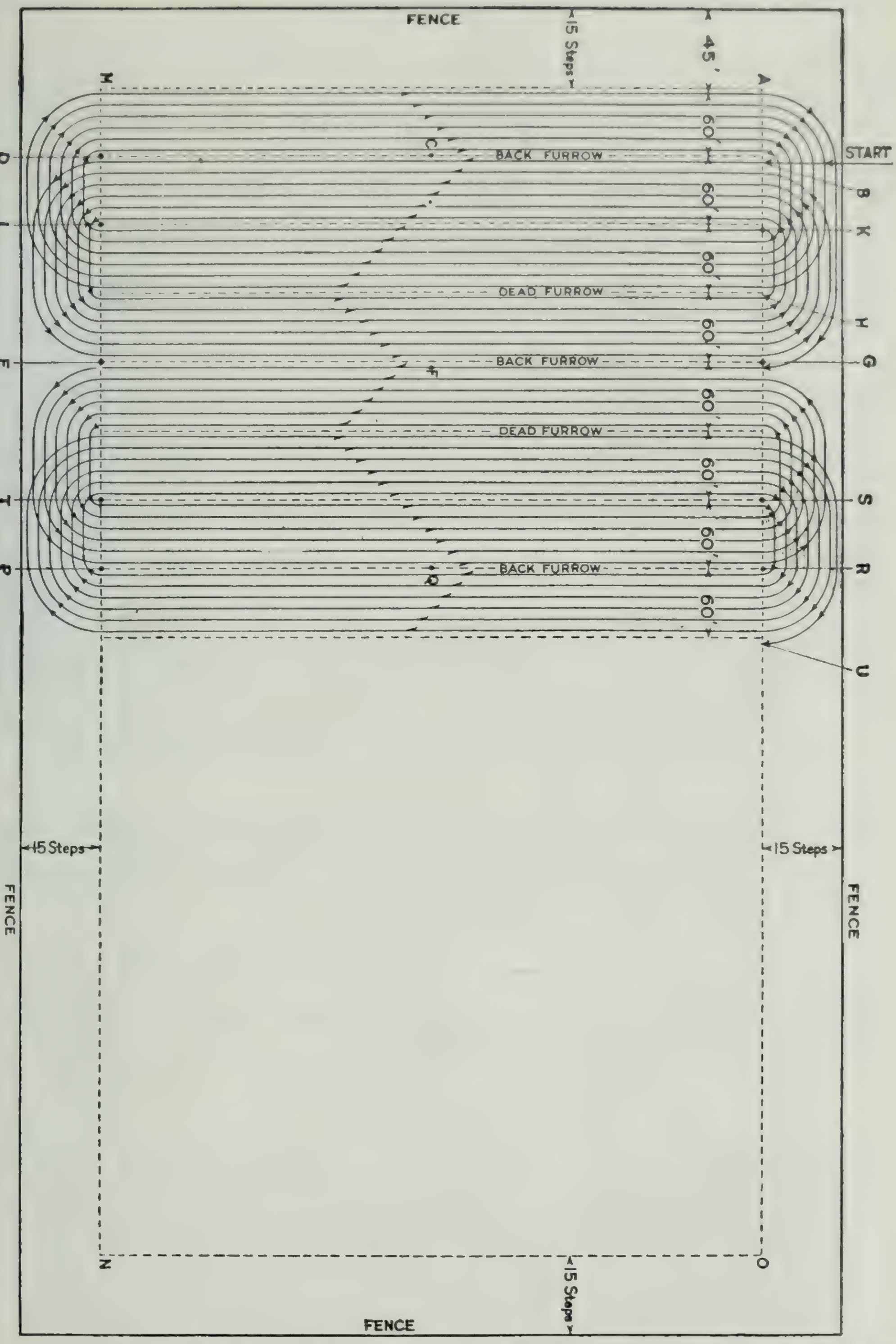


Chart V—Layout for rectangular fields. Note: Starting at point indicated, the line is continuous to "U," and can be easily traced. The line represents merely the course of the outfit in plowing the lands. The arrow heads indicate direction in which the outfit travels, and half arrows the direction in which the furrow is turned. This is the most approved method of plowing because it is all done on a straight pull, which eliminates uneven strains on gears developed by curve plowing where the differential throws the burden of the load upon the outside driver.

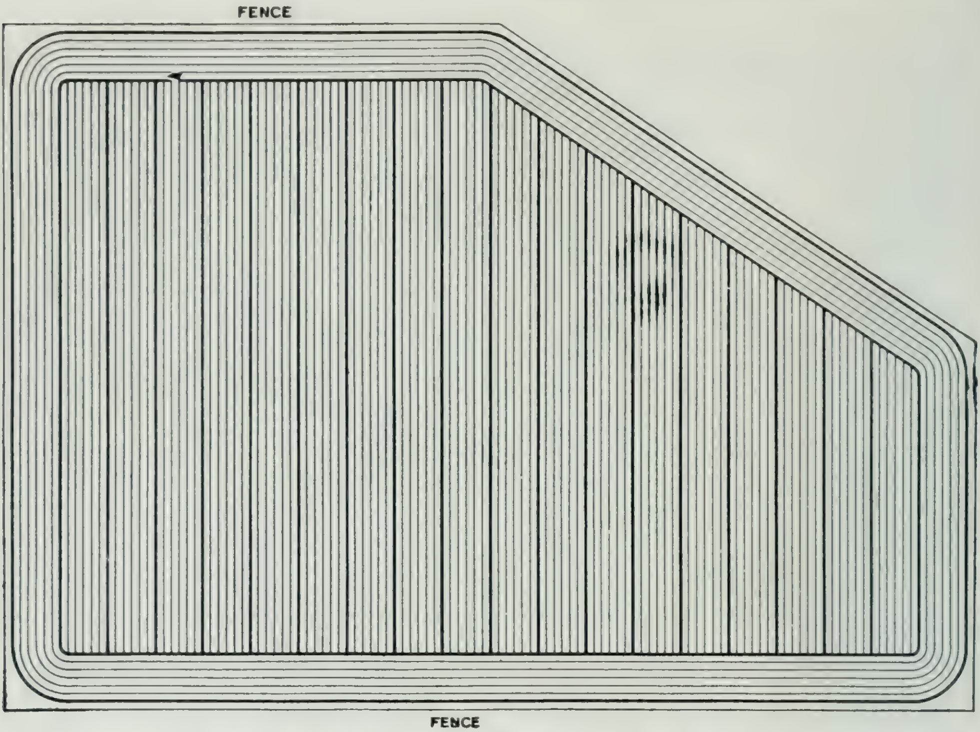


Chart VI—An irregular field plowed by the back-furrowing and dead furrowing method explained in paragraph 75.

posite fence. In plowing, the bottoms should be started into or out of the ground just as the front carrying wheel reaches the bank of these headland furrows.

Now A is 15 steps from both adjacent boundaries. Pace 20 steps (60 feet) to B, and set stakes at C and D 35 steps from the fence. Starting at B, plow through C and D. From D pace off 60 steps to E and set stakes at F, 60 paces from C, and at G, 60 paces from B. Turn the engine as indicated by the lines, and plow through EFG. Turn and come in to the left of B and proceed as indicated until 20 steps have been plowed off both sides of the land BDEG. The engine will now proceed from H to K and plow to L, where it will turn to the right, plow around DBKL, taking off 20 steps on both sides, finishing on the line MA, 15 steps from the fence.

From A proceed to G and plow from G to E. Pace off 60 steps from E to P and set stakes at Q and R 60 steps from F and G, respectively. Plow through PQR, turn around R to the left and swing in again to the left of G. Plow around

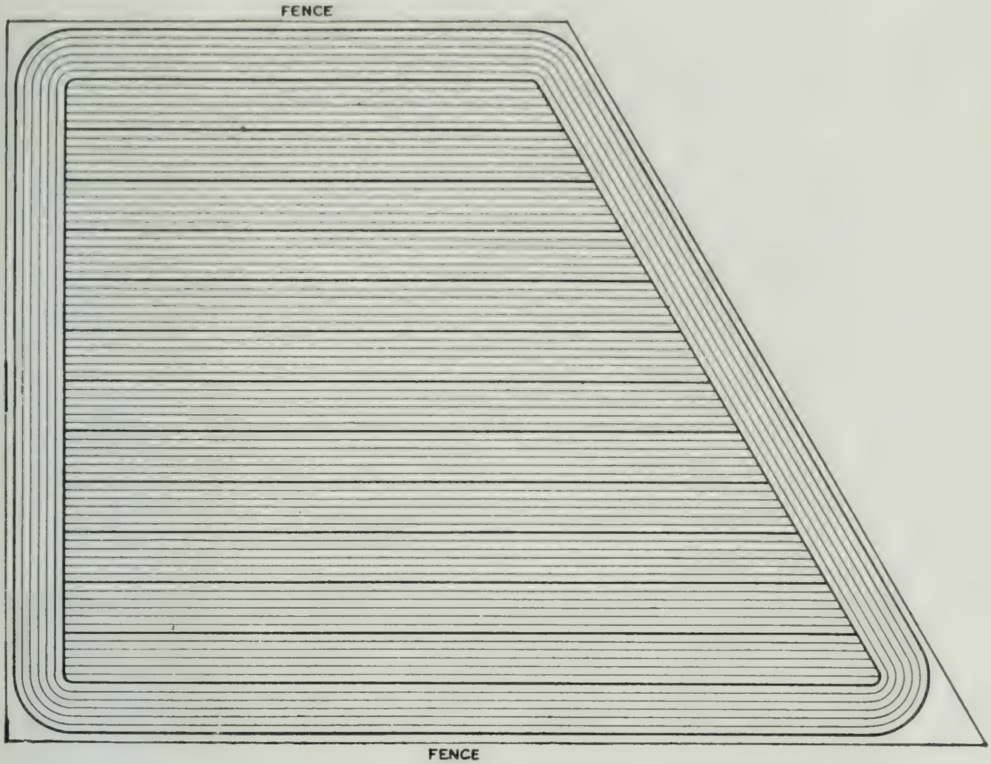


Chart VII—An irregular field plowed as explained in paragraph 75.

20 steps off each side the land GEPR as indicated by the lines. Then plow around the 20-step land STPR, taking off 20 steps on each side. Having finished this, bring the engine around to U and proceed as before.

When laying out the land, it may be a little more or less than the outer lands, and should be divided into greater or smaller portions. For instance, a 45-step land would be divided into strips 15 steps wide.

Illustration 29—Plowing with a medium sized oil tractor and 5-bottom plow

When the field is finished the 15 steps around the border should be plowed by going clear around the lands, cutting across the corners about 20 feet from the corners.

76. Plowing At Various Speeds

The following table indicates the acreage turned by one plow bottom traveling at different speeds of various International Harvester Tractors.

BASIS { A strip 1 ft. wide and 43,560 ft. (8.25 miles) long = 1 acre.
A strip 99 inches wide and 1 mile long = 1 acre or 43,560 sq. ft.
Tractor works 10 hours—**no allowance for stops.**

	Acres Plowed per Day			
	Speed Miles per Hour	One 12″ Plow	One 14″ Plow	One 16″ Plow
Titan 15–30–slow speed	1.87	2.26	2.64	3.02
Mogul 8-16 and 12-25	2.00	2.42	2.82	3.23
Titan 30-60	2.08	2.52	2.93	3.36
Mogul 30-60	2.18	2.64	3.07	3.58
Titan 15–30 fast speed	2.40	2.90	3.38	3.88

The Table Following is Figured On This Basis:

A strip 1 ft. wide and 43,560 ft. (8.25 miles) long = 1 acre.
A strip 99 inches wide and 1 mile long = 1 acre of 43,560 sq. ft.
Machine travels 2 miles per hour or 20 miles per day.
Full 10 hours travel with no time out for stops.

In determining the work accomplished at a different speed than this the work will be greater or less according as the speed is slower or faster. Thus a horse traveling one and one half miles per hour would do only three quarters of the work.

