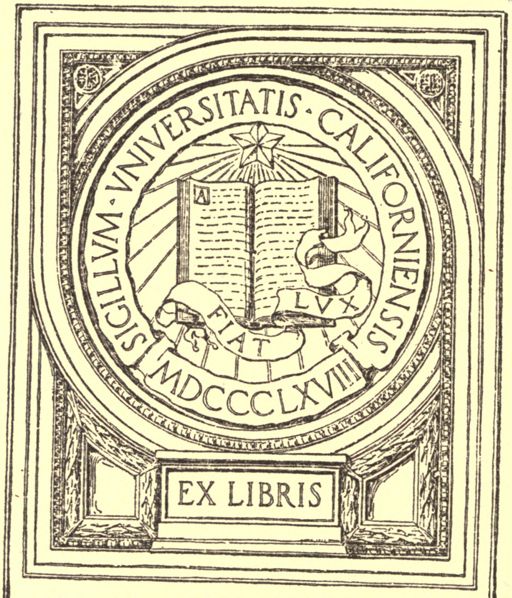
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CONCRETE CONSTRUCTION

ABOUT THE HOME AND ON THE FARM

PUBLISHED BY
THE ATLAS PORTLAND CEMENT CO.
30 BROAD ST. NEW YORK

CONCRETE CONSTRUCTION ABOUT THE HOME AND ON THE FARM

THE RECOGNIZED TEXT BOOK
OF CEMENT USERS

REVISED EDITION
1909

PUBLISHED BY
THE ATLAS PORTLAND CEMENT COMPANY
30 BROAD STREET
NEW YORK

SPECIFICATIONS FOR MIXING AND HANDLING "ATLAS" PORTLAND CEMENT—*Continued.*

Specifications for

FOREWORD.

The development of the American Portland Cement industry during the past decade has been one of the marvels of the age, and while Portland Cement Concrete has come to be recognized as the ideal building material for heavy work, comparatively little attention has been given to its use in the smaller construction about the home and on the farm. That active interest, however, is taken in this important subject by the suburbanite, the villager, and the farmer, is evidenced by the large number of letters of inquiry received by the agricultural and technical journals.

During the past few years the price of lumber has advanced to almost prohibitive figures, and it is therefore only natural that a substitute material which affords the advantages of moderate cost, durability, and beauty should be looked upon with favor.

It is not our purpose to enlarge upon the uses for which Portland Cement is now considered standard, but rather to direct attention to the economy of supplanting wood, brick, and cut stone in divers ways by the more durable, sightly, and sanitary Portland Cement construction.

In the following pages we shall endeavor to point out, in language free from technical terms, some of the uses for which Portland Cement Concrete is especially adapted.

CONCRETE CONSTRUCTION.

Concrete construction dates back to the time of the Romans, who secured good results from a mixture of slaked lime, volcanic dust, sand and broken stone. Even this combination, crude in comparison with Portland Cement Concrete, produced an artificial stone which has stood the test of nearly two thousand years, as evidenced by many works in Rome which are to-day in a perfect state of preservation.

"Portland Cement" is an invention of modern times—its universal use the matter of a quarter of a century. The honor of its discovery belongs to Joseph Aspdin, of Leeds, England, who took out a patent in 1824 for the manufacture of "Portland Cement," so called because of its resemblance in color, to a then popular limestone quarried on the Island of Portland. Manufacture was begun in 1825, but progress was slow until about 1850, when, through improved methods and general recognition of its merits as a building material, commercial success was assured. About this time the manufacture of Portland Cement was taken up in earnest by the French and Germans, and, by reason of their more scientific efforts, both the method of manufacture and quality of the finished product was greatly improved. Portland Cement was first brought to the United States in 1865. It was first manufactured in this country in 1872, but not until 1896 did the annual domestic production reach the million-barrel mark.

Dairy House | Cow Barn | Hay Barn | Calf Barn | Piggery | Horse Barn

EDW. BURNETT, Dairy Expert

ALFRED HOPKINS, Architect

AN ALL CONCRETE DAIRY FARM

GEDNEY FARMS—White Plains, N. Y.

Wonderful as the development of the general industry has been, the growth of the Atlas Portland Cement Company's plants has been even more so. Beginning in 1892 at Coplay, Pa., with the modest capacity of 250 barrels per day, its production has steadily increased through the construction of plants Nos. 2, 3, and 4, at Northampton, Pa., and plants Nos. 5 and 6, at Hannibal, Mo., until now the productive capacity is more than 40,000 barrels each twenty-four hours, or approximately fourteen million barrels per year. This production is greater than the capacity of any other Portland Cement company in the world. "ATLAS" Portland Cement is manufactured from the finest raw materials, under expert supervision in every department of the works. It is of the highest quality, being guaranteed to pass all usual and customary specifications, such as the specifications of the United States Government and those of the American Society for Testing Materials, which latter specifications have been concurred in by The American Institute of Architects, The American Engineering and Maintenance of Way Association, and The Association of American Portland Cement Manufacturers. The quality of eastern and western "ATLAS" is identical. By virtue of its enormous production, The Atlas Portland Cement Company is able to develop and retain in its service the most skilled operating talent in the Portland Cement industry, which insures a thoroughly reliable and uniform product.

"ATLAS" Portland Cement is guaranteed to be "ALWAYS UNIFORM."

CONCRETE

Concrete, which is really an artificial stone, is made by mixing pieces of stone, such as broken granite or hard limestone, which may vary in size from a walnut to a hen's egg, with clean, coarse sand and first-class Portland cement, using enough water to make a mushy mixture about like heavy cream.

The cement and water make the mass begin to stiffen in about half an hour, and in from 10 to 24 hours it becomes hard enough so that an impression cannot readily be made by pressing on it with the thumb. In a month's time the entire mass becomes one hard stone.

Conglomerate or pudding stone in nature is really a natural cement concrete, the large and small particles of pieces of stone and sand being cemented together in the course of ages in a similar way to that by which cement is made.

MORTAR

Where a very strong mortar is required for laying brick or stone, "ATLAS" Portland cement may be mixed with sand in proportions one part "ATLAS" cement to two and one-half parts sand. A characteristic of "ATLAS" Portland Cement is that it gives an especially *greasy* mortar.

A mortar nearly as strong as the above, and which works still better under the trowel, can be made by mixing one bag "ATLAS" Portland cement with one barrel of clean sand and one-half pail of lime putty. The lime putty is made by thoroughly slaking quick lime. The longer the time the putty can stand before using the better it is. It must never be used when hot or until the lime is thoroughly slaked. When laying up brick and stone with any kind of mortar they must be thoroughly wet.

CEMENT

Always use the best Portland cement obtainable. Natural cement is not suitable for concrete. Whatever the kind of cement, unless it is of first-class quality, it may give trouble by not setting up and hardening properly.

Portland cement is manufactured from a mixture of two materials, one of them a rock like limestone, or a softer material like chalk, which is nearly pure lime, and another material like shale, which is a hardened clay or else clay itself. In other words, there must be one material which is largely lime and another material which is largely clay, and these two must be mixed in very exact proportions determined by chemical tests, the proportions of the two being changed every few hours, if necessary, to allow for the variation in the chemical composition of the materials.

"ATLAS" PORTLAND CEMENT then is made by quarrying each of these two materials, crushing them separately, mixing them in the exact proportions, and grinding them to a very fine powder. This powder is fed into long rotary kilns, which are iron tubes about 5 or 6 feet in diameter, lined with fire brick and over 100 feet long. Powdered coal is also fed into the kilns with the ground rock and burned at a temperature of about 3000 degrees Fahrenheit, a temperature higher than that needed to melt iron to a liquid, and there is formed what is called cement clinker, a kind of dark, porous stone which looks like lava.

After leaving the kiln, the clinker is cooled, crushed and ground again to a still finer powder, so fine, in fact, that most of the particles are less than 1/200 of an inch in size, and this grinding brings it back to the very light gray color characteristic of "ATLAS" Portland Cement.

It is now placed in storage tanks or stock houses where it remains for a while to season before it is put into bags or barrels and shipped. The barrels weigh 400 pounds gross, or 376 pounds net. When shipped in bags, the weight is 94 pounds per bag, four bags being equal to one barrel.

At the "ATLAS" plants, from the time the rock is taken from the quarry until it is packed in barrels or bags, all of the work is done by machinery, and a thorough chemical mixture takes place regulated by the experienced chemists in charge of the work.

PACKING OF CEMENT. Portland cement may be obtained in paper bags, cloth sacks or wooden barrels. The most convenient form for most users is the cloth sack. These sacks can be returned to the dealer from whom the cement was purchased and a rebate obtained for them if they are kept dry and untorn.

HOW TO STORE CEMENT. Portland cement must be stored in a dry place, that is, in a barn or shed, for dampness is the only element which will injure its quality. The cement will become lumpy and even form a solid mass when kept in a damp place, and when in this condition it should not be used.

All lumps which do not crumble at the lightest blow should be thrown out.

Cement stored in a building must not be placed on the bare ground. Make a platform which is at least 6 inches above the ground, and store the cement on this platform. If the building has a concrete floor it is advisable to cover the floor with planking upon which to place the cement.

SAND (Fine Aggregate)

Sand, crushed stone or gravel screenings passing when dry a screen having ¼-inch diameter holes is called the fine aggregate. Sand should be (1) clean, that is, free from dirt like vegetable loam, and (2) coarse..

If the sand contains vegetable matter, it is difficult to tell whether the sand is good, because a very small quantity—a fraction of one per cent.—may sometimes prevent the concrete from hardening. When the job is small, however, an approximate idea of the quality may be obtained by examining the sand in the bank and making up a specimen of concrete on the job as described below. The ordinary plan of taking a little sand in the palm of one hand and rubbing it with the fingers of the other to see if it discolors is of little value, and little can be learned from dropping sand in water, because it is not so much the quantity as the kind of impurity that counts.

HOW TO TEST FOR A CLEAN SAND. Two rough tests are as follows: (a) Pick up a double handful of moist sand from the bank, open the hands, holding them with the thumbs up, and rub the sand lightly between the hands, keeping them about ½ inch apart, allowing the sand to slip quickly between them. Repeat this operation five or six times, then rub the hands lightly together so as to remove the fine grains of sand which adhere to them, and examine to see whether or not a thin film of sticky matter adheres to the fingers; if so, do not use the sand, for it contains loam. A further test is to scrape some of this matter from the fingers on the end of a penknife and take a little of it between the teeth. If it does not feel gritty or sharp it indicates vegetable loam, which is bad. Do not use this sand, or if no other can be obtained test it further to make sure that there is not sufficient loam present to prevent the cement from getting thoroughly hard.

SAND (Fine Aggregate) (Cont'd.)

The sand for the test given above must be moist, just as it comes from the bank. When dry the dirt will not stick to the fingers, hence this test cannot be used. Some idea can be obtained, however, by the appearance of the sand, even if it is dry. If it looks "dead," an appearance which is caused by the particles of dirt sticking in little lumps to the grains of sand, sometimes also making the grains of sand stick together in little bunches when picked up, it is almost a sure sign of vegetable matter, and the sand should not be used. Fine roots in a sand will also indicate the presence of vegetable matter.

(b) Make up two blocks of concrete, each about 6 inches square and 6 inches thick, using the same cement and the same sand and gravel or stone as will be used in the structure to be built, and mixing them in the same proportions and of the same consistency. Keep one block in the air out of doors for 7 days and the other in a fairly warm room.