77. Plowing

No. Plows	Acres Plowed per Day		
	12″ Plow	14″ Plow	16″ Plow
1	2.42	2.82	3.23
2	4.84	5.64	6.46
3	7.26	8.46	9.69
4	9.68	11.28	12.92
5	12.10	14.10	16.15
6	14.52	16.92	19.38
7	16.94	19.74	22.61
8	19.36	22.56	25.84
9	21.78	25.38	29.07
10	24.20	28.20	32.30

PART VI
FIELD AND ROAD WORK WITH AN OIL TRACTOR

78. Harvesting with an Oil Tractor

The advantages of an oil tractor in the harvest field are so well stated by P. J. Ruetenick, Manager of the Good Hope Farms at Mentor, Ohio, in one of his recent contributions to The Country Gentleman (Oct. 2, 1915) that we quote herewith:

The same tractor has been used on an eight-foot binder. This is equipped with a tongue truck, to which a pole three feet long is attached. With a clevis on the drawbar this is the only additional equipment required. A mirror is fixed at the side of the tractor. This mirror is large enough to show the knotter arrangement on the grain binder. The operator looks into this mirror and if the twine should break, or the packers become clogged, he can see them and stop in a moment. This

Illustration 30

Pulling five grain binders with an oil tractor

reaping outfit has given the best of satisfaction, and with an eight-foot binder in a contest has accomplished more work than two six-foot binders operated by horses, under the same conditions. The hottest weather is usually experienced at harvest, and flies are the most bothersome, hence there are never three horses that work equally well together. If there is any rush work horses must be changed for fresh ones before the day is over. With the tractor no stops are necessary. The tanks are filled in the morning, and the outfit goes on from morning to night cutting the grain. It is left in the field, and a few hours are put in at the work during the evening.

The binder with tractor for power will take the corners at right angles, without leaving any grain. The operator pulls the binder a little past the grain, then with a quick motion of the steering wheel brings the tractor close to the grain again. This will practically turn the binder at right angles and will take a fresh swath with better ease than the horses. With the mirror attachment, which any handy farmer can make, there need be no operator on the binder, as the man on the tractor can at all times see the knotter on the binder without inconvenience.

Mr. Frank Benders of Benson, Woodford Co., Ill., has an entirely different arrangement from that used by Mr. Ruetenick for making a one-man outfit of his Mogul 8-16 tractor and McCormick binder. He has extended the steering wheel of the tractor back to the seat on the binder, as shown in the illustration and guides the tractor from that position.

Illustration 31
Mr. Frank Bender's one-man harvesting outfit

79. Cost of Harvesting with Grain Binders

Table VIII—With Horse

8-foot binder and 4 horses	15 acres per day	
Horse labor at 12.5 cents per hour (p. 12)	$5.00	
Man labor per day	2.00	
Total per day	$7.00	
Cost per acre		$0.46
Interest on binder—average	$9.70	
Depreciation on binder, average	15.00	
Total, per year	$24.00	
On basis of cutting 160 acres:		
Interest and depreciation—cost per acre		$0.15
Total cost per acre		$0.61

On basis of 20 bushels per acre, cost per bushel is 3 cents.

Table IX—With Tractor

(With a driver for the tractor and a man on each binder)

8-16 tractor and two 8-foot binders	40 acres per day	
Tractor cost per day (par. 54)	$4.00	
Labor of three men	6.00	
Total per day	$10.00	
Cost per acre		$0.25
Interest and depreciation charges per acre same as when horses were used		$0.15
Total cost per acre		$0.40

On basis of 20 bushels per acre, cost per bushel is 2 cents per bushel.

Tables 80 to 88 are Figured On This Basis:

A strip 1 ft. wide and 43.560 ft. (8.25 miles) long = 1 acre.

Machine travels 2 miles per hour or 20 miles per day, with no time out for stops.

At a different speed than this work will be greater or less as the speed is faster or slower. A horse traveling 1½ miles per hour would do only three-quarters of the work.

80. Disking

Size of Disk Harrow	Acres Disked per Day		
	1 Harrow	2 Harrows	3 Harrows
8-disk—4-ft.	9.68	19.36	29.04
10-disk—5-ft.	12.1	24.2	36.3
12-disk—6-ft.	14.52	29.04	43.56
14-disk—7-ft.	16.94	33.88	50.82
16-disk—8-ft.	19.36	38.72	58.08

81. Harrowing

Width of Section	Acres Harrowed per Day		
	With 2 Sections	With 3 Sections	With 4 Sections
5 ft.	24.2	36.3	48.4

82. Drilling

Size of Drill	Acres Seeded per Day		
	With 1 Drill	With 2 Drills	With 3 Drills
6x8— 4′	9.68	19.36	29.04
8x8— 5′ 4″	12.91	25.82	38.73
12x6 or 9x8— 6′	14.52	29.04	43.56
10x8— 6′ 8″	16.13	32.26	48.39
11x8— 7′ 4″	17.75	35.50	53.25
16x6 or 12x8— 8′	19.36	38.72	58.08
14x8— 9′ 4″	22.59	45.18	67.77
9x7— 5′ 3″	12.7	25.4	38.1
10x7— 5′10″	14.12	28.24	42.36
11x7— 6′ 5″	15.53	31.06	46.59
14x6 or 12x7— 7′	16.94	33.88	50.82
14x7— 8′ 2″	19.76	39.52	59.28
16x7— 9′ 4″	22.59	45.18	67.77
18x7—10′ 6″	25.41	50.32	76.23
20x7—11′ 8″	28.23	56.46	84.69
10x6— 5′	12.1	24.2	36.3
15x6— 7′ 6″	18.15	36.30	54.45
18x6— 9′	21.78	43.56	65.34
20x6—10′	24.2	48.4	72.6
22x6—11′	26.62	53.24	79.86

83. Harvesting With Corn Binders

Spacing of Rows	Acres Harvested per Day		
	With 1 Binder	With 2 Binders	With 3 Binders
40-in. rows	8.06	16.12	24.18
42-in. rows	8.47	16.94	25.41
44-in. rows	8.86	17.72	26.58

(Basis for Figures on preceding Page—no allowance made for stops)

84. Harvesting With Grain Binders

Size of Binder	Acres Harvested per Day			
	With 1 Binder	With 2 Binders	With 3 Binders	With 4 Binders
5-ft.	12.1	24.2	36.3	48.4
6-ft.	14.52	29.04	43.56	58.08
7-ft.	16.94	33.88	50.82	67.76
8-ft.	19.36	38.72	58.08	77.44

85. Mowing

Size of Mower	Acres Cut per Day		
	With 1 Mower	With 2 Mowers	With 3 Mowers
3½-ft.	8.47	16.94	25.41
4 -ft.	9.68	19.36	29.04
4½-ft.	10.89	21.78	32.67
5 -ft.	12.10	24.2	36.3
6 -ft.	14.52	29.04	43.56
7 -ft.	16.94	33.88	50.82

86. Hay Loading

BASIS—Figuring 1½ tons (*) of hay per acre, it is necessary to travel ⅔ of a mile with an 8-ft. loader to gather a ton load (8′3″x1 mile = 1 acre). At the rate of 2 miles per hour (tractor speed) it will take 20 minutes to travel ⅔ of a mile and pick up a ton load. Allow 10 minutes for changing wagons and start to gather another load. On this basis a tractor travels 40 minutes out of every 60, or 1⅓ miles per hour, picking up 2 loads per hour—10 hours = 13 miles or 20 loads.

Width of Loader	Acres Raked per Day		
	1½ Tons per Acre 1⅓ Miles per Hour	2 Tons per Acre Travels 12 Miles per Day	2½ Tons per Acre Travels 10 Miles per Day
Rake Loader 8-foot	13⅓ acres 20 ton loads	12 acres 24 ton loads	10 acres 27 ton loads
Windrow Loader 6-foot	Same as rake loader, because a side delivery rake is 7½ or 8 ft. wide and puts hay covering a strip that wide into a windrow.		

*1910 Census says—
Timothy averaged.......................1.22 tons per acre
Clover averaged.........................1.29 tons per acre
Clover and Timothy averaged............1.27 tons per acre
Alfalfa averaged.........................2.50 tons per acre
(Page 638, U. S. C. R. 1910, Vol. V)
Also—Average acreage of forage of all kinds 21.2 in 1909
(Page 643, U. S. C. R. 1910, Vol. V)

87. Planting Corn (With Horses—20 Miles Travel a Day)

Spacing of Rows	Acres Planted Per Day	
	With 1 Planter	With 2 Planters
40-in. rows	16.12	32.24
42-in. rows	16.94	33.88
44-in. rows	17.72	35.44

88. Cultivating Corn (With Horses—20 Miles Travel a Day)

Spacing of Rows	Acres Cultivated per Day	
	With 1 Cultivator	With 2 Cultivators or 1 Double Row Cultivator
40-in. rows	8.06	16.12
42-in. rows	8.47	16.94
44-in. rows	8.86	17.72

89. Draft of Wagons

An average draft per ton of load, on a four-wheeled wagon, according to the best authorities (Kent, Gen. Morin, Rankine, Trautwine, and Haswell) is as follows:

On macadam road— 50 lbs. per ton
On gravel road —140 lbs. per ton.
On sand road —240 lbs. per ton.

An 8-16 tractor with a 1,400 lb. drawbar pull would therefore haul, on level gravel road, $1{,}400 \div 140 = 10$ tons.

The increase in the tractive power required per ton on various grades is as follows:

TABLE X

Grade	Macadam Road	Gravel Road	Sand or Earth Road
Level	50 lbs.	140 lbs.	240 lbs.
1 per cent	70 lbs.	160 lbs.	260 lbs.
2 per cent	90 lbs.	180 lbs.	280 lbs.
5 per cent	150 lbs.	240 lbs.	340 lbs.
10 per cent	250 lbs.	340 lbs.	440 lbs.
15 per cent	350 lbs.	440 lbs.	540 lbs.

From the table above, it will be noted that the better the road the greater the increase in draft on up-grades, but on a level road, the better the road the lighter the draft. To illustrate this in terms of animal power, the maximum load of a 1,200 pound horse [pulling 1/10 of his weight or 120 pounds] on a gravel road in good condition is about 2,000 pounds; on a macadam road from 2,000 to 5,000 pounds. Assuming that a horse can draw 2,000 pounds on an improved level gravel road, with the same pull against the collar he can only draw 750 pounds on a ten per cent grade.

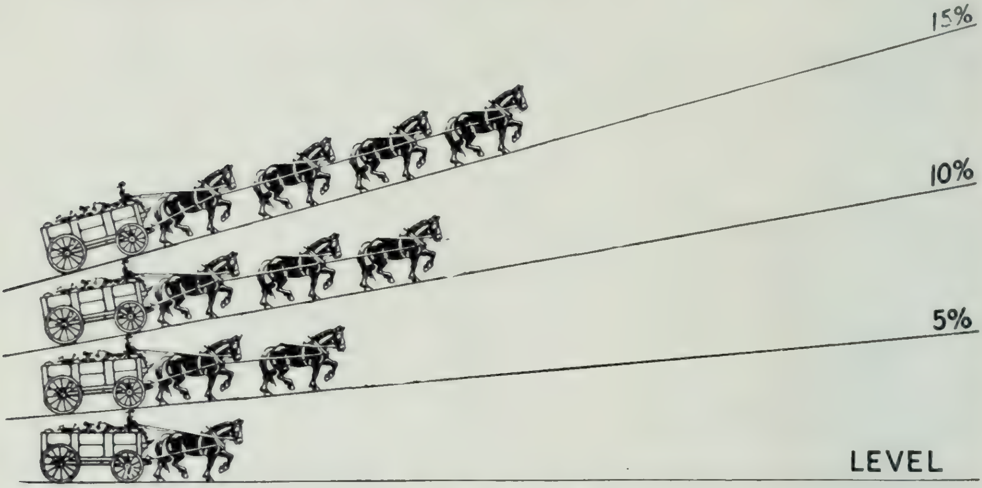


Illustration 32

This shows the increase of power needed on a gravel road. The better the road the greater the increase of power required on grades. On a good gravel road if one horse pulled the load on a level, two would be needed on a 5% grade, three on a 10% and four on a 15% grade.

90. Cost of Hauling with Horses

A two-horse team will haul 50 bushels of 60-pound grain on a good, hard gravel road (which will require a draft of 210 pounds according to the table given) at the rate of two miles per hour and at a cost of 25 cents per hour for horse labor only.

According to Farmers' Bulletin No. 672, the Bureau of Crop Estimates finds an average distance from market of 6.5 miles for the farms of the United States. It requires about one-half a day for the average farmer to make a round trip with wagon from farm to market and back. This Bureau also finds that the average size of a wagon load of cotton in the United States is three bales or 1,500 pounds, while the average wagon load of wheat is 53.5 bushels or 3,200 pounds.

On the basis of two trips per day, the farmer makes one trip to market and back, 13 miles, in about five hours. At 25 cents per hour for horse labor, this trip costs $1.25. An approximate load of 3,000 pounds or a ton and a half for $6\frac{1}{2}$ miles is $9\frac{3}{4}$ ton miles. This makes the cost of hauling wheat about 13 cents per ton mile, not including labor.

The Government estimated in 1906 the following as the cost of wagon hauling per day:

Wheat	$3.60
Corn	3.00
Cotton	2.80

Since 1906 wage, labor and feed have increased considerably, so that 1915 wheat hauling per day will cost about $4.35. If $9\frac{3}{4}$ ton miles are hauled each trip, or $19\frac{1}{2}$ ton miles per day, the cost is about 23 cents per ton mile including labor.

This average cost varies. In some cases the Government finds it cost only 17 cents a ton mile on good roads, while on extremely bad roads the cost runs up to 35 cents a ton mile.

TABLE XI

Hauling crops from farms—distance—time and size of load.
Synopsis of Table VI in Farmers' Bulletin 672
(These figures refer to wagon hauls from farms to all points at which products are delivered by farmers)

STATES	Average for all Farms 1915	Average for the more Remote Farms 1915		Average Size of Wagon Load 1915			Estimated Time Spent in Hauling from Farms in an Average Year		
	Distance to Market one way	Distance to Market one way	Round Trip per day	Corn (unshelled)	Wheat	Cotton (ginned)	Corn	Wheat	Cotton
	Miles	Miles	No.	Bush.	Bush.	Bales	Days	Days	Days
Eastern	5.0	6.7	1.7	49.8	47.1	......	433,700	489,100	....
Southern	6.8	8.8	1.6	25.8	30.0	2.4	1,547,800	744,500	2,128,100
Central	4.5	6.2	1.8	44.8	48.3	......	1,564,000	465,100	....
Northwest	7.6	10.1	1.5	45.6	59.5	......	1,288,600	2,475,500	....
Southwest	8.9	11.6	1.5	36.6	52.1	3.5	1,524,100	2,683,200	402,700
States of very small prod.	....	....	....	....	....	....	....	....	1,500
United States	6.5	8.7	1.6	40.5	47.4	3.0	6,358,200	6,857,400	2,532,300

91. Cost of Hauling with an Oil Tractor

An 8-16 tractor with a pull of 1,500 pounds on the drawbar will haul, on a good gravel road, 10 tons of grain (335 bushels) at an average of about two miles an hour, at a total cost of 40 cents per hour, or 20 cents per mile, or 2 cents per ton mile. Adding cost of return trip, the total is about 4 cents per ton mile.

The value of these figures is not so much that they give the actual hauling cost per mile with horses and tractors, but rather that they afford a comparison. We can safely say that under average conditions a tractor should be able to haul a ton a mile for one-fourth the cost of hauling with horses.

92. Time and Money the Tractor Might Save on Our Annual Hauling Cost

Farmers' Bulletin No. 672 says—"It would require about 6,358,000 days for one wagon to haul from farms the marketed portion of an average corn crop. The corresponding figure for wheat is about 6,857,000, and for cotton 2,532,000."

An 8-16 oil tractor will haul from five to six times the load that a team will, so the total of more than 15,000,000 days for one wagon with horses could be cut to about 3,000,000 days with a tractor, and on the total hauling cost of more than $45,000,000 we could save almost $30,000,000 by using the tractor.

93. The Oil Tractor Can Be Used For Road Work

Men familiar with country road conditions say that the main reasons why most American roads are so bad is that farm horses are already overworked and that therefore farmers will not put their horses to work on road improvement except under process of law. It is difficult for an amateur to see the difference between abusing horses by making them work on road improvements, or abusing them by making them haul loads over the fearful roads that result from such neglect. Both kinds of work are harder than horses should be asked to do.

The oil tractor has time and energy after the farm work is done to improve the roads. There is no road machine made that cannot be handled as effectively and at less expense with the tractor than with horses. A few of the uses of the oil tractor in this work are shown on page 52.

94. Belt Power Required To Operate Machines

TABLE X

	Approximate Horse Power
Meadows Corn Mill No. 1	2 to 4
Meadows Corn Mill No. 2	4 to 6
Meadows Corn Mill No. 3	6 to 8
Meadows Corn Mill No. 4	10 to 15
Meadows Corn Mill No. 5	15 to 20
International Feed Grinder, Type B—6″	2 to 5
International Feed Grinder, Type B—8″	3 to 10
International Feed Grinder, Type B—10″	6 to 15
International Feed Grinder, Type C—6″ (small grain)	2 to 5
International Feed Grinder, Type C—8″ (small grain)	4 to 10
International Feed Grinder, Type D—8″ (unhusked corn)	6 to 10
International Feed Grinder, Type D—10″ (unhusked corn)	8 to 15
Keystone XL Sheller	2
Keystone Sheller	2
Keystone 2-hole Sheller	4
Keystone 4-hole Sheller	8
Keystone 6-hole Sheller	12
Deering 2-roll Husker and Shredder	8
Deering 4-roll Husker and Shredder	10 to 12
Deering 6-roll Husker and Shredder	15 to 20
McCormick Little Giant 4-roll Husker and Shredder	10 to 12
McCormick Little Giant 6-roll Husker and Shredder	12 to 15
McCormick Improved 6-roll Husker and Shredder	15 to 20
McCormick Improved 8-roll Husker and Shredder	20 to 25
Sterling Thresher No. 26	6 to 8
Sterling Thresher No. 30	6 to 8
Sterling Thresher No. 21	4 to 6
Sterling Thresher No. 21½	4 to 6
New Racine Thresher 20 x 32	6 to 12
New Racine Thresher 24 x 40 (with attachments)	16 to 25
New Racine Thresher 28 x 48 (with attachments)	15 to 30
New Racine Thresher 32 x 52 (with attachments)	20 to 35
New Racine Thresher 36 x 56	35 to 45
Buffalo Pitts Thresher 28 x 48 (with attachments)	25 to 30
Buffalo Pitts Thresher 30 x 50 (with attachments)	30 to 35
Buffalo Pitts Thresher 32 x 50 (with attachments)	30 to 40
Buffalo Pitts Thresher 34 x 56 (with attachments)	35 to 45
Buffalo Pitts Thresher 38 x 62 (with attachments)	40 to 50
Buffalo Pitts Thresher 41 x 62 (with attachments)	40 to 50
International Power Press 14 x 18	6 to 12
International Power Press 16 x 18	6 to 12
International Power Press 17 x 22	6 to 12
International Ensilage Cutter Type F	4 to 6
International Ensilage Cutter Type E	10 to 15
International Ensilage Cutter Type B	15 to 20
International Ensilage Cutter Type A	20 to 25
Steel King Ensilage Cutter No. 14	15 to 20
Steel King Ensilage Cutter No. 12	12 to 15
Steel King Ensilage Cutter No. 10	6 to 8
Belle City Power Feed Cutter B-2	10
Belle City Power Feed Cutter A-2	8
Belle City Power Feed Cutter No. 1	6
Belle City Power Feed Cutter No. 3	4

95. Tractor Hitches for Field Use

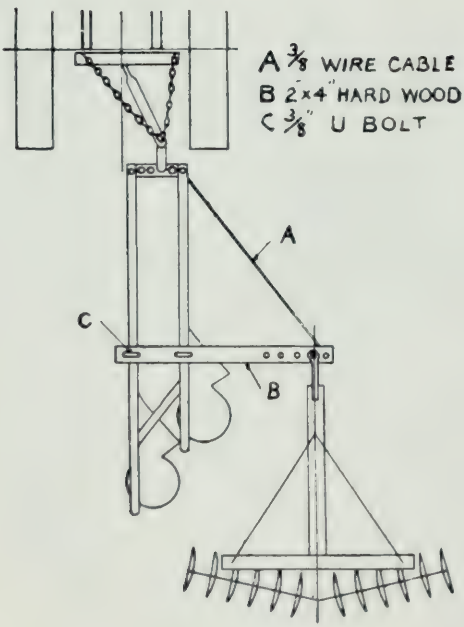
When it is desired to pull a number of machines by the tractor, care must be exercised to properly hitch the machines. When plowing, this problem gives no trouble as only a clevis is necessary; but when a number of machines are combined to be used at the same time, trouble will be experienced if hitches are not properly made. On the following pages are shown diagrams of practical hitches which can be made easily on any farm.

It will be noted from the designs that most of these hitches require a supplementary drawbar made of 2 x 4 hard wood, one or two pieces bolted together and wide enough to accommodate the number of machines being pulled. This supplementary drawbar is sometimes called a "spreader." In hitching this to the tractor, note that the chains must cross. This is necessary in order to have an even pull and prevent twisting of the outfit.

In pulling wagons, grain drills, and all machines and implements with poles, a false pole of about 3 or 4 feet in length should be substituted for the horse pole wherever the machine is to be carried close to the tractor or the supplementary drawbar. This short pole will allow the machines to get close to fence corners and other places, and will afford a rigid brace for backing if necessary.