The specimen in the warm room should set so that on the following day it will bear the pressure of the thumb without indentation, and it should also begin to whiten out at this early period. The specimen out of doors should be hard enough to remove from the molds in 24 hours in ordinary mild weather, or 48 hours in cold, damp weather. At the end of a week test both blocks by hitting them with a hammer. If the hammer does not dent them under light blows, such as would be used for driving tacks, and the blocks sound hard and are not broken under medium blows, the sand as a general rule can be used.

HOW TO WASH SAND. Sand cannot be washed simply by wetting the pile of sand with a hose, for this only washes or transfers the dirt to a lower part of the pile. Sand, provided it is not too fine, can be satisfactorily washed, however, by making a washing trough, as shown in Fig. 1. For sands a screen with 30 meshes to the linear inch is necessary to prevent the good particles from passing through it. This must be supported by cleats placed quite near together, or it will break through. The sand is shoveled on to the upper end of the trough by one man, while another one can wash it with a hose. The flow of water will wash the sand down the incline, and as the sand and water pass over the screen the dirty water will drain off through the screen, leaving the clean sand for use. By this arrangement the dirt which is washed out cannot in any way get mixed with the clean sand

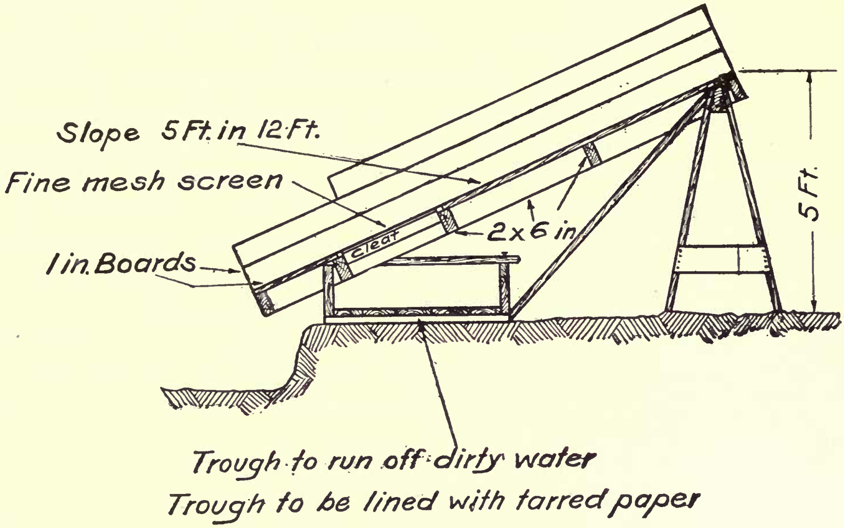


Fig. 1. Washing Trough for Sand or Gravel.

COARSE SAND. Sand should be coarse. By this we mean that a large proportion of the grains should measure 1/32 to 1/8 inch in diameter, and should the grains run up to 1/4 inch the strength of the mortar is increased. Fine sand, even if clean, makes a poor mortar or concrete, and, if its use is unavoidable, an additional proportion of cement must be used with it to thoroughly coat the grains.

If the sand is very fine a mortar or concrete made from it will not be strong. Sometimes fine sand must be used because no other can be obtained, but in such a case, double the amount of cement may be required. For example, instead of using a concrete one part cement to two parts sand to four parts stone, a concrete one part cement to one part sand to two parts stone may be used.

NATURAL MIXTURES OF BANK SAND AND GRAVEL. Very often the sand and gravel found in a bank are used by inexperienced people just as it is found without regard to the proportions of the two materials. This may be all right in some cases, but generally there is too much sand for the gravel or stone, so that the resulting concrete is not nearly as strong as it would be if the proportions between the sand and gravel were right. It is better then to screen the sand from the gravel through a 1/4-inch sieve, and then mix the materials in the right proportions, using generally about half as much sand as stone. By so doing a leaner mix can be used than where the sand and gravel are taken from the bank direct. The cost of the cement saved will more than pay for the extra labor required to screen the material. For example: Using even a very good gravel bank, a mixture one part cement to four parts natural gravel must be employed instead of one part cement to two parts sand to four parts of screened gravel. So much more cement is thus required with the natural gravel that a saving of one bag of cement in every seven is made by screening and remixing in the right proportion.

CRUSHER SCREENINGS. Screenings from broken stone make an excellent fine aggregate, which can be substituted for sand unless the stone is very soft, shelly or contains a large percentage of mica.

GRAVEL OR BROKEN STONE (Coarse Aggregate)

Gravel or broken stone forms the largest part of the mass of a good concrete, and is called the coarse aggregate. If the concrete is to be used simply for filling, or in a low wall against which nothing is to be piled, clean cinders, screened to remove the dust, may sometimes be used for the coarse aggregate. The concrete made from them, however, is not strong and is very porous. Slag or broken brick are sometimes used for the coarse aggregate.

The size of the stone is best graded from fine particles about 1/4 inch diameter up to the coarser. The largest size pieces may be 2 1/2 inches where a foundation or a wall 12 inches thick or over is being built, while for thin walls and where reinforcement is used the largest particles had best be about 3/4-inch size.

With gravel the danger is apt to lie in the grains being coated with clay or vegetable matter which prevents the cement from sticking to them, and hence a very weak concrete results. The method for washing gravel should be the same as that described for sand (see page 14) and shown in Fig. 1. The screen when washing the gravel should have openings 1/4 inch square.

WHAT NOT TO USE. Do not use dirty stone or gravel in any case. Avoid soft sandstones, soft freestones, soft limestones, slate and shale.

WATER

The water used for concrete must be clean. It should not be taken from a stream or pond into which any waste from chemical mills, material from barns, as manure, or other refuse, is dumped. If the water runs through alkali soil or contains vegetable matter it is best to make up a block of concrete, using this water, and see whether the cement sets properly. Do *not* use sea water.

PROPORTIONS

Concrete is composed of a certain amount or proportion of cement, a larger amount of sand, and a still larger amount of stone. The fixing of the quantities of each of these materials is called proportioning. The proportions for a mix of concrete given, for instance, one part of cement to two parts of sand to four parts of stone or gravel, are written 1:2:4, and this means that one cubic foot of packed cement is to be mixed with two cubic feet of sand and with four cubic feet of loose stone.

For ordinary work use twice as much coarse aggregate (that is, gravel or stone) as fine aggregate (that is, sand).

If gravel from a natural bank is used without screening, use the same proportion called for of the coarse aggregate; that is, if the specifications call for proportions 1:2:4, as given above, use for unscreened gravel (provided it contains quite a large quantity of stone) one part cement to four parts unscreened gravel.

If when placing concrete with the proportions specified, a wall shows many voids or pockets of stone, use a little more sand and a little less stone than called for. If, on the other hand, when placing, a lot of mortar rises to the top, use less sand and more stone in the next batch.

In calculating the amount of each of the materials to use for any piece of work, do not make the mistake so often made by the inexperienced that one barrel of cement, two barrels of sand and four barrels of stone will make seven barrels of concrete. As previously stated, the sand fills in the voids between the stones, while the cement fills the voids between the grains of sand, and therefore the total quantity of concrete will be slightly in excess of the original quantity of stone. This point is very clearly shown in Fig. 2.

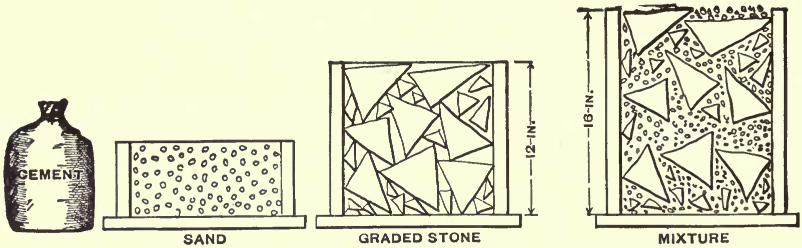


Fig. 2. Diagram Illustrating Measurement of Dry Materials and the Mixture.*

PROPORTIONS (Cont'd)

The following quotation from Concrete, Plain and Reinforced,* by the well-known authorities, Taylor and Thompson, is printed as a guide to those who wish to build any concrete structure for which specific instructions are not given in the following pages.

"As a rough guide to the selection of materials for various classes of work, we may take four proportions which differ from each other simply in the relative quantity of cement."

"(a) A Rich Mixture for columns and other structural parts subjected to high stresses or requiring exceptional water-tightness: Proportions—1:1½:3; that is, one barrel (4 bags) packed Portland cement to one and one-half barrels (5.7 cubic feet) loose sand to three barrels (11.4 cubic feet) loose gravel or broken stone.

"(b) A Standard Mixture for reinforced floors, beams and columns, for arches, for reinforced engine or machine foundations subject to vibrations, for tanks, sewers, conduits and other water-tight work: Proportions—1 : 2 : 4; that is, one barrel (4 bags) packed Portland cement to two barrels (7.6 cubic feet) loose sand to four barrels (15.2 cubic feet) loose gravel or broken stone.

"(c) A Medium Mixture for ordinary machine foundations, retaining walls, abutments, piers, thin foundation walls, building walls, ordinary floors, sidewalks and sewers with heavy walls: Proportions—1:2½:5; that is, one barrel (4 bags) packed Portland cement to two and one-half barrels (9.5 cubic feet) loose sand to five barrels (19 cubic feet) loose gravel or broken stone.

"(d) A Lean Mixture for unimportant work in masses, for heavy walls, for large foundations supporting a stationary load and for backing for stone masonry: Proportions—1 : 3 : 6; that is, one barrel (4 bags) packed Portland cement to three barrels (11.4 cubic feet) loose sand to six barrels (22.8 cubic feet) loose gravel or broken stone."

*Taken by permission from Taylor & Thompson's "Concrete Plain and Reinforced," John Wiley & Sons, New York, publishers.

Green timber is preferable, for, if seasoned, it is likely to swell and warp when brought in contact with moisture from the concrete. White pine is best, but fir, yellow pine or spruce are also suitable. If a smooth surface is desired, the form boards or planks next to the concrete must be planed and the edges tongued and grooved or beveled. Grease the inside of forms with either soap, linseed oil, mixed lard and kerosene, or crude oil, that is, petroleum, otherwise particles of concrete will stick to the forms when they are removed, thus giving an unnecessarily rough surface to the face of the concrete. Forms

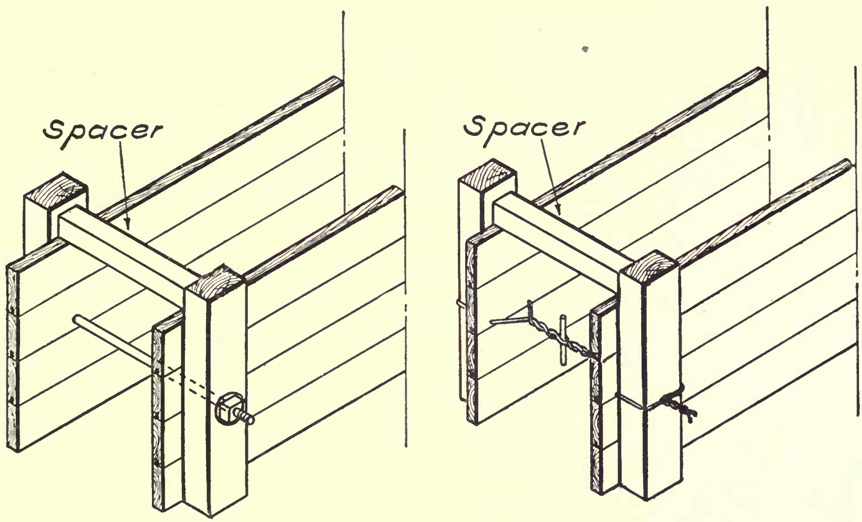


Fig. 3. Section of Forms Showing Method of Holding Sides of Forms.

should not be greased when it is intended to plaster the surface of the concrete, but should be thoroughly wet immediately before placing the concrete.

Lay the sheathing or form boards horizontally. These may be of 1-inch, 1½-inch or 2-inch lumber, the distance apart of the studding being governed by the thickness of sheathing selected. Place the studs not more than 2 feet apart for 1-inch sheathing, nor more than 5 feet apart for 2-inch sheathing. They should be securely braced to withstand the pressure of the soft concrete, also of the ramming and tamping. In building forms do not drive the nails all the way home. Leave the heads out so that it is possible to draw them with a claw hammer. The less hammering done around green concrete the better. Avoid cracks in forms into which the mortar will force itself and form "fins" on the surface of the work.

The length of time the forms should be left in place varies with conditions. Where no pressure is brought to bear on the concrete, forms can be removed within one-half to two days, or as soon as the concrete will withstand the pressure of the thumb without indentation. On very small work, like drain tile, two to four hours is sufficient time, provided it is carefully handled and left in place until thoroughly hard. On large and important walls one to three days are generally required, and if any water or earth pressure comes against the walls the forms should be left in place from three to four weeks. Slab forms can be removed in about one week, but the supporting posts under any beams and slabs must not be touched for a month after laying the concrete.

Concrete forms are kept from separating or bulging either by using bolts or by wiring. Bolts as a general rule are more satisfactory on large work than wire, but as they cannot always be conveniently obtained, wires are used extensively. In Fig. 3 are sketched both methods for holding side forms together. The spacers are only placed between the forms to hold them the proper distance apart, and must be removed after some of the concrete is placed. Where wires are used, the forms are drawn together by twisting, as shown in the figure. This is done with a large nail or a hammer handle.

CIRCULAR FORMS

For a round structure two sets of circular forms are usually needed, namely, inner and outer forms, "A" and "B," Fig. 5. Both of these come into use when building a silo or other structure having a thin wall, but in the case of a solid column only the outer form is necessary. Both inner and outer forms are made practically the same, except that the radius of the outer one is of necessity greater than that of the inner because of the thickness of the walls between the two forms.

A simple method of drawing the circle for the outer form is as follows: Take a piece of string, attach one end to a long spike, marked "A," Fig. 4, and stick it into the ground. Measure off on the string one-half the diameter of the circle desired, tie a knot, through which force a nail (marked "B," Fig. 4), and, keeping the string stretched between these two points, draw a continuous line. Lay the boards around the line just made, nail them together firmly and then mark the circle out on them and saw to the line. After making two or more forms, place them at equal distances apart, and put on the sideboards in the manner shown in Fig. 5. These boards are called "Lagging."

CIRCULAR FORMS (Cont'd)

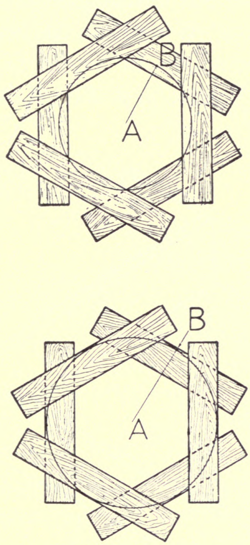


Fig. 4. Laying Out Circular Forms.

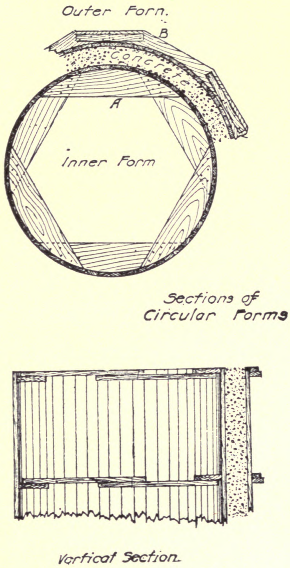
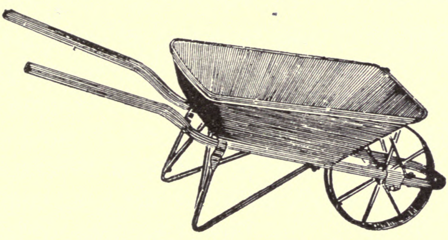


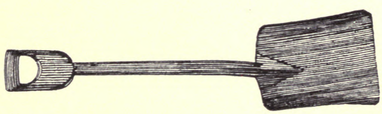
Fig. 5. Circular Forms.

The quantity of tools will, of course, vary with the size of the gang of men. The following schedule is based on a small gang of two or three men, making concrete by hand:

TOOLS AND APPARATUS



Concrete Wheelbarrow.



Square Pointed Shovel

Three No. 3 square-pointed shovels.
Two wheelbarrows (iron wheelbarrows the best).
One tamper, a piece of 2 x 4-inch joist is sufficient.
One garden spade or spading tool.
One water barrel.
Three water buckets.

One sand screen, ¼-inch or ⅜-inch mesh, for screening sand from the gravel.

One measuring box (see Fig. 6).

One mixing platform about 10 feet square built so substantially that it can be moved without coming to pieces, having a 2 x 3-inch strip around the edge to prevent the waste of materials and water. This platform can be made of 1-inch stuff, resting on joists about 2 feet apart, provided it is stiffened by being tongued and grooved.

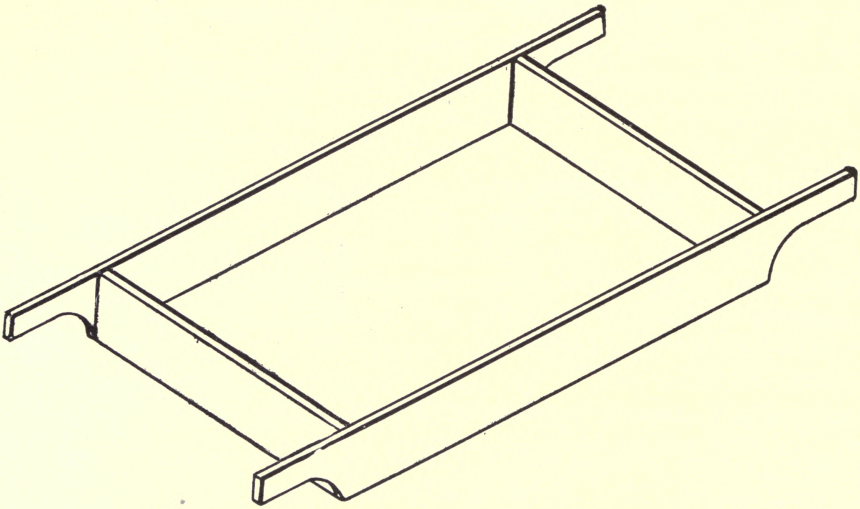


Fig. 6. Measuring Box for Sand and Gravel.*

Concrete should be mixed as near the place where it is to be used as practicable, so as to avoid delay in getting it into place. If left standing any length of time it will set and become useless. To avoid this, mix small batches at a time, using on a small job not more than a half barrel or two bags of cement to the batch. Should the cement take its initial set, i. e., begin to harden, before being placed in the forms, so that it lumps when retempered, discard it, as the hardening qualities of cement are affected if disturbed after it has begun to set.

If sand or gravel require washing, add to the above list of tools and apparatus:

One washing screen for sand with 30 meshes to the linear inch.

One washing screen for gravel with ¼-inch meshes.

*See footnote, page 18.

Too much attention cannot be paid to this important part of concrete making. The best and most convenient way to measure the sand and stone is to make a measuring box or frame as shown in Fig. 6.

MEASURING

The inside dimensions of the box for different mixes of concrete are given in the table below, the size of the box being

QUANTITY OF MATERIALS AND SIZES OF MEASURING BOXES.

Mix	Cement Bags	Sand	Gravel	Concrete Made, Cu. Ft.	Size of Measuring Box Lgth.Dpth.Wdth.
1:1½:3	2	2.8 cu. ft. or ¾ bbl.	5.6 cu. ft. or 1½ bbl.	7.0	3′ 0″x2′ 0″x10″
1:2 :4	2	3.8 cu. ft. or 1 bbl.	7.6 cu. ft. or 2 bbl.	9.0	4′ 0″x2′ 4″x10″
1:2½:5	2	4.8 cu. ft. or 1¼ bbl.	9.6 cu. ft. or 2½ bbl.	10.9	4′ 6″x2′ 2″x12″
1:3 :6	2	5.8 cu. ft. or 1½ bbl.	11.6 cu. ft. or 3 bbl.	12.8	4′ 6″x2′ 7″x12″

Note.—A cement barrel holds 3.8 cubic feet.

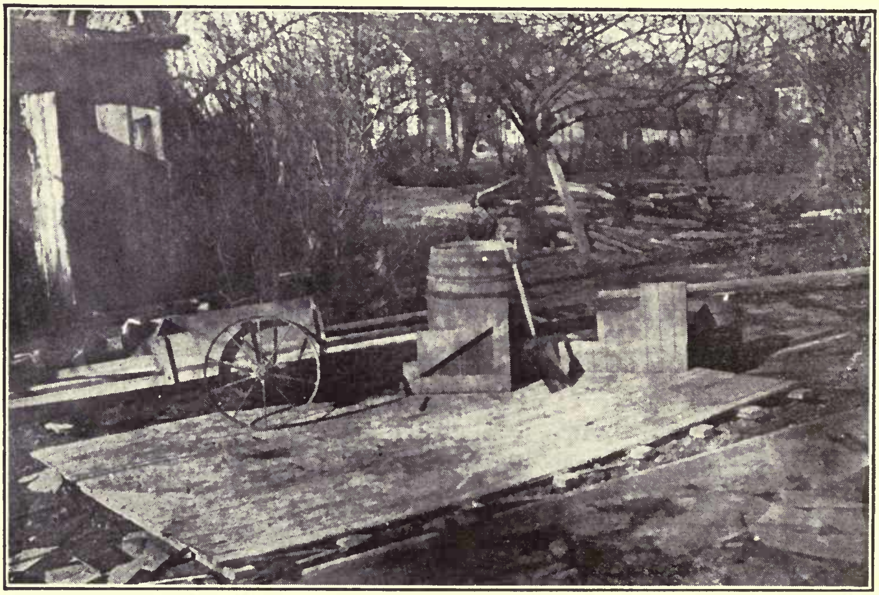
based on a two-bag batch of concrete; that is, using two bags "ATLAS" Portland Cement to each batch. The use of the box or frame for measuring can be best illustrated by the following example: Assume a 1:2:4 mix. From the table a measuring frame or box, 10 inches high by 2 feet 4 inches by 4 feet inside dimensions, must be made. Lay this box on the mixing platform, fill it exactly half full of sand, up to a mark previously made all around it, and level off the sand to make sure that the sand just fills half the frame, and then raise the measuring frame. Dump two bags of cement on the sand and mix it as described under "Mixing," on page 24. Even off the mixed cement and sand, place the measuring box on top of it and fill the frame with stone level with the top. Level off the stone carefully, raise the measuring box and the correct amount of stone is ready to be mixed with the cement and sand.

Another way to measure the sand and stone is by using a wheelbarrow. To determine the capacity of the wheelbarrow, dump into it one or two bags of cement and see how much of the wheelbarrow is filled; taking this as a unit, measure the sand and stone accordingly, using perhaps a little less of the sand and stone than would be indicated by the cement measure considered as one part. This method is not nearly so accurate as the first one, and if used the barrow should be filled with the cement two or three times a day to keep the eye trained.