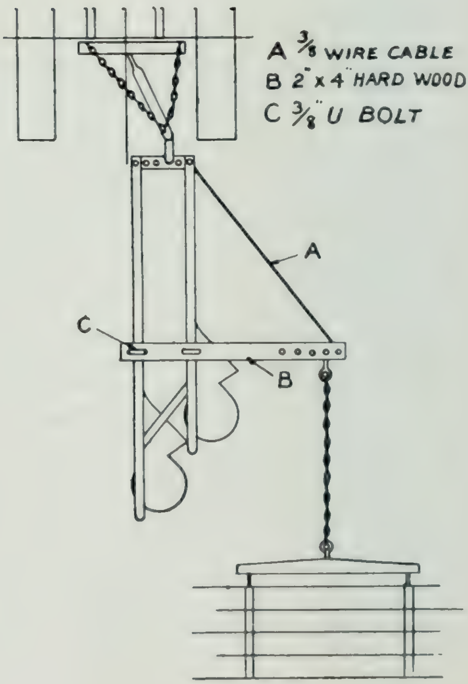
96. Hitch for Plow and Disk Harrow

Illust. 33

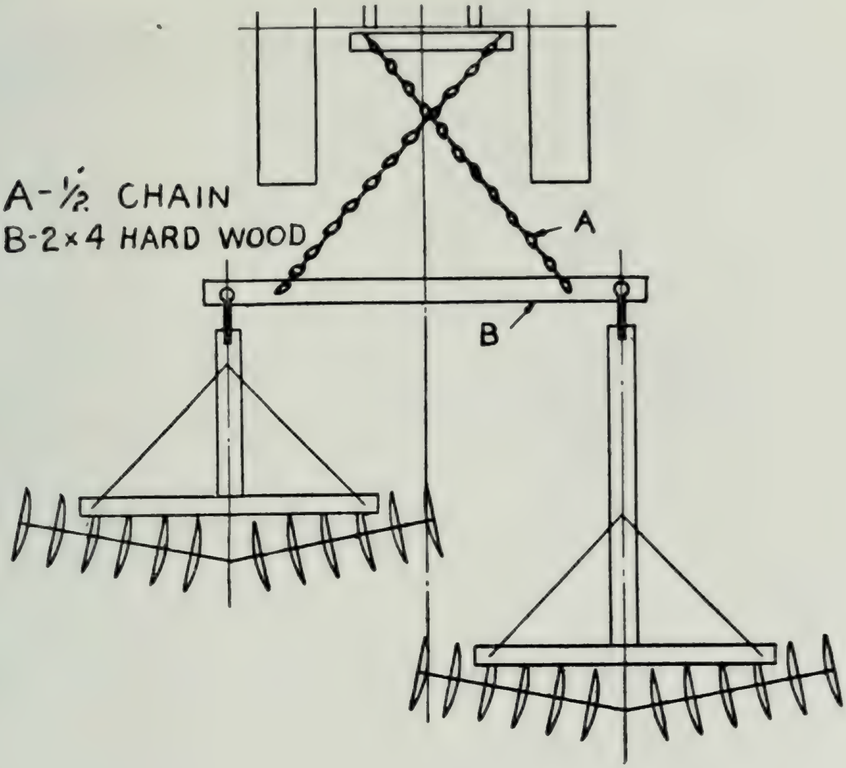


97. Hitch for Plow and Peg Harrow

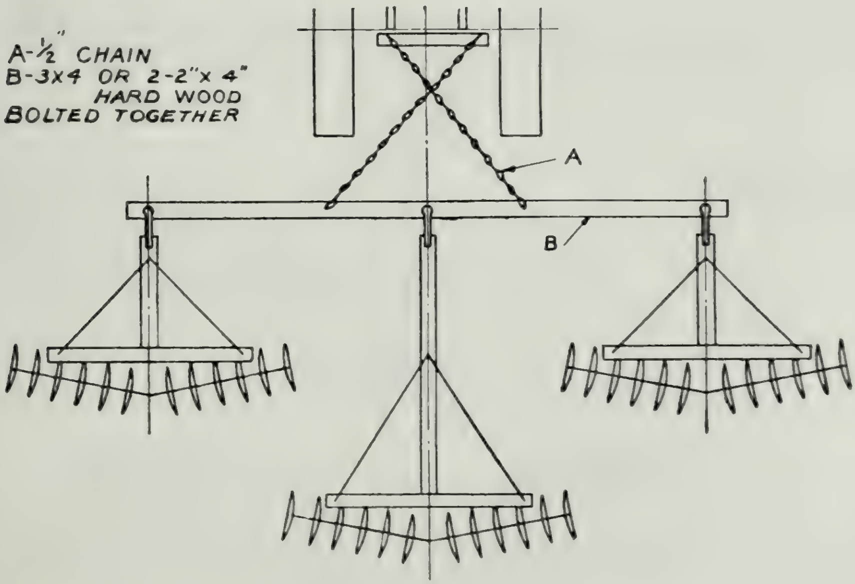
Illust. 34



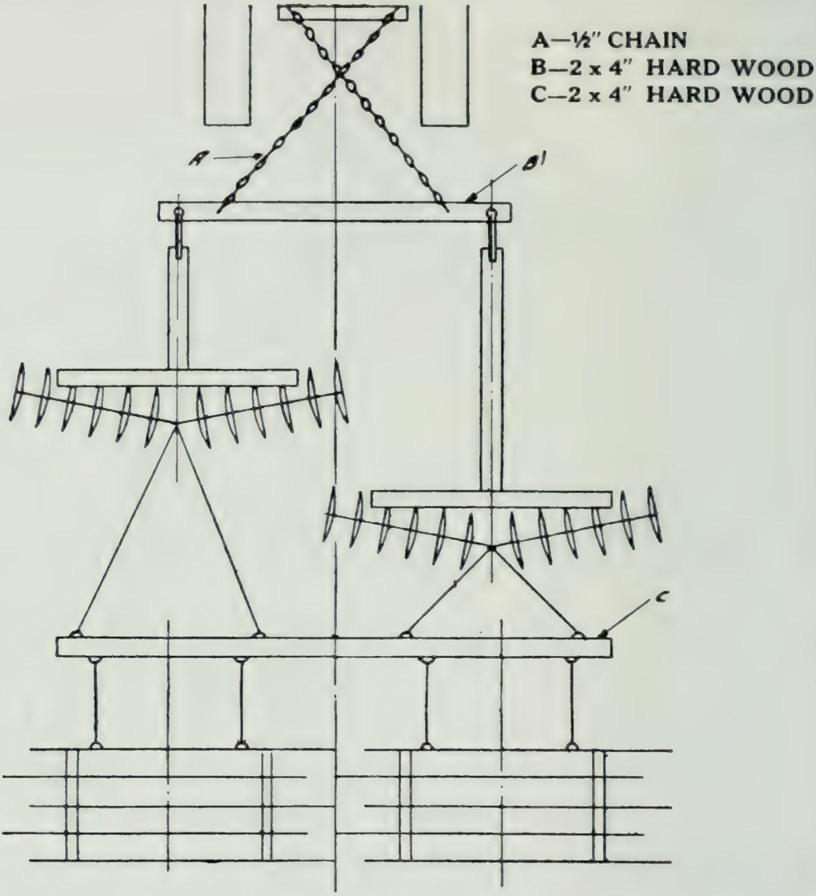
98. Hitch for Two Disk Harrows Illust. 35



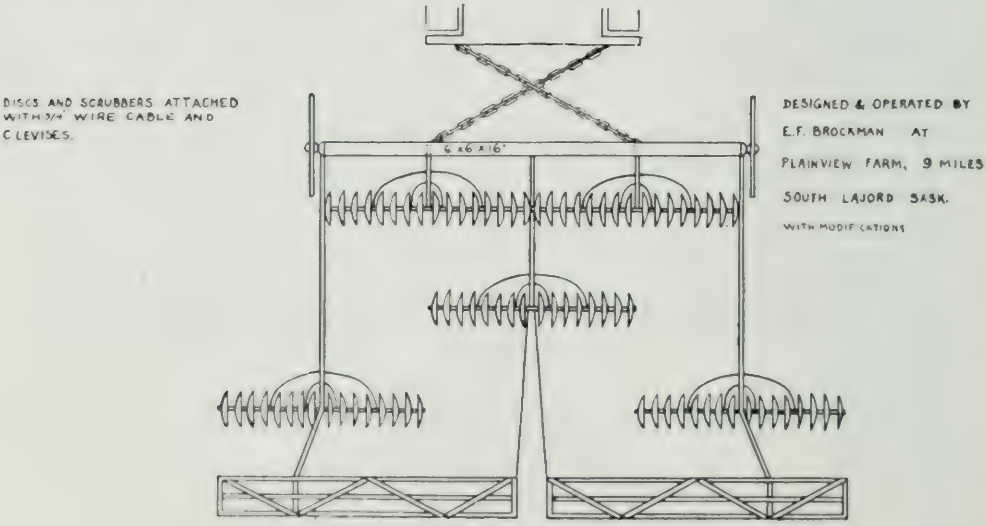
99. Hitch for Three Disk Harrows Illust. 36



100. Hitch for Two Disk Harrows and Peg Harrows Illust. 37

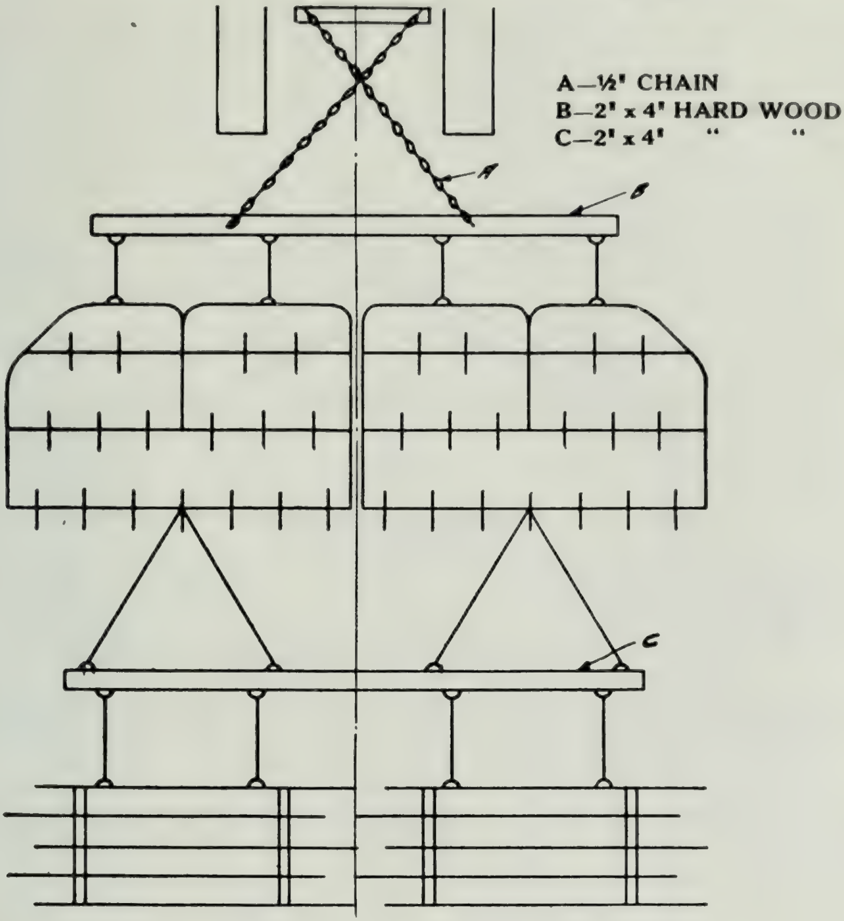


101. Hitch for Disk Harrows and Drags Illust. 38



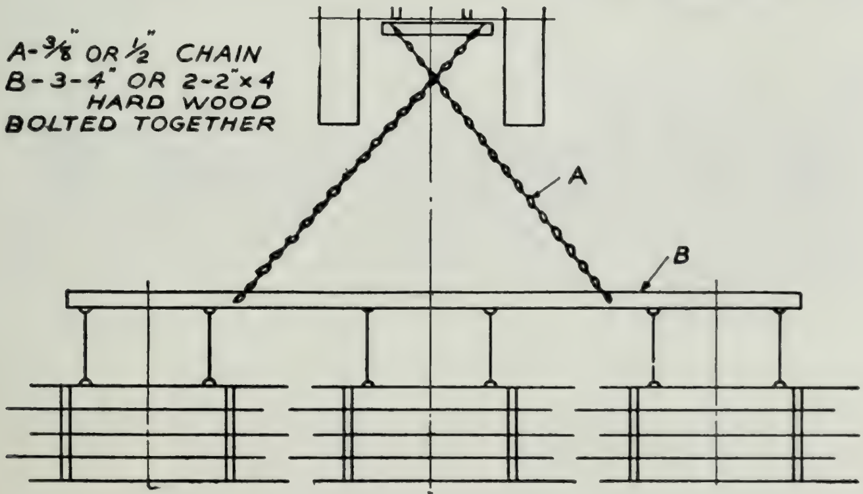
102. Hitch for Two Spring-Tooth and Peg-Tooth Harrows

Illust. 39



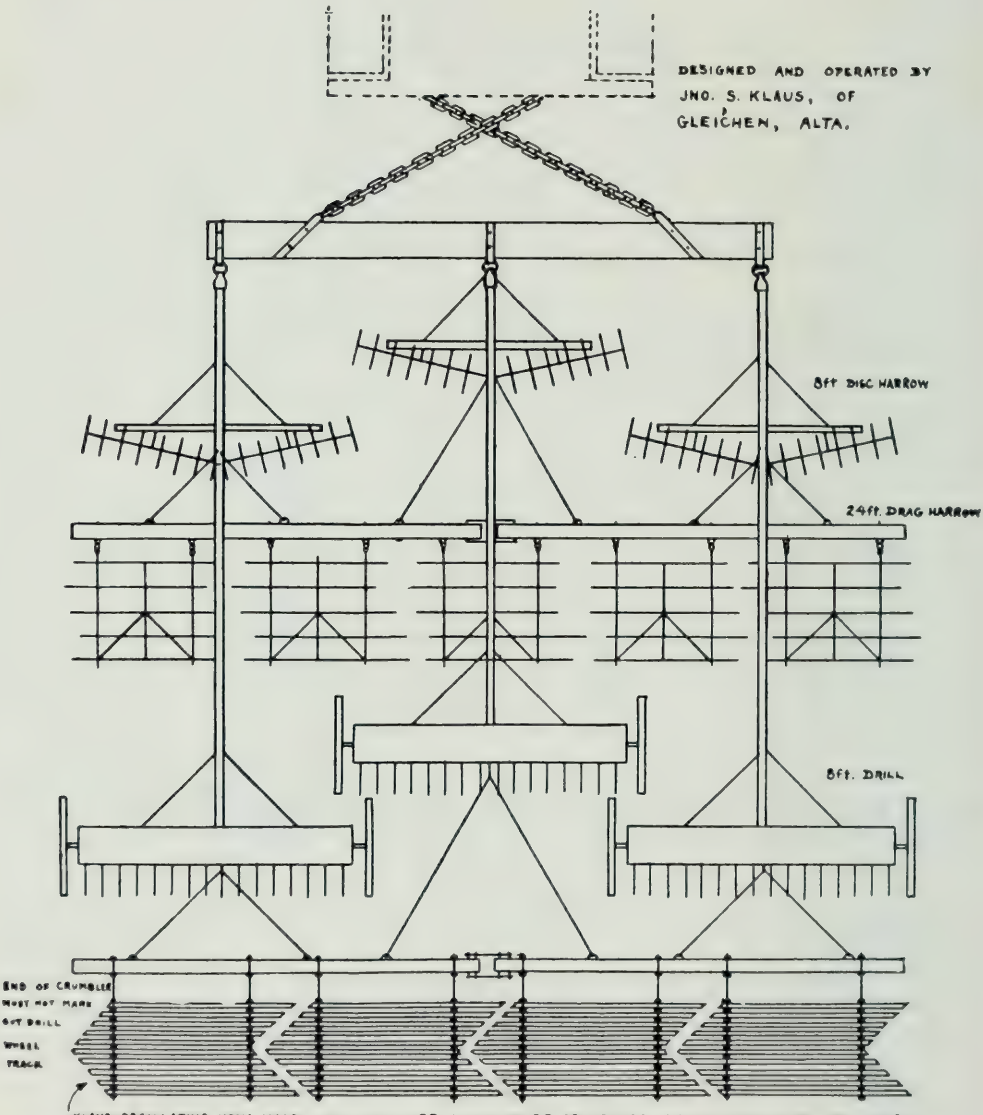
103. Hitch for Three Peg-Tooth Smoothing Harrows