MIXING

An essential to thorough mixing is a flat water-tight platform, a convenient size being about 10 feet square, the boards forming which must be laid with tight joints to prevent the cement and water from running through while mixing. If these boards are planed off on top it will make the shoveling easier.

The operation of mixing the materials for concrete is as follows: Measure the sand and spread it in a layer of even depth as shown in Fig. 7. Place the cement on top of the sand. First turn these two materials toward the center of the board (see Fig. 7) and then turn them twice more or until they are thoroughly mixed together, as indicated by a uniform



IMPROVISED MIXING PLATFORM AND TOOLS USED ON SMALL JOB AT COLUMBIA, MO.

color. Next wet the stone, throw it on top of the mixed cement and sand and turn the whole mass at least three times, water being slowly poured on during the first turning, the quantity varying according to the nature of the work. In general, add sufficient water to give a "mushy" mixture just too soft to bear the weight of a man when in place. Pails are most convenient for measuring the water, and enough pailfuls should be provided in advance for wetting an entire batch. Do not use a hose. In turning the concrete use square-pointed

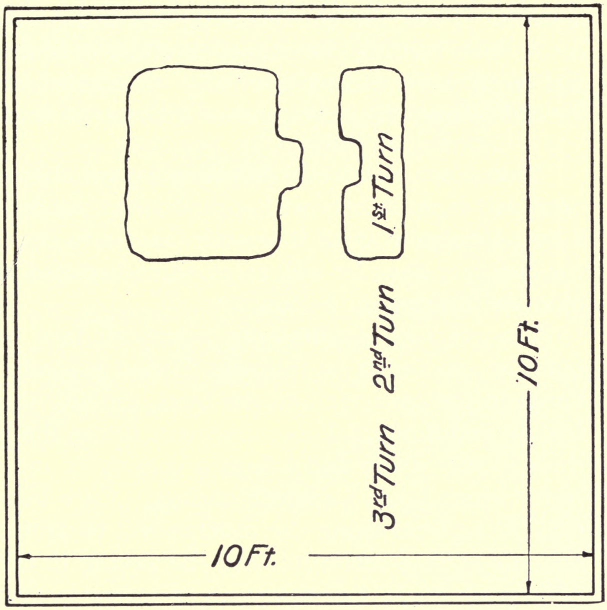


Fig. 7. Position of Piles of Cement and Sand During Mixing.*

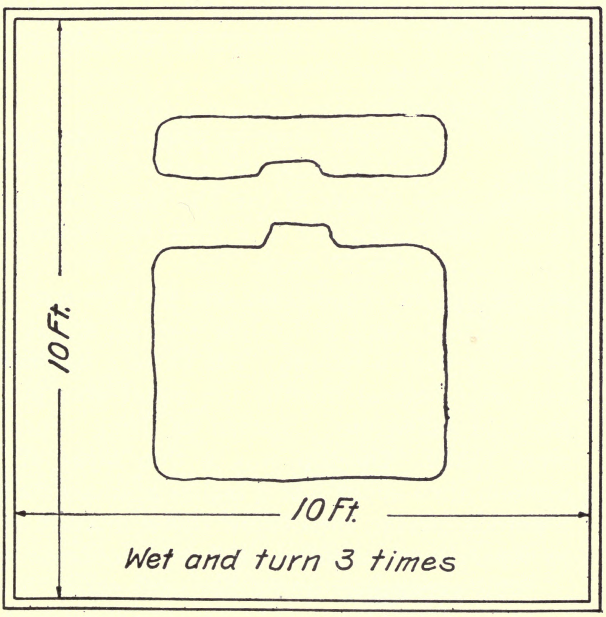


Fig. 8. Position of Materials During Mixing of Concrete.*

***See footnote, page 18.**

shovels. Push the shovel along the boards under the mass, lift it, then turning the shovel carefully over deposit the material with a spreading motion. Concrete mixing machines should be used on large jobs as a matter of economy.

PLACING CONCRETE IN FORMS

Place the concrete in forms in layers about 6 to 12 inches deep and tamp lightly with a rammer or puddle with a piece of 2 by 4-inch joint until the water flushes to the top. Note that the concrete must be well rammed and spaded to avoid pockets of stone forming in the concrete.

The method of obtaining a smooth face on concrete frequently adopted is as follows: Thrust a spade or thin paddle between the concrete and the form, moving the handle to and fro, up and down. This movement forces the broken stone in the concrete away and brings a coating of mortar next to the form, which gives a smooth surface. Care taken in manipulation of concrete along the moulds will be amply repaid by the smooth surface resulting, and the saving in time and expense otherwise made necessary in plastering over cavities and smoothing rough places.

Concrete which is exposed to the sun should be soaked with water each day for a week or two. This will allow the interior of the walls to dry uniformly with the exterior, and thus prevent scaling or cracking.

PLACING CONCRETE UNDER WATER

Concrete should never be placed under water if it possibly can be avoided, because the materials are in danger of separating. The danger of the fine material separating from the coarse was illustrated in a little test made by the engineers constructing the Holyoke Dam. A small batch of concrete was mixed in proportions one part cement to two and one-quarter parts sand to five parts stone, and shoveled into a pail of water with a trowel. The surface hardened satisfactorily, and after several months the water was poured off and the material taken out. Instead of being concrete, three layers were found. On top was a thin layer of practically neat cement, then about 2 or 3 inches of mixed sand and cement in a porous mortar, then below this a mixture of sand and stone as separate and clean as before the concrete was mixed.

This experiment and other tests show that if concrete has to be placed under water it must be deposited in large masses and never by shovelfuls.

PLACING CONCRETE UNDER WATER (Cont'd.)

On small work put the concrete in pails, place a board over the top of the pail and lower it carefully into the water to the bottom. Turn the pail upside down, carefully remove the board and slowly raise the pail, allowing the concrete to flow out. Great care must be used not to disturb the water in which the concrete is being placed nor to touch the green concrete. Concrete must never be placed under water if there is any current, because the cement will be washed away, leaving only the sand and stone.

Another method for depositing concrete under water is to pass the concrete slowly through a spout or tube which reaches to within a couple of inches of the bottom where the concrete is to be placed. The tube must be kept full and the concrete kept moving continuously and slowly through it. On large work specially designed buckets are used for depositing the concrete under water, but these are generally operated by a derrick.

SURFACE FINISH

Surface finish of concrete may be for either of two purposes: To make the concrete more water-tight, or to improve the appearance. It is advisable to leave the outside surface of the concrete just as it comes from the forms, having used care in placing to see that there are no stone pockets or voids; or else to take off the skin of cement so as to expose the sand and stone and leave an even but slightly rough surface.

PURE CEMENT WASH. On exterior surfaces a coat of pure cement will check with fine hair cracks because of the rapid drying out of the mortar. However, for the interior of a tank which will be kept wet while in use, a coat of neat cement may serve to make the concrete more water-tight. Put this on just as soon as the forms are removed, and take off forms as early as possible. In small pieces of concrete, like a small trough, the inner form may be removed within two or three hours, and the wash applied immediately. Leave the outside forms, however, until the concrete is hard. Wet the inside surface thoroughly and apply the pure cement with a brush or a trowel.

REMOVING SURFACE SKIN OF CEMENT WHILE CONCRETE IS GREEN. The best method of obtaining a good outside finish is to rub off the skin of cement which comes to the surface next to the forms and thus expose the sand or stone. There are various ways of doing this. The easiest way is to remove the forms as soon as the concrete is set, which for a wall may be in 24 or 48 hours; just as soon, in fact, as the concrete will bear the pressure of the thumb. Wet the surface thoroughly, and rub it either with a brick, with a board, with a plasterer's wooden float, or with a carborundum block. By this plan the surface can be simply smoothed of roughnesses, or the skin of cement can be taken off to leave a sandy finish, or by still further work the stones can be exposed. The resulting finish, while rough, should be uniform and pleasing.

PICKED SURFACE. If the concrete has hardened, the skin of cement can be removed with a tool. A stone cutter's bush hammer can be used for this, or a tool can be made with a toothed edge.

PLASTERING. Plastering on exterior surfaces requires great care and skill to prevent cracking and peeling. The forms in which the concrete is laid must be wet instead of oiled. Roughen the surface, either when the concrete is green, by rubbing off the cement, or by picking the hardened surface with an old hatchet or a stone axe. Wet thoroughly and apply as thin a layer as possible, about 1/16 inch thick is best, of mortar, one part "ATLAS" Portland Cement and one part fine, but very clean, sand. For thick layers, pick and wet the surface, then brush on a thin coat of pure cement grout on a small part of the surface, and before this has begun to stiffen apply the plaster.

REINFORCED CONCRETE

Reinforced concrete is ordinary concrete in which iron or steel rods or wire are imbedded. Reinforcement is required when the concrete is liable to be pulled or bent, as in beams, floors, posts, walls or tanks, because, while concrete is as strong as stone masonry, neither of these materials has nearly so much strength in tension as in compression. Moreover, concrete alone, like any natural stone, is brittle, but by imbedding in it steel rods or other reinforcement, the cement adheres to the metal and binds the particles together so that the reinforced concrete is better adapted to withstand jar and impact. Even railway bridges are built, not only in arch form, like a stone arch, but in some cases like a steel girder bridge, with a flat reinforced concrete floor supported by horizontal beams of the same material.

Reinforcement may be iron or steel. Steel is nearly always used because it is nowadays cheaper than iron and easier to buy. The ordinary iron rods, so-called, as found in the stores are almost always steel.

Round rods or square twisted rods, or rods with special surfaces designed to better pervent pulling out from the concrete, are used in most of the important work in reinforced concrete. For slabs, metal fabrics like expanded metal or woven wire is frequently used instead of rods. In some of the smaller structures described in the pages which follow, the reinforcement is put in to prevent cracking, and, as stated in the text, almost any kind of wire can often be used. Nearly every farmer has fence wire which is well adapted for reinforcing watering troughs and for small pieces of work.

Concrete, like other materials, shrinks when the weather is cold, and it also shrinks in setting, so that a long wall is bound to have occasional cracks in it unless it is very heavily reinforced or unless joints are placed every 30 feet or so.

An engineer or architect experienced in reinforced concrete design should be employed in preparing the plans for houses, barns or other large structures, but by carefully following the directions and specifications in this booklet small reinforced concrete construction may be safely undertaken by the inexperienced.

The table which follows gives the thickness and reinforcement of slabs, and the dimensions and reinforcement of reinforced concrete beams for a number of conditions which are liable to be met with in common practice. While the values are as low as should be adopted without knowing the local conditions, complete mathematical calculations of dimensions should be made for large structures, not only from the standpoint of safety, but also because of the saving in cost of material which can be effected by fitting each member in its proper place.

Rules, which are written as footnotes to the table, give very important directions.

An invariable rule in placing steel is to insert it in the face where the pull will come. Thus in a beam or slab it must be close to the bottom. In a wall, to withstand earth pressure, it must be in the face nearest the earth. If, for example, a beam were designed according to the table, but the steel placed in

TABLE FOR DESIGNING REINFORCED CONCRETE BEAMS AND SLABS

PROPORTIONS OF CONCRETE 1: 2: 4. [See important foot-note.]

Length or Span of Beam.	Distance apart of Beams.	Dimension of Beams			Reinforcement of Beams					Thickness of Slabs		Reinforcement of Slabs	
		Width	Depth	Depth below Steel	Number of Rods required	Diameter of Rods	Number of Stirrups at each end	Diameter of Stirrup Rods	Spacing* of Stirrups	Total Thickness	Depth below Steel	Diameter of Rods	Spacing of Rods
Feet	Feet	Inches	Inches	Inches		Inches		Inches		Inches	Inches	Inches	Inches
Medium Heaby Floor Loading - - - 125 Pounds per Square Foot													
8	4	6	13	1 1/2	3	1/2	1	5/16"	6"	3	3/4	5/16	6
	6	7	15	1 1/2	3	9/16	2	5/16"	6"	3 3/4	3/4	3/8	6
	8	8	17	1 1/2	3	5/8	2	3/8"	6"	5	1	1/2	7 1/2
10	4	7	14	1 1/2	3	1/2	2	5/16"	8"	3	3/4	5/16	6
	6	9	17	1 1/2	4	9/16	3	5/16"	8"	3 3/4	3/4	3/8	6
	8	9	20	2	4	5/8	3	3/8"	8"	5	1	1/2	7 1/2
12	4	9	16	1 1/2	4	9/16	2	3/8"	8"	3	3/4	5/16	6
	6	10	20	2	4	5/8	3	3/8"	8"	3 3/4	3/4	3/8	6
	8	11	22	2	4	11/16	4	3/8"	8"	5	1	1/2	7 1/2
14	4	10	18	1 1/2	4	5/8	2	3/8"	8"	3	3/4	5/16	6
	6	11	24	2	4	3/4	3	3/8"	8"	3 3/4	3/4	3/8	6
	8	13	24	2	4	13/16	4	3/8"	8"	5	1	1/2	7 1/2
Light Floor Loading - - - - 50 Pounds per Square Foot													
8	4	5	10	1 1/4	3	3/8				3	3/4	1/4	5 1/2
	6	6	13	1 1/2	3	7/16				3 1/2	3/4	5/16	7
	8	7	13	1 1/2	3	1/2				4	3/4	3/8	5 1/2
10	4	6	12	1 1/4	3	3/8				3	3/4	1/4	5 1/2
	6	7	15	1 1/2	3	9/16				3 1/2	3/4	5/16	7
	8	8	16	1 1/2	3	5/8				4	3/4	3/8	5 1/2

12	4	7	13	1½	3	½				3	¾	¼	5½
	6	8	17	1½	3	⅝				3½	¾	5/16	7
	8	9	18	1½	4	9/16				4	¾	⅜	5½
14	4	7	15	1½	3	9/16				3	¾	¼	5½
	6	8	19	2	3	⅝				3½	¾	5/16	7
	8	10	21	2	4	11/16				4	¾	⅜	5½
Roofs - - - 30 Pounds per Square Foot													
8	4	5	10	1¼	3	⅜				2¾	¾	3/16	6
	6	6	11	1¼	3	7/16				3	¾	¼	5½
	8	7	12	1¼	3	½				3¼	¾	⅜	7½
10	4	6	12	1¼	3	7/16				2¾	¾	3/16	6
	6	7	13	1½	3	½				3	¾	¼	5½
	8	8	14	1½	3	9/16				3¼	¾	⅜	7½
12	4	7	13	1½	3	½				2¾	¾	3/16	6
	6	7	16	1½	3	9/16				3	¾	¼	5½
	8	8	17	1½	3	⅝				3¼	¾	⅜	7½
14	4	7	15	1½	3	9/16				2¾	¾	3/16	6
	6	8	17	1½	3	⅝				3	¾	¼	5½
	8	9	18	1½	3	11/16				3¼	¾	⅜	7½

1. Bend, diagonally upwards, one rod in three, or two rods in four from ¼ points in beam to top of beam and over supports. (See Fig. 9.)
2. Stirrups are made U-shaped with bent ends. (See Fig. 9.)
3. Slab reinforcement is placed at right angles to supporting beams. (See Fig. 9.)
   Cross reinforcement of slightly smaller rods or same rods farther apart is also placed in slabs parallel to beams.
4. Wire fabric or expanded metal mesh may be substituted for rods in the slabs, provided the area of section of metal is kept the same as the rods.
5. Cinder concrete should not be used for beams.
6. Cinder concrete may be used for roof slabs if thickness is increased one inch.
7. After setting 30 days, test two of the slabs and one beam by loading two panels with sand to depth of:
   18 inches deep for heavy floor loading;
   8 inches deep for light floor loading;
   5 inches deep for roof loading.

*Place first stirrup in every case 6 inches from support.

the middle or top of the beam instead of in the bottom, it would certainly break under a very light load. There must be only enough concrete outside of the steel to protect it from rusting or fire. In floor or roof slabs of small structures this thickness should be one-half inch to three-quarters inch below the bottom of the steel, and for beams from one to one and one-half inches.

A typical beam with its connecting floor slabs, the concrete of both of which should be laid at the same operation, is shown in Fig. 9. It will be seen that the beam reinforcement consists of rods running lengthwise of the beam—one-half or one-third of these rods being bent up about one-third way from each end and extending over the supports, as shown in Fig. 9 and for the heavier beams U-shaped bars or stirrups are used which pass under the longitudinal rods and up on each side of the beam. The horizontal bars withstand the direct pull in the bottom of the beam due to bending when a load is placed upon it; the U-bars or stirrups and the bent-up bars prevent diagonal cracks, which sometimes occur under loading, and the bars passing over the supports prevent the cracking of the beam on top at the ends.

The steel in the slab is placed just above the bottom surface at the center of the span and then bent upward over the supports as shown in the drawing.

Proportions for all reinforced concrete must not be leaner than one part "ATLAS" Portland Cement, two parts clean, coarse sand and four parts broken stone or clean screened gravel. Maximum size of broken stone or gravel should not be over one inch diameter in order to pass between and under the steel rods. Consistency of concrete should be like heavy cream.

COST OF CONCRETE WORK

The cost of concrete work varies considerably on account of the many elements entering into the work. For instance, the cost of building the various structures illustrated in this book may be very small, as the work itself may be done by the owner or farmer at odd times or with comparatively cheap help, while in building with other materials, either brick or wood, it is necessary to employ carpenters or masons. Moreover, even if the lumber for the forms costs nearly as much as the lumber for a wooden structure, as is sometimes the case, it need not be thrown away, but may be used again for other purposes. If hired laborers and carpenters do the work it may be stated as a general rule that concrete is always more expensive in first cost than wood. On the other hand, concrete does not rot, it does not burn, and it does not have to be painted, so that it frequently may be cheaper in the long run. Besides this, more unique and pleasing effects may be produced.

MATERIALS FOR ONE CUBIC YARD OF CONCRETE.

Proportion by Parts			Bbls. Cement in 1 Cubic Yard	Bbls. Sand in 1 Cubic Yard	Bbls. Gravel or Stone in 1 Cubic Yard
Cement	Sand	Stone or Gravel			
1	1½	3	2.00	3.00	6.00
1	2	4	1.57	3.14	6.28
1	2½	5	1.29	3.23	6.45
1	3	6	1.10	3.30	6.60

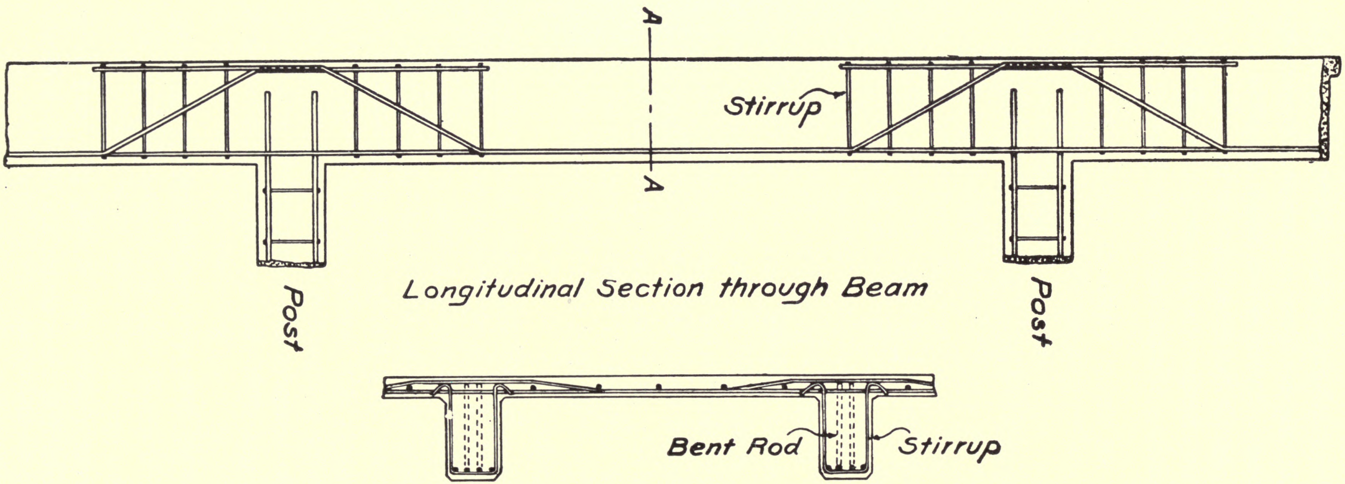
EFFECT OF EXTERNAL AGENCIES ON CONCRETE

FIRE RESISTANCE. Concrete is one of the best fireproof materials known. It resists intense heat better than iron, steel, ordinary brick or stone, and in the San Francisco and Baltimore fires it stood the test better than any other material. It can therefore be depended upon to resist any ordinary fire. Concrete is used extensively as a fire-protective covering for steel, for which purpose about two inches is necessary. In reinforced concrete the iron or steel should be imbedded one or two inches for protection.

WATER TIGHTNESS. By mixing wet and using proportions one part "ATLAS" Portland Cement to one and one-half parts sand to three parts screened gravel and placing in one continuous operation, so that no surface is allowed to harden, or else by forming very good joints as described on page 116, concrete is watertight under ordinary conditions. Long walls to resist water pressure must be well reinforced to prevent cracks due to temperature contraction, since concrete expands and contracts with changes of temperature just like other materials.

CORROSION OF METAL REINFORCEMENT. Concrete properly proportioned and mixed wet absolutely prevents any metal imbedded in it from rusting.

SEA WATER. Concrete resists sea water, provided it is properly proportioned with first-class materials and is carefully laid.



Cross-Section at A through Beams & Slab

Fig. 9. Typical Beam and Slab Sections.

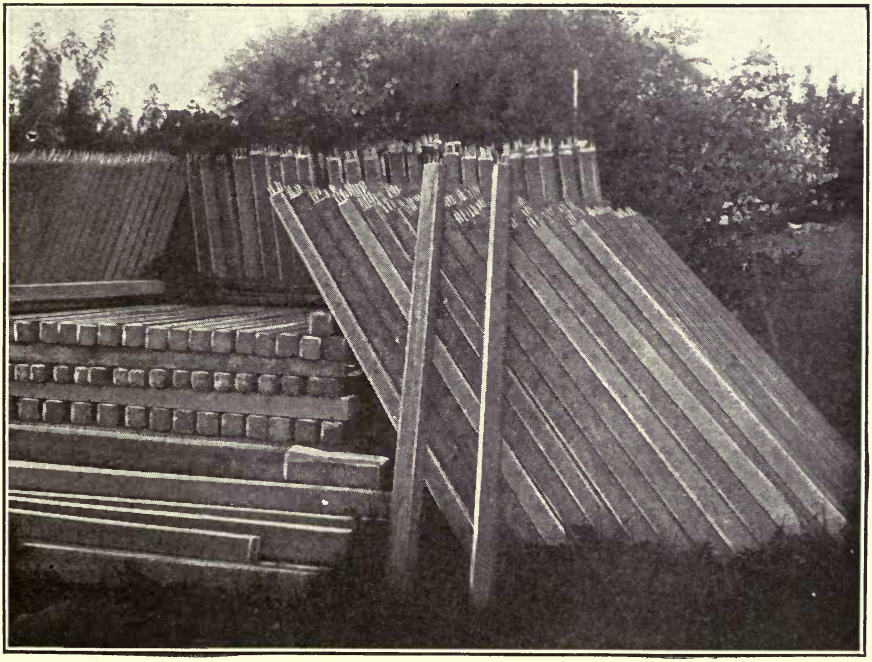
ACIDS. After concrete has thoroughly hardened it resists acids better than almost any other material. A substance like manure, because of the acid which it contains, has been known to slightly injure the surface of green concrete, but after the concrete has hardened for at least a week it is proof against injury.