Illust. 40



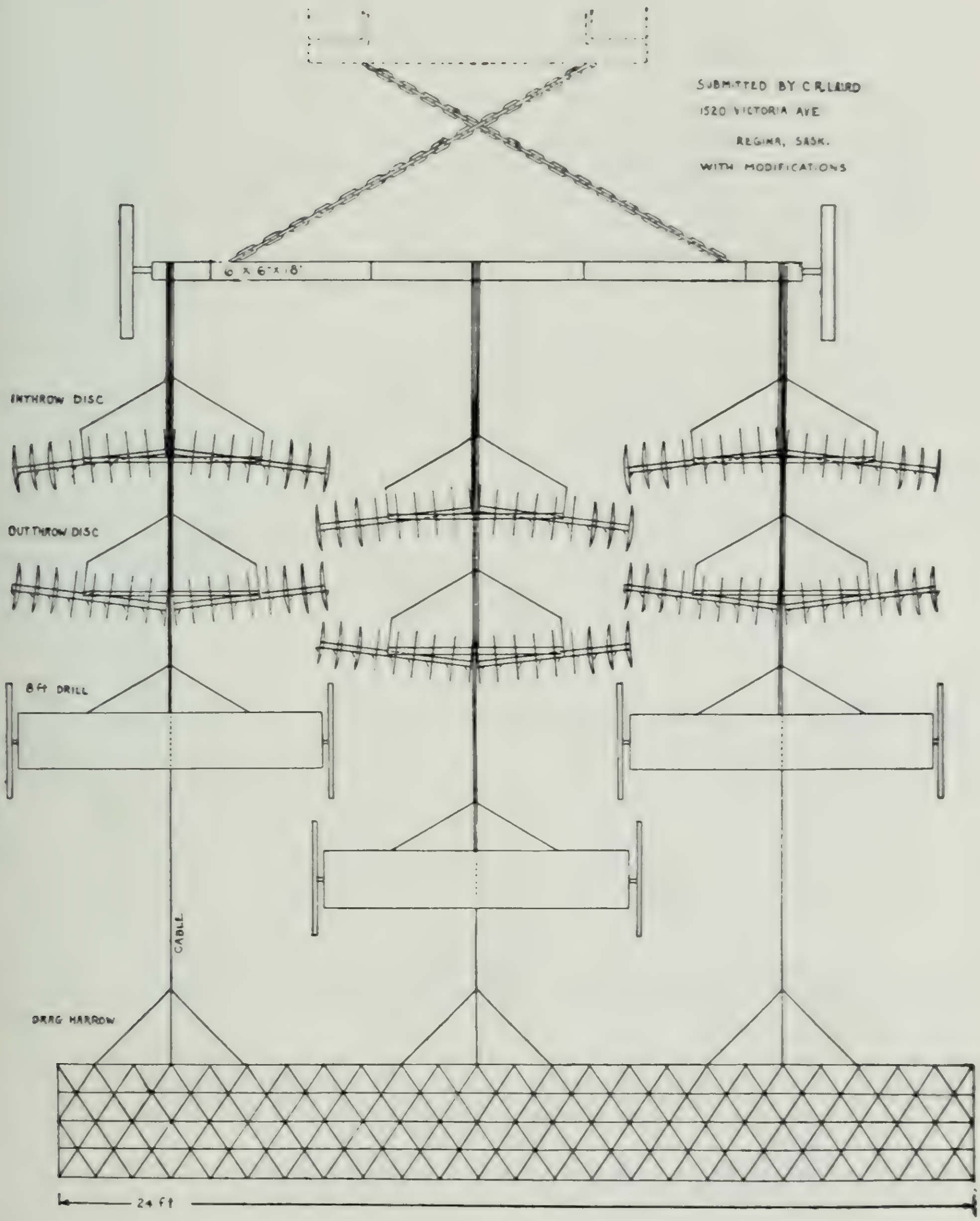
104. Hitch for Disk and Peg Harrows, Drills and Crumblers

Illust. 41

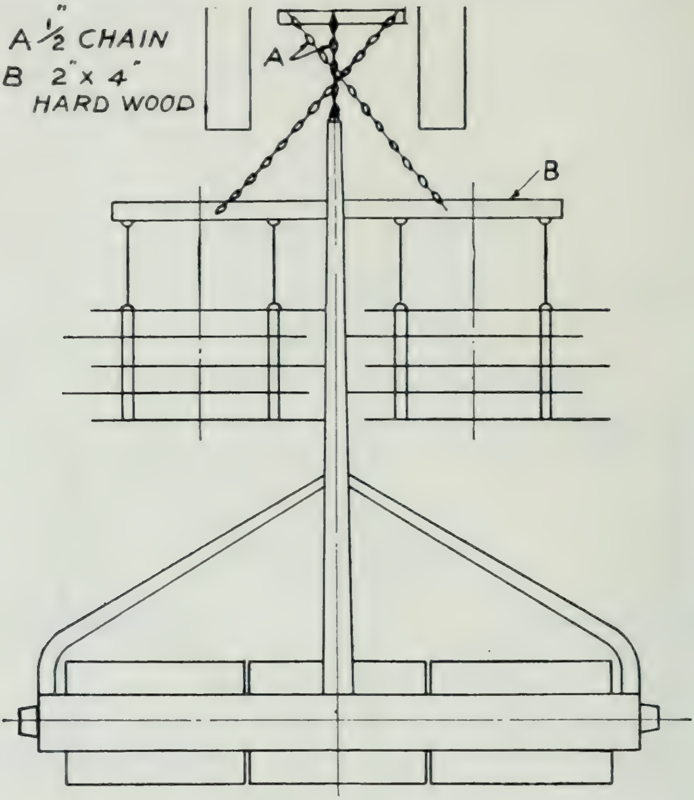


KLAUS OSCILLATING HOME MADE CLOD CRUMBLER AND MOISTURE PRESERVER MADE OF CEDAR POSTS WITH HOLES BORED THRU CENTER FOR ROPE OR CABLE KNOT BETWEEN EACH POST IT ROLLS THE CLODS INTO DUST AND MAKES AN AIR TIGHT BLANKET OVER SEED BED

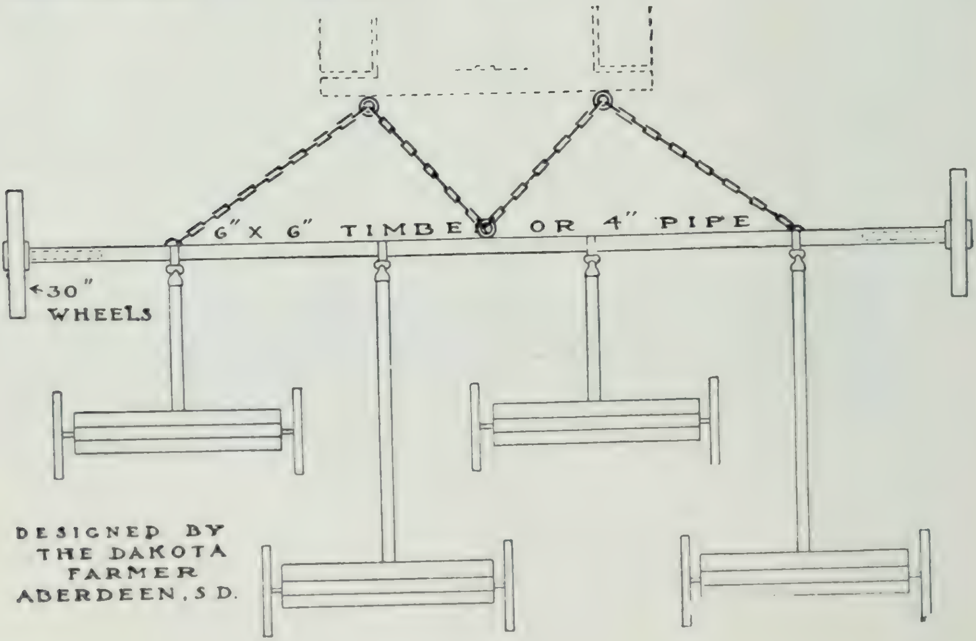
105. Hitch for Disks, Drills and Drag Harrows Illust. 42



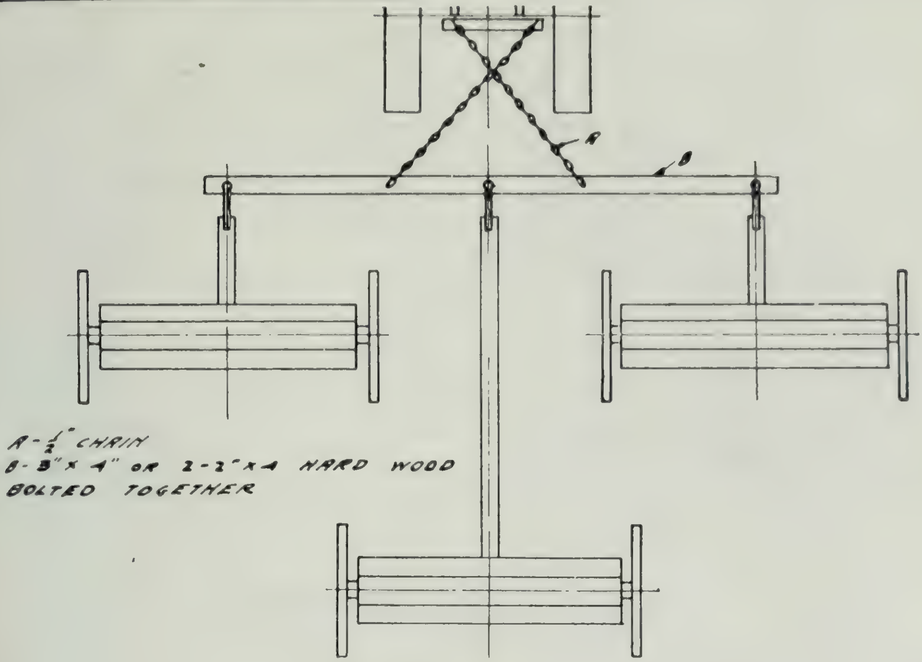
106. Hitch for Smoothing Harrows and Roller Illust. 43