OILS. When concrete is properly made and the surface carefully finished and is hardened before the oil comes against the concrete, it can be depended upon to resist the action of almost any oil.

ALKALIES. For use in the arid regions where there is alkaline ground water, concrete should be especially rich, dense and water-tight.

FREEZING. Concrete work should be avoided so far as possible in freezing weather, as the frost will prevent the bonding of different layers and will cause a thin scale to peel off of the surface of concrete.

It is a good rule to follow, therefore, never to lay concrete if the temperature is below freezing or liable to fall below freezing in a day or two.



CONCRETE FENCE POSTS AT SIOUX RAPIDS, IOWA

POSTS.

FENCE POSTS. The use of concrete fence posts is becoming very general. This is due not only to the scarcity and high price of good straight wood posts, but to the almost unlimited life of the concrete post, its greater strength and more pleasing appearance.

Concrete fence posts should be a little larger than wood fence posts, and may be made either straight for the whole length or slightly tapering. Five or six inches square at the bottom and four or five inches square at the top is an ordinary size, or for convenience in molding they may not be made exactly square, say, 6 inches by 5 inches at the bottom and 5 inches by 4 inches at the top, this size being selected for the form shown in Fig. 10.

As a very slight heaving of a fence post by frost is not objectionable, they

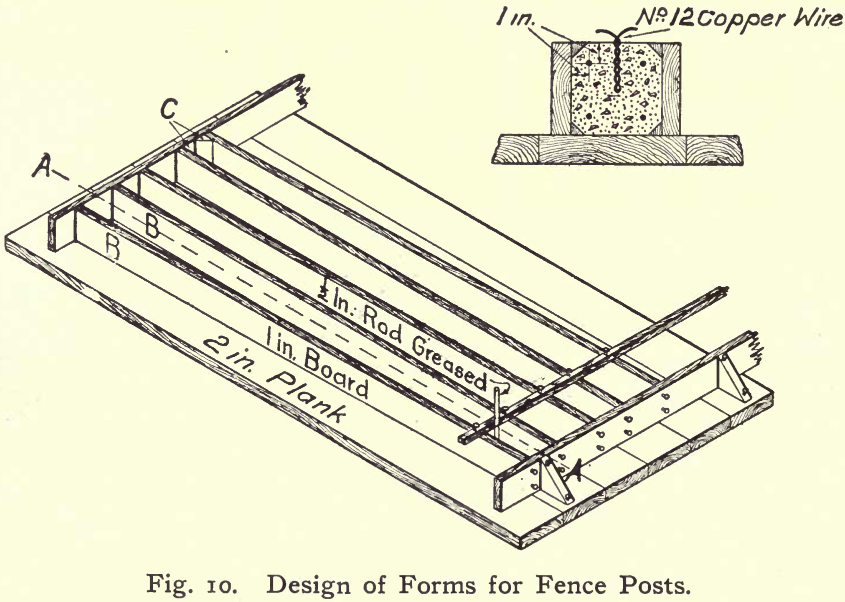
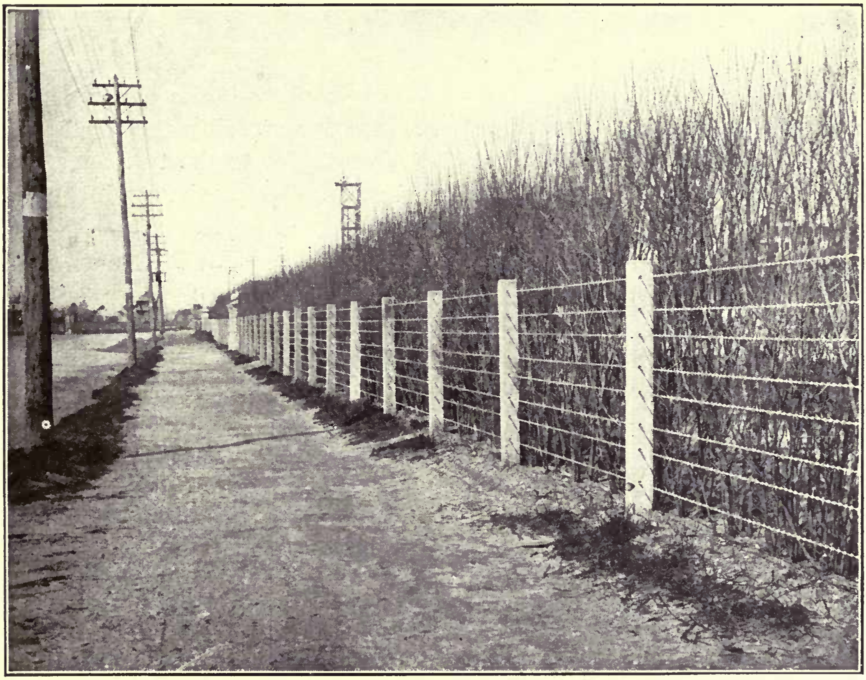


Fig. 10. Design of Forms for Fence Posts.

do not need to be placed in the ground more than 2½ feet, although if for any reason they should be absolutely rigid the lower end should go below frost line, which in the Northern States is as much as 4 feet down. The length of the post is determined by the height which is desired above the ground.

Posts may be built separately, that is, in a separate form laid on the ground, but the cheapest way is to build forms for a number of posts so that several can be molded at the same time, and then the forms used for another set as soon as the concrete has hardened.

To mold a lot of posts at one time build the forms in the following manner: Select some place where the posts can be left in their original position for at least ten days. Level off the ground and place the bottom planks, which should be of 1½-inch or 2-inch planed lumber, side by side upon 2 or 3 cross sills, making a solid floor upon which to mold the posts. Place two 1-inch by 5-inch boards on edge parallel to each other and the height of the posts apart and brace them on the outside with triangular braces as shown in the



CONCRETE FENCE POSTS AT FAR ROCKAWAY, L. I.

figure. To locate the center of first post stretch a line from one side across to the other at right angles to the boards on edge as indicated by line AA. At one end of this line AA measure 3 inches each side of it for the bottom of the post and at the other end measure 2 inches each side of this line for the top of the post. This will locate the boards BB for the sides of the posts. Nail these intermediate boards at the ends with a nail or two to the two parallel boards, allowing the heads to project so they can be pulled out with a claw hammer.

Make the posts, as is shown in the sketch, with every alternate post lying the opposite way. By so doing one intermediate board serves as a side to two posts, thus requiring less lumber per post than by any other arrangement of forms. With this method of construction also the least amount of ground area is required for molding the posts and no bracing is necessary to support the boards for the sides of the posts. Triangular 1-inch bevel strips may be placed on all edges, as shown in the cross section, Fig. 10, which will give the posts a neat and pleasing appearance. These bevel strips can be obtained readily from a mill, or they may be sawed from a 1-inch board by ripping the board lengthwise. If desired the top of the post can be finished with a taper by simply inserting a triangular block, as shown at C in Fig. 10. Never plaster the top of any post; instead, remove the end form when the concrete is green and smooth the surface with a trowel or float.

If straight instead of tapering posts are preferred, the same kind of a form as has just been described can be used for molding them except that the intermediate boards B are placed at right angles to the two long parallel boards instead of at an angle to them, as shown, making them 5 inches apart. The forms are now ready to fill and the quantity of materials for certain size posts can be taken from the following table:

QUANTITY OF MATERIAL FOR FENCE POSTS

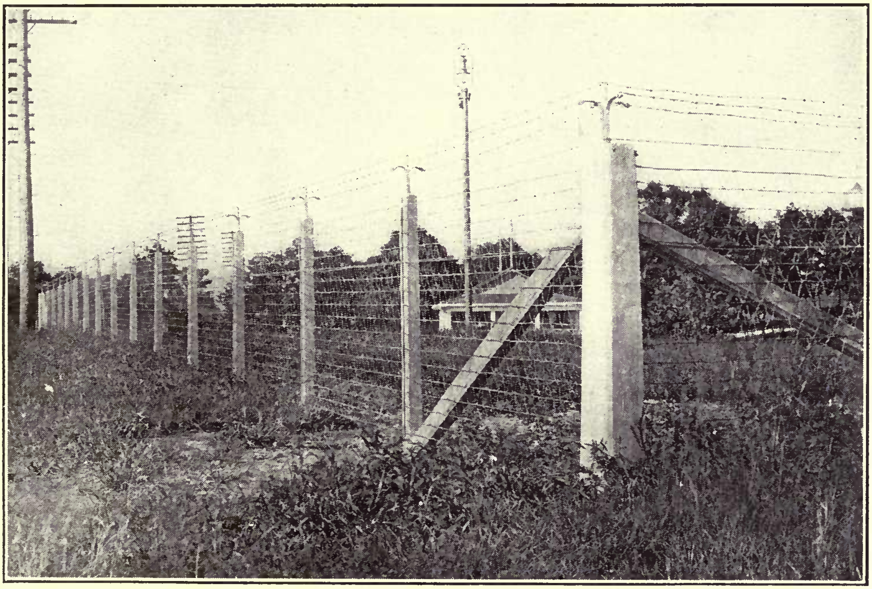
All Posts Are 4 x 5 Inches at Top; All Posts are 5 x 6 Inches at Bottom.
One-Half Small Single Load* of Sand Required per Barrel of Cement; One Small Single Load* of Screened Gravel or Stone Required per Barrel of Cement.
Proportion: 1 Part "Atlas" Portland Cement; 2 Parts sand; 4 Parts Gravel or Stone.

Length of Posts, Feet	No. of Posts per Barrel (4 Bags) of Cement	Weight per Post, Pounds
5	20	130
6	17	160
7	14	180
8	12	210
9	11	234

* Small single load = 15 cubic feet.

The posts should be made with one part "ATLAS" Portland Cement, two parts clean, coarse sand and four parts broken stone or gravel, about 1 inch diameter particles. Grease or oil the form and fill the bottom of the form with concrete to a depth of 1 inch, upon which place immediately two pieces of ¼-inch round or steel rods or No. 6 wire 1 inch in from each side and running the full length of the post. Then quickly fill the form to within 1 inch of the top with concrete, tamping the wet concrete slightly to drive out any air bubbles. Next place two more rods or wires, each 1 inch from each side and fill in the rest of the concrete, spading the faces of the posts next to the form boards to leave a smooth surface, and lightly trowel the top surface. The end boards and the boards between the posts must not be removed until the concrete is hard and the posts should not be handled or moved for at least ten days without danger of cracking them. They should be left for three or four weeks at least before using and kept damp by sprinkling. The surfaces of the posts do not need to be finished off in any special way, for they should be smooth enough without.

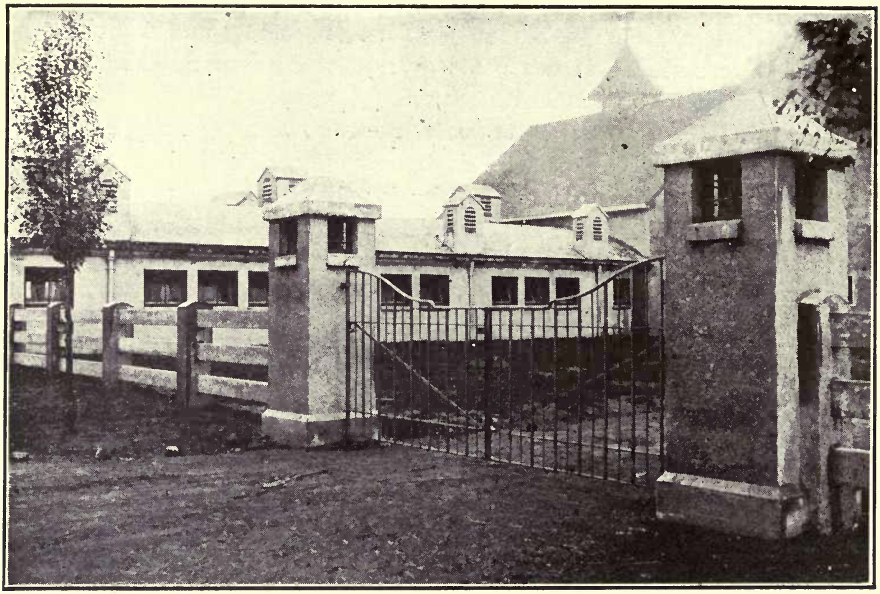
For fastening fence wire to the posts, the following method is suggested: Take a piece of No. 12 copper wire 12 inches long, bend it in two and twist the halves together, leaving the ends free for about 2 inches; these should be made beforehand. While the concrete is being placed in the forms set two or three of these copper wires in the concrete the proper distance for stringing



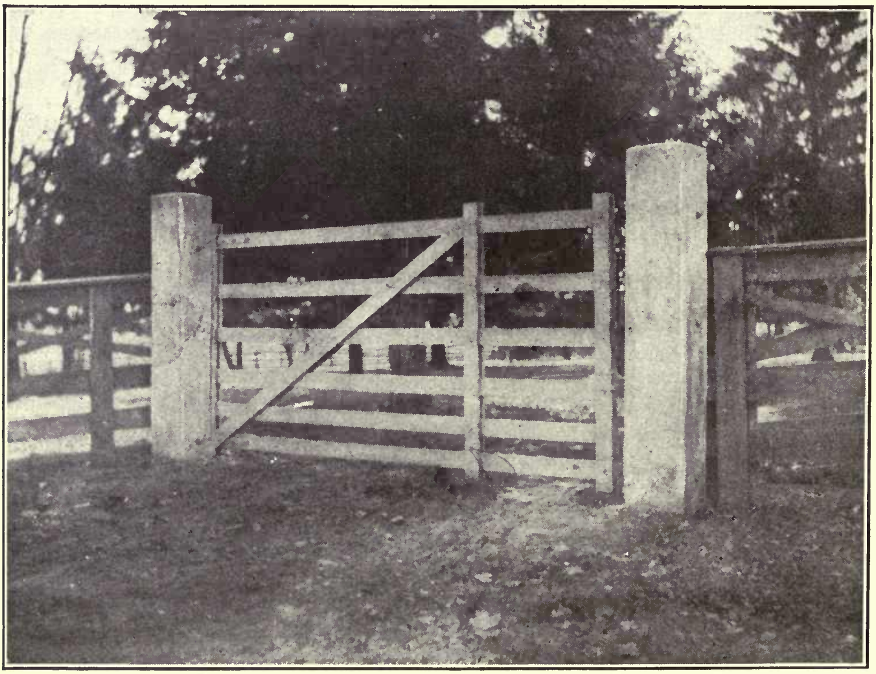
VIEW OF DELLWOOD PARK FENCE, JOLIET, ILL.

wires so that they will be imbedded in the post about 4 inches and leave the two free ends to project from the post about 2 inches. See cross section of post in Fig. 10.

Another very good method is to get a number of ½-inch or 1-inch round rods or wood dowells 6 or 8 inches long and place them vertically in the form the proper distance apart for stringing wires. To hold them in place nail a strip of wood across the top of the form beside the rod and drive a nail into this strip and bend the nail around the rod so as to hold it up against the strip. The rods should be well greased and left in the concrete about 1 day, when they can be removed. If they are not well greased it will be almost impossible to remove them without injuring the concrete. Through the holes



CONCRETE FENCE AT GEDNEY FARMS, WHITE PLAINS, N. Y.



CONCRETE GATE POSTS AT COLUMBIA, MO.

the fence wire can be strung, or a short piece of wire can be run through and the ends twisted around the running fence wire.

There are several other methods of providing the same means of attaching the fence wire to the posts. For instance, insert in place of the copper wire described above a galvanized screw eye and run the fence wire through it or attach it to the screw eye by means of wires.

CORNER POSTS. Corner posts should be made about 10 inches square the full length of the posts and 9 feet long. On account of the weight of such a large post it is easier to mold the posts in place, as they will weigh about 940 pounds, but if desired they can be made in the same manner as the other fence posts just described. Reinforce corner posts with a 3/8-inch rod in each corner of the post instead of the No. 6 wire used for the smaller ones. Set a corner post at least 3½ feet in the ground. If special finish is necessary, refer to method of treating horse blocks, page 43.

QUANTITY OF MATERIAL FOR CORNER POSTS

One-Half Small Single Load* of Sand Required Per Barrel of Cement; One Small Single Load* of Screened Gravel or Stone Required Per Barrel of Cement.

Proportions: 1 Part "Atlas" Portland Cement to 2 Parts Sand to 4 Parts Gravel.

Size of Posts			No. of Posts per Barrel (4 Bags) Cement	Weight per Post, Pounds
Length, Feet	Top, Inches	Bottom, Inches		
6	12	12	2¾	900
7	12	12	2½	1,050
8	12	12	2¼	1,200
9	12	12	2	1,350
9	10	10	3	940
9	6	6	8	337
7	24	24	½	4,200

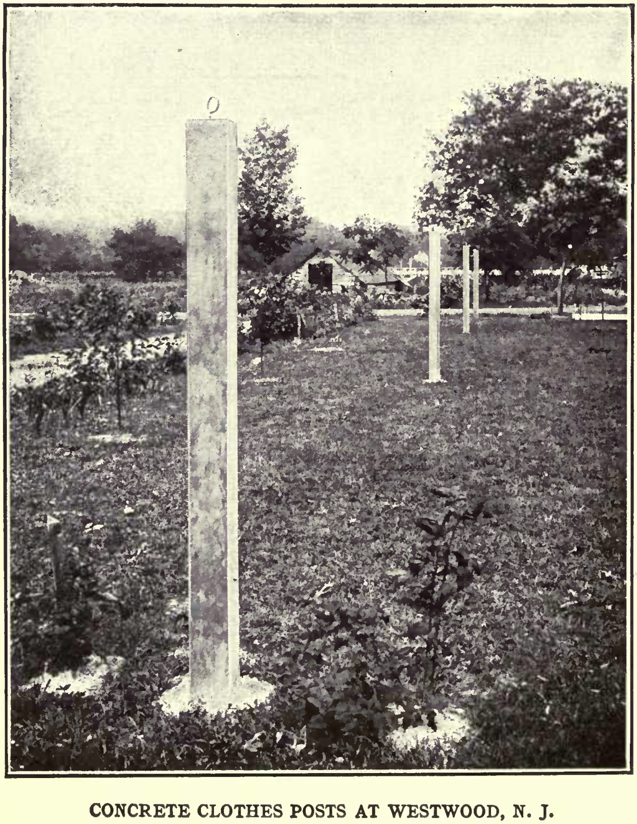
* Small single load = 15 cubic feet.

COST OF FENCE POSTS. Seven-foot fence posts constructed as described on page 36, without hiring outside help so that the cost of labor need not be considered, can be made for about 20c. to 30c. each. They will cost from 10c. to 20c. apiece more if the cost of labor is considered.

HITCHING POSTS. Hitching posts can be built and reinforced in the same manner as finished fence posts. Make a post about 6 feet long so that it will set about 2½ feet in the ground. Make forms and handle the concrete same as described above for fence posts. Cast a long ½-inch diameter iron staple, holding an iron ring, in the top of the post by passing it through a slot in the head of the form before the concrete is poured, just as the staple is placed in the clothes post described on page following.

A neat and inexpensive round hitching post may be designated as the "stove-pipe" hitching post. Dig a hole 18 inches deep and 10 inches in diameter in the ground and fill with one part "ATLAS" Portland Cement, two parts of clean, coarse sand and four parts of screened gravel or broken stone. Place on this base of concrete, before it has set, a section of 7-inch stove pipe. For reinforcement place a 1-inch gas pipe in the center of the stove pipe and push it into the soft base of concrete. Insert in top of post a round hitching post ring. Leave the stove pipe in place and paint it if desired, which makes a very neat and attractive post. When the stove pipe rusts off, the concrete post still remains as attractive as ever.

STOVE-PIPE HITCHING POST AT COLUMBIA, MO



CONCRETE CLOTHES POSTS AT WESTWOOD, N. J.

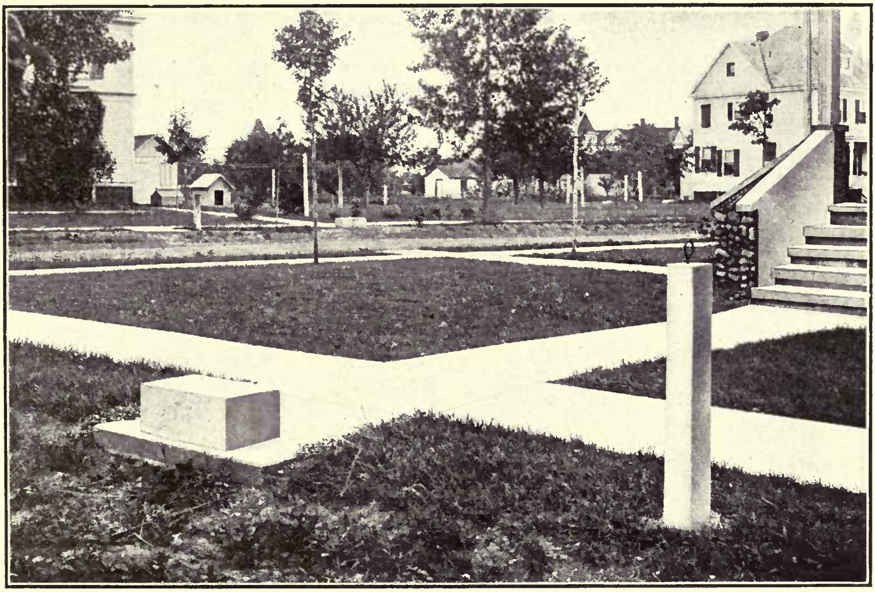
CLOTHES POSTS. Clothes posts may be made in the same general way as the finished fence posts, except that they should be 6 inches square, 9 feet long, and reinforced with 3/8-inch rods in each corner instead of No. 6 wire. Imbed an iron staple 1/2 inch in diameter in the top of the post for a clothes line. This can be done by cutting a hole in the head of the form large enough to pass the eye of the staple through, then placing the staple before the concrete is poured and hold it in place by a wad of paper to plug the hole. Another plan is to form a hole near the top of the post by placing a greased dowel in the form before pouring the concrete.

HORSE BLOCKS.

Horse blocks can be built solid in place.