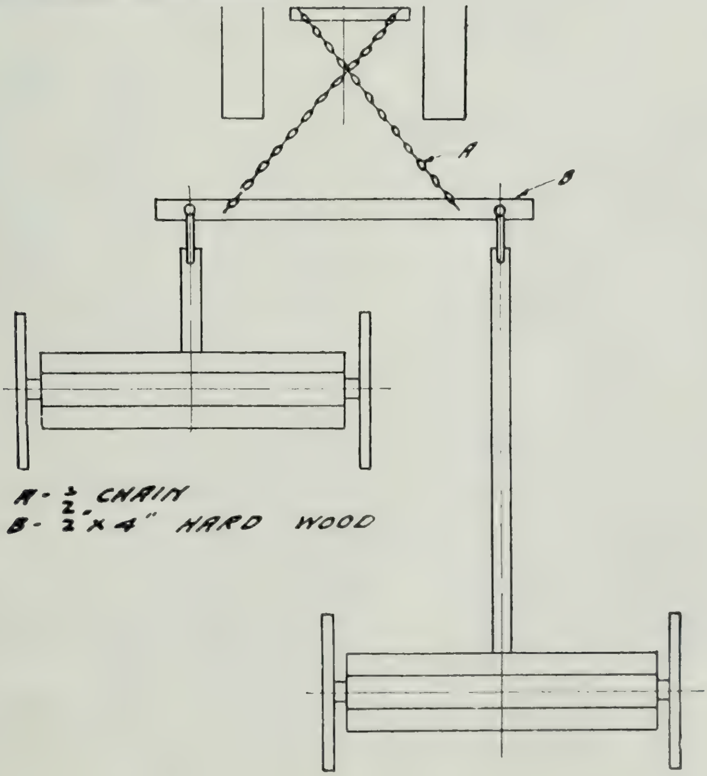
107. Hitch for Four Drills Illust. 44



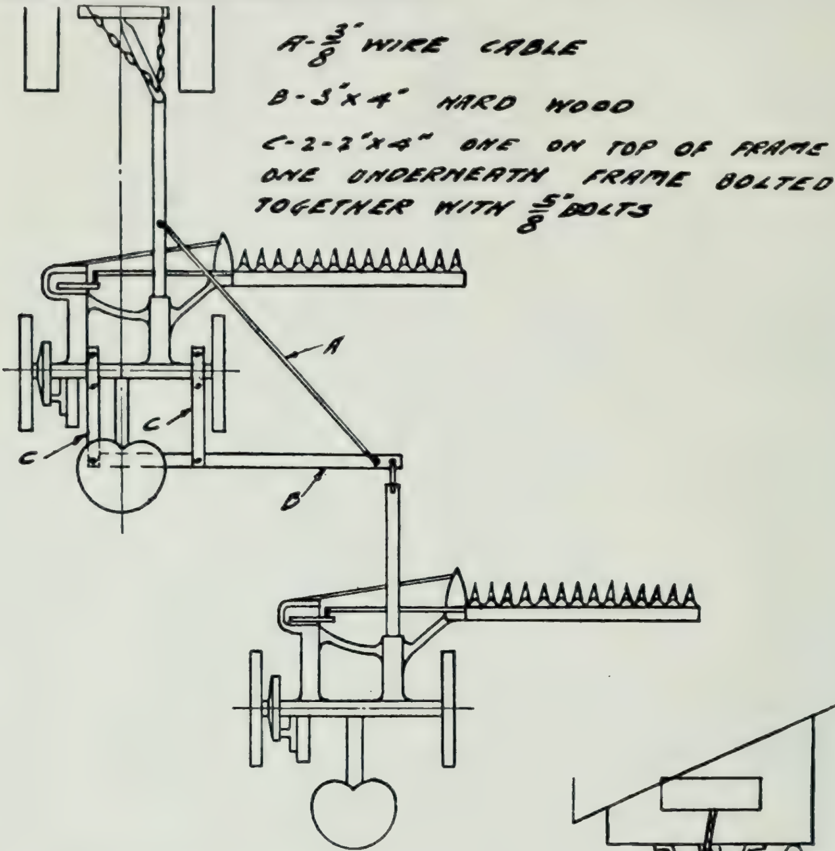
108. Hitch for Three Drills Illust. 45



109. Hitch for Two Drills Illust. 46

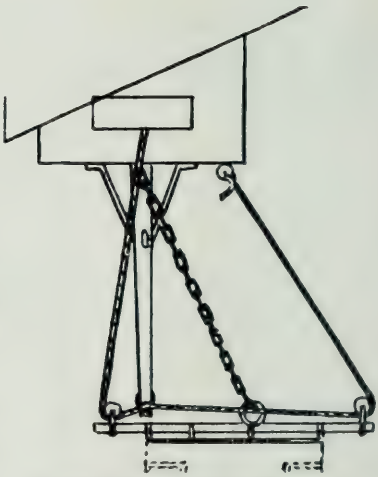


110. Hitch for Two Mowers



Illust. 47

111. Hitch for Road Grader


Illust. 48 Grader Hitch

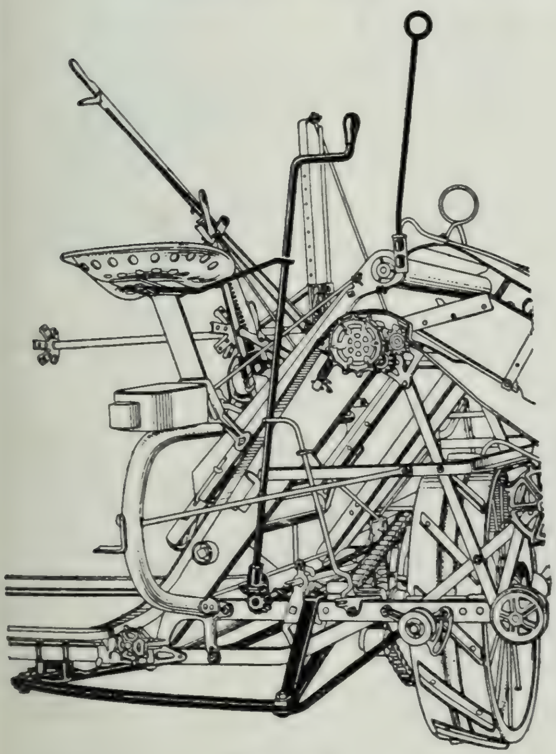
We illustrate herewith an easily made set-off hitch for use when working the roads if a regular set-off hitch is not available. Note that the rope is hitched from one side of the grader to one end of the tractor drawbar, then tied around the end of the grader pole through a hook on the other end of the tractor drawbar and back to the driver's seat. A special draw chain is attached from the tractor drawbar to the front axle of the grader. The operator on the grader seat holding one end of the rope can then manipulate the position of the grader to accommodate any width of road. By tying to the grader the end of the rope which the operator holds, the hitch becomes stationary, and the grader will always travel in the set-off position to which it is adjusted.

112. Tractor Binder Hitches

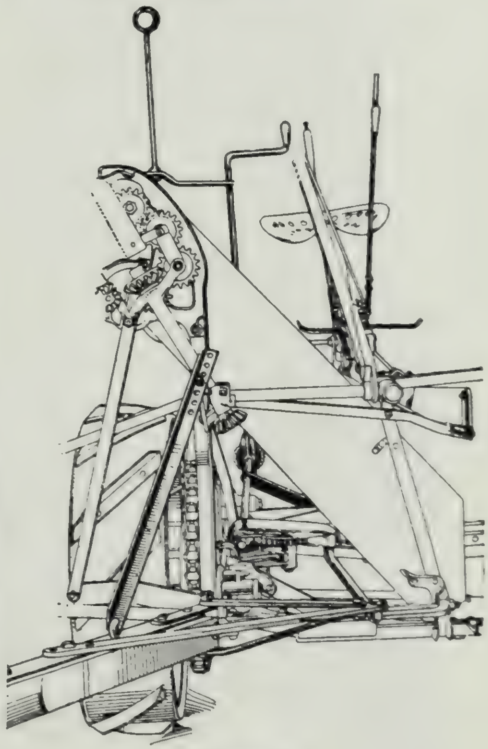
In hitching more than one binder behind a tractor, a hitch must be designed to relieve the binder from the strains caused by the machines which follow, and at the same time provide a means of making the binder travel in the desired offset relation to the machines in front. The operator must also be able to guide his machine to cut a full swath and in turning corners he must avoid running down standing grain.

A home made hitch to accomplish this is impractical, besides, each make of binder requires a hitch suited to the construction of the binder. For this reason special binder tractor hitches have been designed which can be attached to the binders in the field without alterations to the machine, with no changes in the frames, or no necessity for boring extra holes.

Herewith we show partial views of the special binder tractor hitches designed for Deering and McCormick grain binders. In ordering tractor hitches, it is necessary to state the make of binder for which the hitch is intended.



Illust. 49
Rear View—Deering Binder Hitch

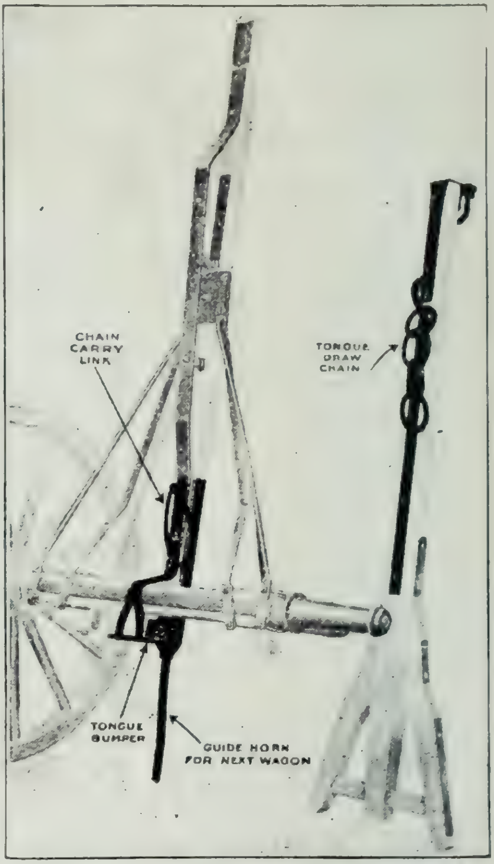


Illust. 50
Front View—McCormick Binder Hitch

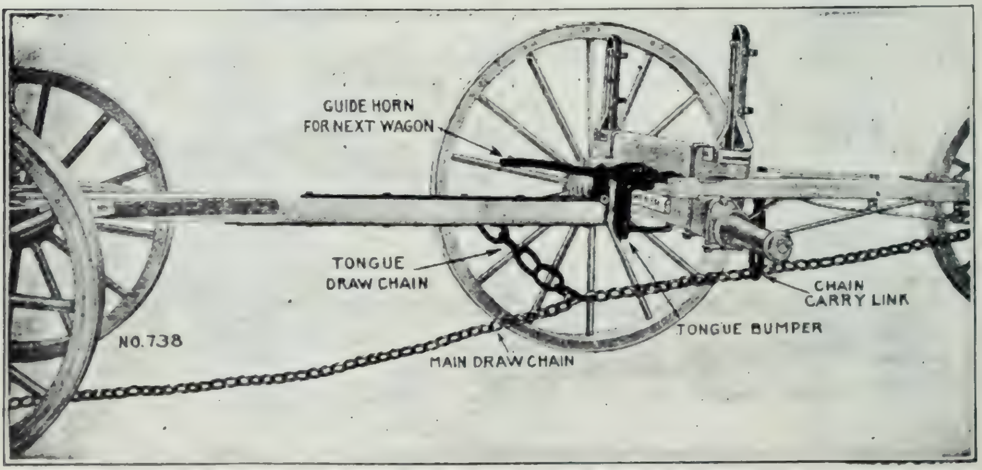
113. Special Tractor-Wagon Hitch

With this hitch it is possible to draw one or more wagons with all the pull on the tractor drawbar instead of on the gear of the first wagon. Hitch No. 114 is a home made hitch which is practical if only two wagons are to be drawn, because the gear of the first wagon can probably carry the pull of the second, but if the loads are heavy and the roads rough and more than two wagons are being hauled, a hitch of this kind may cause some trouble.

The special hitch herewith shown sould be a part of every farm equipment where considerable hauling is done with the tractor. The first wagon carries a special tongue, and on the tractor drawbar is fastened the guide horn and bumper attachment (shown on end of reach in illustration 51). If a second wagon is to be carried, the reach and rear axle of the first wagon are also provided with a guide horn and bumper attachment (similar to that on the tractor drawbar) to which is attached the trailer tongue of the second wagon. This guide horn and bumper attachment on the tractor drawbar and on the reach of all but the last wagon takes all the bumps and serves to hold in line and guide the wagons. The main draw chain (Illustration 52) is attached to the tractor drawbar, then passes through the chain carry link under the first wagon and is attached to the draw chain on the trailer tongue of the second wagon. Any number of wagons may be attached in this way by securing the special tongues and guide horn and bumper attachments. With these on the wagons the tractor can safely take over the road, without strain on any wagon, all the load the machine will pull.

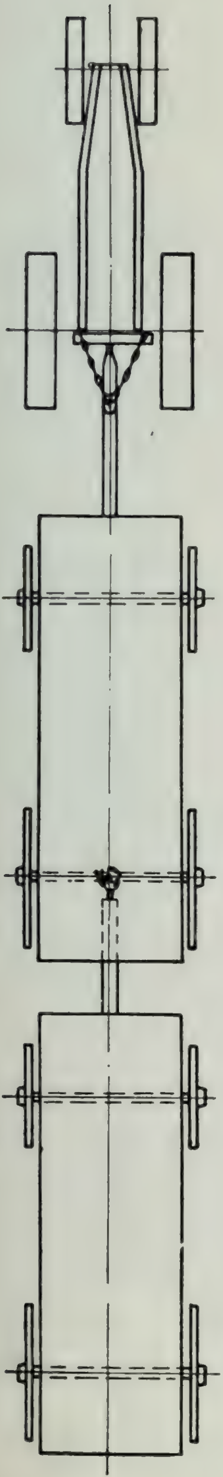


Illust. 51. Right, guide horn and bumper attachment on end of reach Left, special tongue

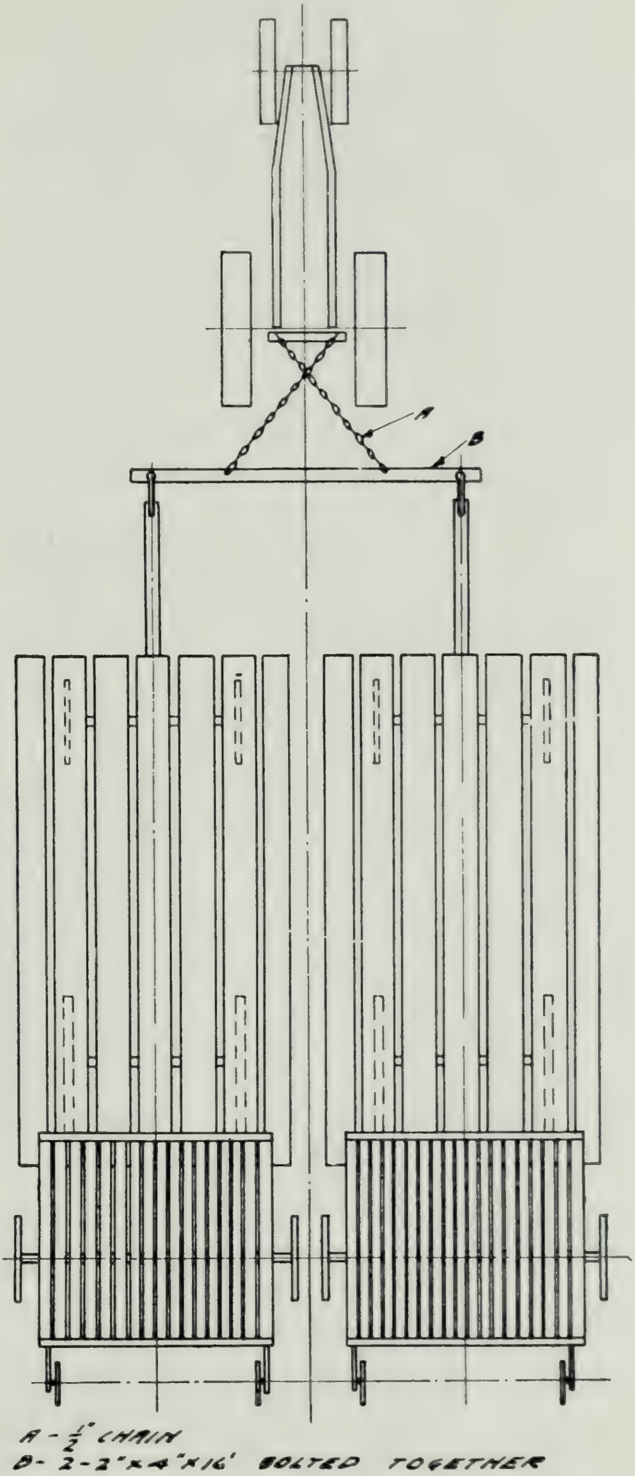


Illust. 52. Two wagons hitched with main draw chain in place

114. Hitch for Two Wagons Illust. 53



115. Hitch for Two Hay Loaders Illust. 54



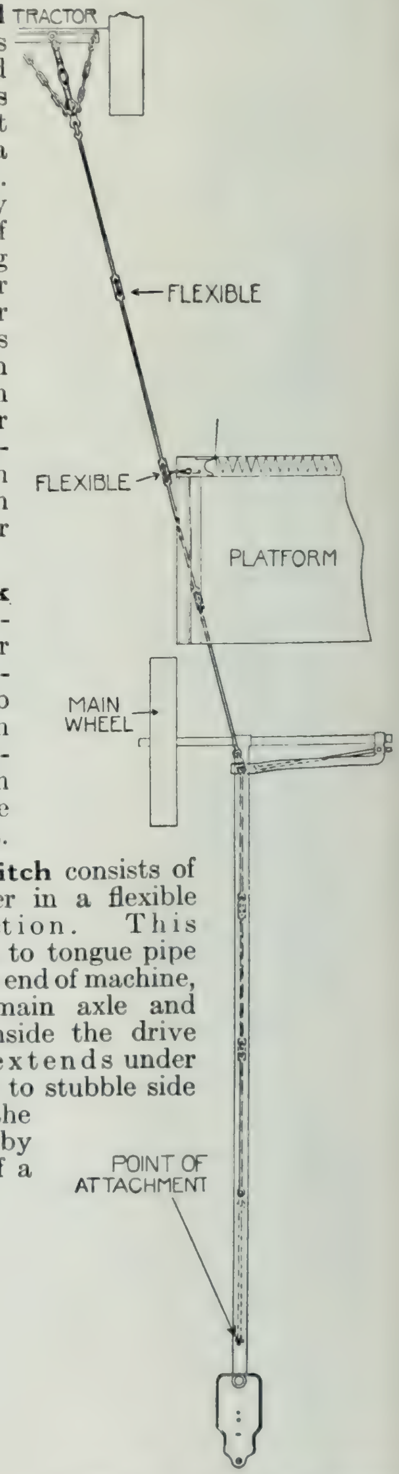
116. Hitches for Deering and McCormick Headers and Header Binders

Tractor hitches pull instead of push. Hitches for both Deering and McCormick push machines attach for a pull against the load rather than a push as when using horses. They are simple and easily attached, and by the use of tractor power make big cutting operations easier for all concerned. The tractor is easier handled on turns than the three horses on each side of the pole. In each instance the draw bar extending under the platform does not interfere with the position of the platform when set for either high or low cutting.

Illust. 55. McCormick Hitch consists of steel pull-bars bolted rigidly together at one end and opens sufficiently at the other to attach to the axle on each side of drive wheel. Substantial bracing between the bars gives ample strength to resist all strains.

Illust. 56. Deering Hitch consists of steel rods linked together in a flexible connection. This attaches to tongue pipe near rear end of machine, also to main axle and frame inside the drive wheels, extends under platform to stubble side and to the tractor by means of a chain.

Illust. 55. Hitch for McCormick Push Machines



Illust. 56. Hitch for Deering Push Machines

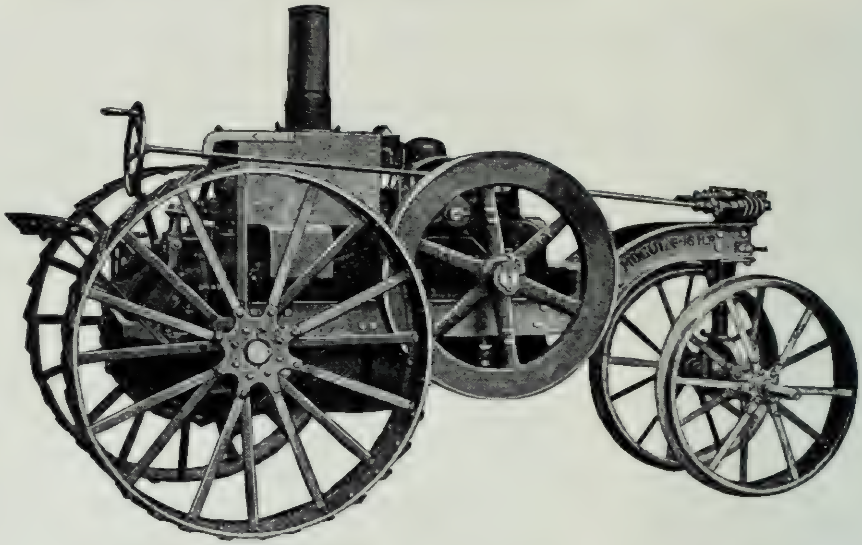
The Verdict of The Judges At The San Francisco and San Diego Expositions, 1915

In accordance with its well-known policy of many years' standing, the Harvester Company arranged to exhibit its machines at both the Panama-Pacific International Exposition at San Francisco and the Panama-California Exposition at San Diego. At San Francisco these machines were placed on the floor of the agricultural building for the express purpose of permitting an unbiased jury of international reputation to pass upon their fitness to do the work for which they were intended. At San Diego a better opportunity was afforded to show the tractors at work, for adjoining the Harvester Building was a large demonstration field where the tractors could be shown in actual work. At San Francisco the jury of awards, men well known to the farming fraternity and of long experience in the farm machine business, awarded International Harvester Oil Tractors the grand prize. At San Diego another jury also awarded these same machines a grand prize. No other tractor received the distinction of winning the two highest prizes at two expositions of this magnitude.

To the farmer who is thinking of replacing his expensive power equipment of horses by the cheaper oil power, this verdict is worth a great deal, for it points out to him the tractors in which he can place the most confidence.

We firmly believe that the decision of the judges at both San Francisco and San Diego is a reliable guide.

MOGUL 8-16-H. P. KEROSENE TRACTOR



General Purpose Small-Farm Tractor

This small-farm kerosene burning tractor will do the field and belt work on more than 80 per cent of the farms of this country. It is just the right size for the average farm—inexpensive to buy, to keep and to operate.

Power Plant: A single cylinder, slow speed oil-burning engine of extremely simple construction. Crank case completely enclosed to keep out dust and grit.

Governor: Fly-ball throttling governor running in oil.

Mixer: Identical with the mixer used on larger Mogul engines. Very simple, yet handles great variety of fuels—kerosene, distillate down to 39 degrees Baume, gas oil, solar oil, motor spirits, naphtha and gasoline.

Cooling: Water-cooled by large hopper holding 35 gallons.

Ignition: Make-and-break, the current being furnished by high-grade oscillating type magneto. No batteries required.

Lubrication. Main bearings and piston are lubricated by an automatic force feed oiler.

Transmission: Planetary transmission, the simplest ever designed, is used on this tractor. The gears are always in mesh, and as they are thrown in or out of action by means of brake bands there is no danger of stripping them. Gear case is dust-tight, and gears run in bath of oil.

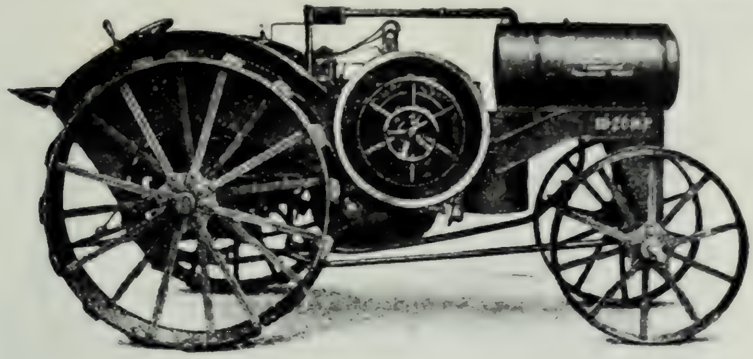
Chain Drive: Power is transmitted from transmission to the large drive wheels by chain on left side.

Steering: Tractor is steered by a hand wheel convenient to the driver, operating a non-reversible worm and sector steering gear.

Specifications

Power—8-H. P. drawbar—16-H. P. brake	Speed—2 miles per hour
Speed of Motor—400 R. P. M.	Total Length—Inches, 135
Number of Cylinders—One	Total Width—Inches, 56
Fuel—Kerosene or gasoline	Total Height—Inches, 61
	Weight—5,000 lbs.

TITAN 10-20 H. P. KEROSENE TRACTOR



General Purpose, Light Farm Tractor

This is a kerosene-burning light tractor, designed for all drawbar and belt work requirements on the average farm.

Power Plant: Twin-cylinder, valves in head, enclosed crank, oil-burning engine, built in units so that one section can be removed at a time, exposing a considerable part of the engine for examination without detaching numberless small parts.

Governor: Fly-ball, throttling governor, running in enclosed case.

Ignition: Jump spark. The operating current is supplied by a built-in high-tension magneto, with accelerator for starting—no batteries required.

Mixer: Special design, handling kerosene, distillate down to 39 degrees Baume, as well as gas oil, solar oil, motor spirits, naptha, and gasoline.

Cooling System: Water cooled, circulating from a tank holding 39 gallons.

Lubrication: All working parts including rear truck bearings are oiled by force feed lubricators.

Transmission: Two-speeds ahead and one reverse by sliding gear transmission, controlled by one lever. The gears run in oil and are entirely enclosed. Forward speeds, 1.85 miles, 2.50 miles per hour. Reverse, 2.50 miles per hour.

Double Chain Drive: Chain drive to both rear wheels, eliminating gears, giving a more even and flexible distribution of power than by any other system.

Steering: Automobile type with hand wheel and specially designed steering knuckle, making control positive and easy under all conditions.

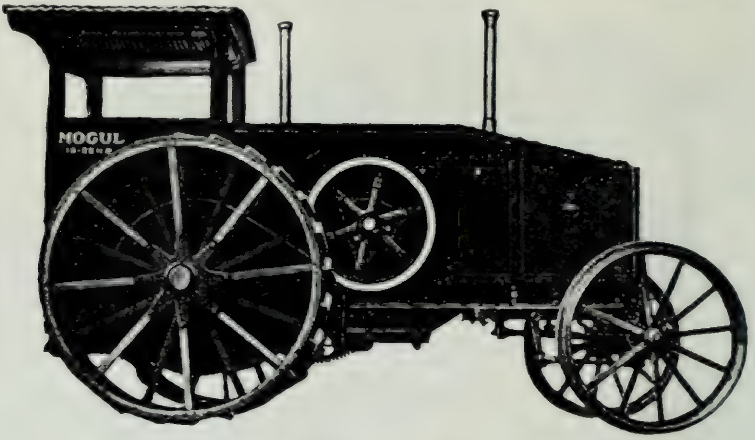
Brake: Foot power brake by contacting bands acting on both rear wheels. Equipped with ratchet lock for blocking.

Specifications

Power—10 H. P. drawbar
20 H. P. brake
Speed of Motor—500 R. P. M.
Number of Cylinders—2 (Twin)
Fuel—Kerosene or gasoline
Speeds—1.85 and 2.50 miles per hour.
Reverse 2.50

Total Length (with seat)—
147 inches
Total Width—60 inches
Total Height—66¾ inches
Weight—5225 pounds

MOGUL 12-25-H. P. KEROSENE TRACTOR



Medium Weight General Purpose Tractor

This is a medium weight kerosene-burning tractor with ample horse power to do the work on all excepting the very largest farms.

Power Plant: Two-cylinder opposed kerosene-burning engine of simple design, developing 25-H. P. on the brake.

Ignition: Jump spark ignition is used, the current for which is furnished by the Wyco ignition system. No batteries are needed.

Mixers: A mixer is furnished for each cylinder. These are the famous Mogul oil mixers that operate successfully in kerosene and heavier fuels. Recent reports from twenty points in different states show a wide spread between the cost of gasoline and kerosene in favor of kerosene. From indications kerosene will remain much cheaper than gasoline. The kerosene-burning feature of these tractors enables you to use the fuel that is the cheapest.

Cooling: Water-cooled by a special heavy duty type radiator, through which water is circulated by plunger type pump.

Starting: A crank with friction wheel makes turning of the flywheel easy.

Lubrication: Crankshaft, connecting rod bearings, and pistons lubricated by a 6-feed mechanical oiler.

Transmission: Transmission is of the sliding gear type with two speeds forward and one reverse. Gears enclosed in dust-tight case and run in oil. Chain drive is used from engine crankshaft to countershaft.

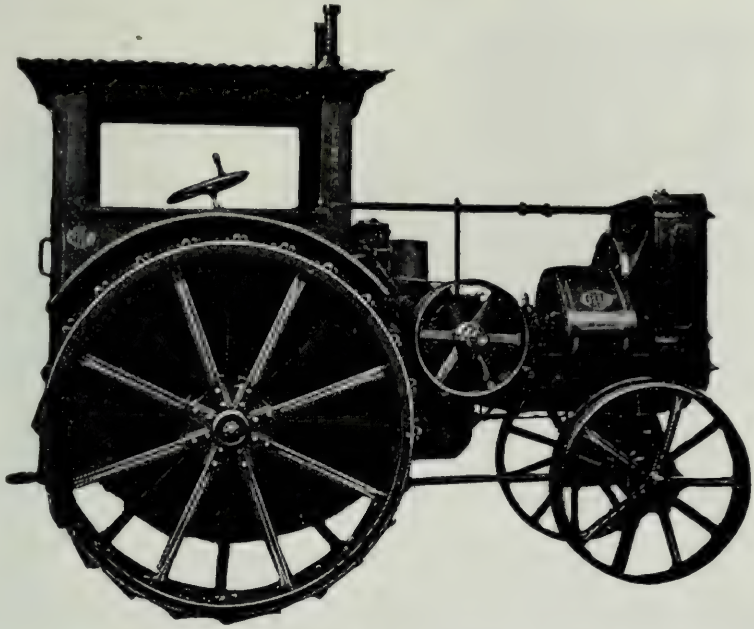
Steering: Steering mechanism is of the worm and sector type.

Cab: The steel cab is removable, so that the tractor can be made low enough to go under the trees in the orchard. Tractor can be operated from cab, as all levers are within easy reach of the operator's seat.

Specifications

Power—12-H. P. drawbar—25-H. P. brake
Speed of Motor—500 R. P. M.
Number of Cylinders—Two—opposed
Fuel—Kerosene or gasoline
Speed—2 and 3 miles per hour
Total Length—Inches, 162
Total Width—Inches, 81
Total Height—Inches, 100
Weight—10,000 lbs.

TITAN 15-30-H. P. KEROSENE TRACTOR



A Medium Size All-Purpose Farm Motor

This 15–30 Titan tractor is a light weight, powerful, kerosene tractor, that will do all the heavy work and belt work on most farms.

Four-Cylinder Motor: The engine is of the four-cylinder type, set horizontal across the machine, so that power is delivered direct through spur gears without bevel gear. Four-cylinder design and low speed eliminate vibration. Completely enclosed in dust-tight crank case with removable cover.

Mixer: One mixer with two fuel needle valves and a single water needle valve is used, which reduces adjustments to the minimum. This mixer will handle any of the cheap fuels, such as kerosene, distillate down to 39 degrees Baume, gas oil, solar oil, motor spirits, gasoline, or naphtha.

Governor: A fly-ball throttling type governor controls amount of fuel entering cylinders in proportion to the load.

Ignition: The ignition is jump spark, current being furnished by high-grade gear driven magneto—no battery equipment.

Lubrication: Motor is lubricated by automatic force feed oiler with twelve feeds. Transmission is lubricated by another automatic force feed oiler with five feeds.

Cooling: The motor is water-cooled, circulation through cylinders and a vertical tube radiator being secured by a belt-driven rotary pump.

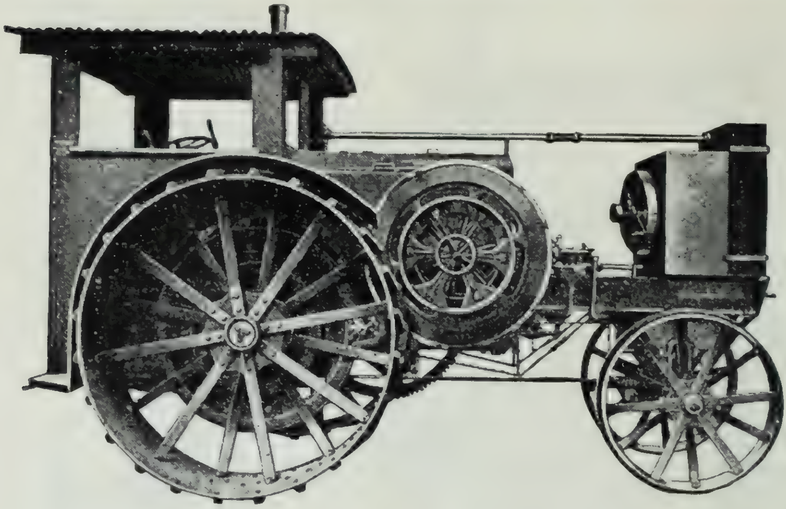
Transmission: Two speeds forward and one reverse, all controlled by a single lever. Gears run in oil. Double chain drive to rear wheels. Chains tightly encased.

Steering: Automobile type.

Specifications

Power—15-H. P. drawbar—30-H. P. brake
Speed of Motor—575 R. P. M.
Number of Cylinders—Four
Fuel—Kerosene or gasoline
Speeds—1.8 and 2.4 miles per hour and reverse
Weight—9,500 lbs.

TITAN 30-60-H. P. KEROSENE TRACTOR



The Most Powerful Titan Built

Here is the machine for power, for endurance, long hours under a heavy load day after day. It's the tractor for plowing a large acreage, running big threshing outfits, and heavy road work. With all its immense power it is not clumsy or hard to handle.

Power Plant: A twin cylinder 60-H. P., four-cycle engine, simple in construction, with all parts accessible, furnishes power. Engine enclosed by a sheet metal case.

Cooling: The engine is water-cooled by means of radiator and a centrifugal type circulating pump.

Ignition: Current for ignition is furnished by a magneto, gear driven from the cam shaft. Batteries are furnished for easy starting.

Governor: Fly-ball, spring controlled throttling type operating a butterfly valve in the intake manifold.

Mixer: Specially designed for operation on low grade fuels. Will handle kerosene, distillate, solar oil, gas oil, gasoline, motor spirits, and naphtha equally well.

Transmission: By gears from crankshaft to main axle. Reverse accomplished by means of sliding gears.

Oiling: A 10-feed mechanical oiler lubricates all the engine bearings and cylinders. Another 4-feed mechanical oiler lubricates the gears only.

Steering: Automobile type steering device.

Operating Levers: Only two operating levers, one for throwing the clutch in and one for reverse. Brake is operated by a foot pedal below the steering wheel.

Specifications

Power—30-H. P. drawbar—
60-H. P. brake
Speed of Motor—425 R. P. M.
Number of Cylinders—Two

Fuel—Kerosene or gasoline
Speed—2.8 miles per hour
Weight—20,300 lbs.

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BRANCH HOUSES

INTERNATIONAL HARVESTER COMPANY OF AMERICA

(INCORPORATED)

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CINCINNATI. OHIO
CLEVELAND OHIO
COLUMBIA. S C
COLUMBUS. OHIO
CONCORDIA. KAN
COUNCIL BLUFFS IA
CRAWFORD NEB
DAVENPORT IA
DENVER. COLO
DES MOINES. IA
DETROIT MICH
DUBUQUE. IA
EAST ST LOUIS. ILL.
EAU CLAIRE. WIS.
ELMIRA. N. Y
EVANSVILLE. IND
FARGO. N. D
FT DODGE. IA
FT WAYNE IND
GRAND FORKS. N D
GRAND RAPIDS. MICH
GREEN BAY WIS
HARRISBURG. PA
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HUTCHINSON KAN
INDIANAPOLIS IND
JACKSON. MICH
JACKSONVILLE. FLA
KANKAKEE. ILL
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LINCOLN. NEB
LITTLE ROCK. ARK
MADISON. WIS
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MEMPHIS TENN.
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MINNEAPOLIS. MINN
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OGDENSBURG N Y
OKLAHOMA CITY OKLA.
OMAHA. NEB
PARKERSBURG. W VA.
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PEORIA. ILL.
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