Make a form or box, without a bottom, 36 inches long, 18 inches wide and 12 inches deep, inside dimensions. Grease this form and fill with concrete, one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand and five parts screened gravel or broken stone.

It is best not to plaster the top surface or sides of the block, for if it is plastered it is apt to crack or peel off. The top surface should be smoothed off with a trowel when the concrete is first laid, then in a few hours, as soon as it has begun to stiffen, scrape off any light colored scum with a wire brush or



HORSE BLOCK, HITCHING POST AND SIDEWALK AT WESTWOOD, N. J.

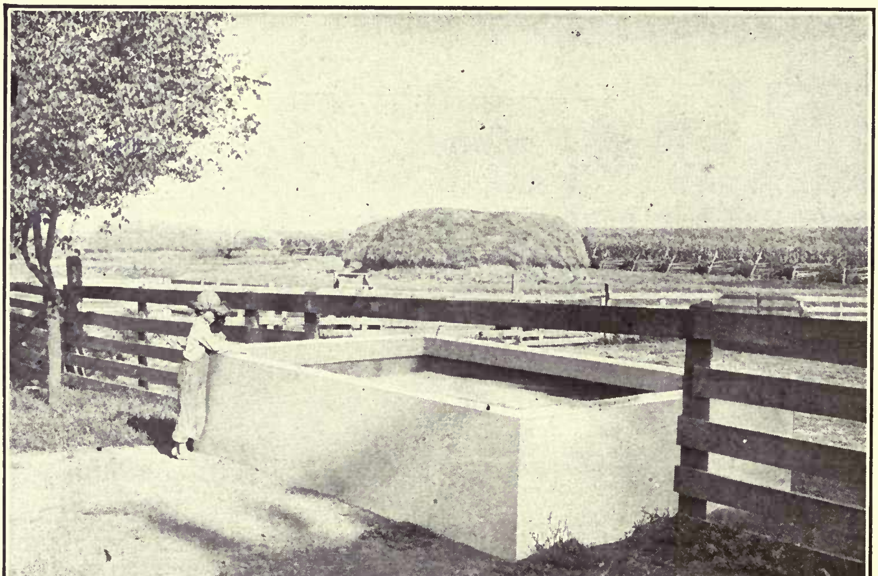
horse curry comb, and trowel the surface again, preferably with a wood float, but using no fresh mortar. The form should be removed the next day, or as soon as the concrete is hard enough not to show thumb marks, and while the concrete is green rub down the sides with a wood float or brick. Keep damp by sprinkling for a week. If the surface thus left is not good enough, it may be necessary to plaster it, even though at the risk of checking and cracking. To do this pick the surface with a stone axe, wet thoroughly and trowel on a coat of mortar one part "ATLAS" Portland Cement to one part clean, fine sand, making the layer not over 1-16 inch thick.

The weight of a horse block of the above dimensions is about 675 pounds and about two bags of cement are needed.

WATERING TROUGHS.

One of the most useful and essential devices about a farm is the small watering trough, and when made of concrete it is not only of pleasing appearance, but is practically indestructible. Moreover, if an inlet pipe with float valve connection has been provided it needs absolutely no attention.

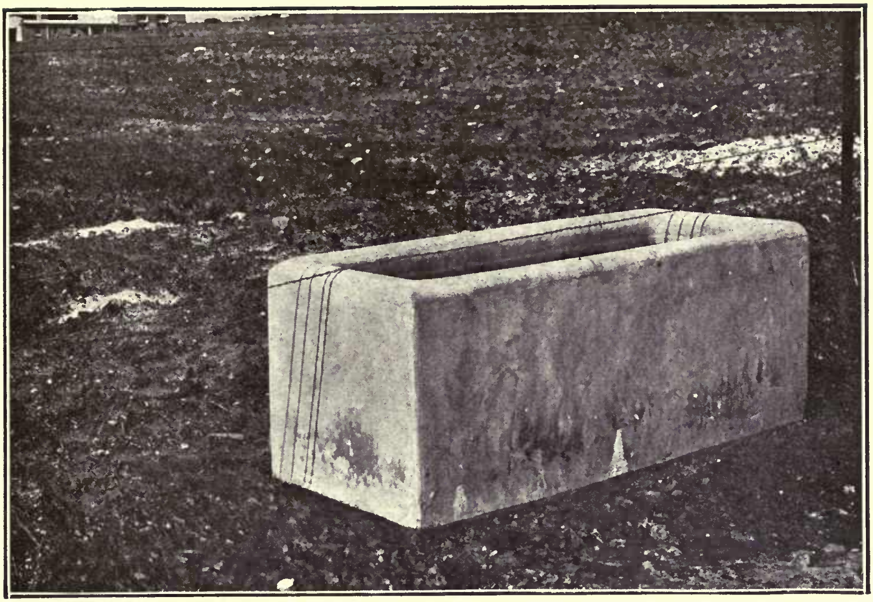
Watering troughs, like many other concrete structures, may be made without steel reinforcement, but if so constructed the walls must be half again as thick as when reinforced, and even then are more apt to crack. The size and capacity of the trough varies with the purpose for which it is used, but



WATERING TANK, BOODY, ILL.

for troughs up to about 10 feet long by 2 feet wide by 2 feet deep the thickness of the reinforced walls should be about 5 inches.

It is essential that a watering trough be water-tight. The conditions for obtaining a trough which will not leak are (1) a richer mix of concrete than is required for ordinary work; (2) enough water in mixing to give a sloppy concrete, and (3) the placing of all the concrete at one operation. It is extremely difficult to make any structure water-tight unless all three of the above conditions are complied with.

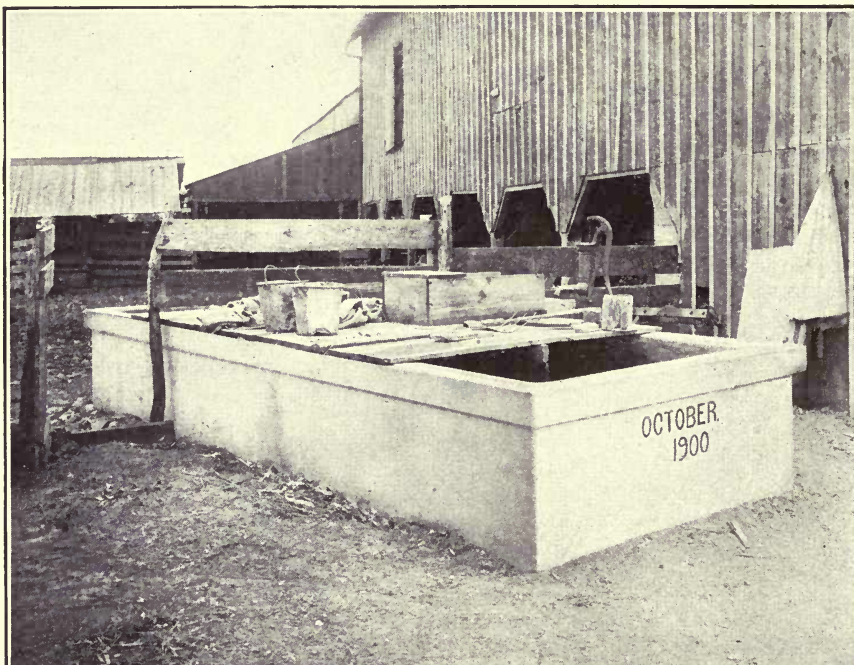


FIELD TROUGH AT GEDNEY FARMS, WHITE PLAINS, N. Y.

WATERING TROUGH AT BERRY HILL, L. I.

The best mix of concrete to use varies with the sand and gravel employed, but generally speaking one part of "ATLAS" Portland Cement to one and one-half parts of clean, coarse sand to three parts of screened gravel or broken stone are advised, or if gravel from the natural bank is used without screening, one part of "ATLAS" Portland Cement to three parts of natural bank run gravel. If sand alone is available use one part "ATLAS" Portland Cement to two parts sand.

The amount of excavation necessary for the foundation of a trough depends upon the size. For a small trough level off the earth and tamp the ground well before placing any concrete, but for a trough of large capacity a solid

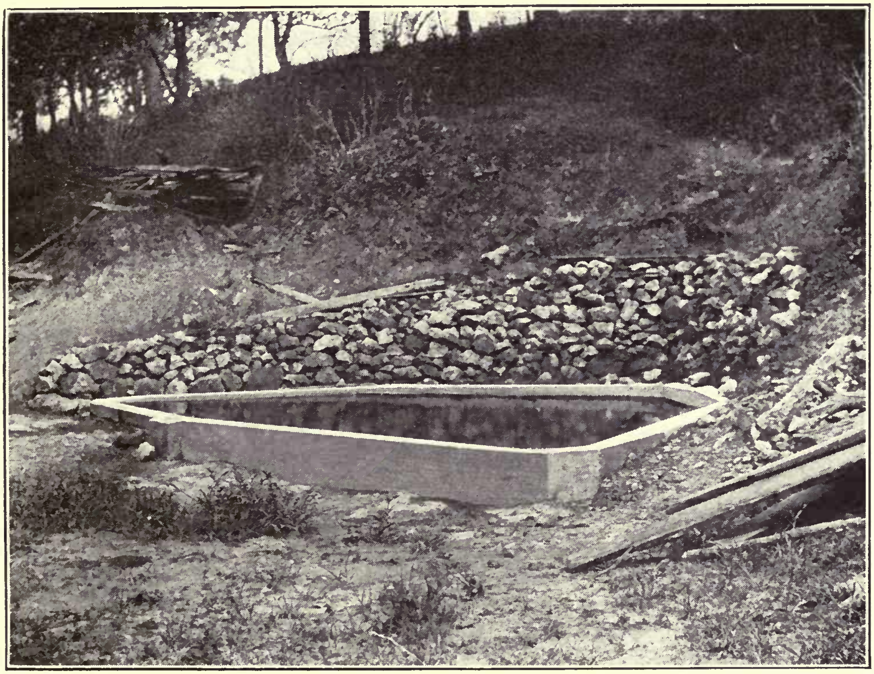


WATERING TROUGH, DECATUR, ILL.

foundation should be used. To construct a solid and reliable foundation, excavate about 12 inches and fill in 6 inches with either cinders or gravel from which the sand has been screened, tamp this well and fill in 6 inches of concrete, using only half the proportion of cement to sand and stone that is used for the trough itself.

Next place the outer forms in position, brace and oil them well and mix the concrete according to the directions given on page 24.

Place a 2½-inch layer of concrete in the form, and immediately after placing and before the concrete has set, place a sheet of woven fence wire or some other wire fabric over the concrete, bending it up so that it will come to within one inch of the top of the forms at the sides and ends. Place 2¼ inches more of the concrete in the bottom and ram lightly to bring the mortar to the surface and smooth it off evenly. Have the inner form all ready and as soon as the base is laid and before it has begun to stiffen set it, taking care to keep it at equal distances from the sides, and then immediately fill in the concrete between the outer and inner forms to the required height. The time at which to remove the form depends upon several conditions, such as the wetness of the concrete, the weather and the temperature, but generally



FIELD WATERING TROUGH, KNOXVILLE, IOWA

such forms can be removed within two days. After removing the forms, wet the concrete thoroughly and paint the inside surface with pure "ATLAS" Portland Cement mixed as thick as cream. Protect the trough from the sun until it is filled with water keeping it wet for about a week. Do not fill with water until a week after laying the concrete.

The outside surface can be finished off very satisfactory if done as soon as the forms are removed by wetting the surface thoroughly with a whitewash brush, using plenty of water, and rubbing it down with a wood float or board or a brick. This will remove the marks of the form boards and make a very pleasing appearance. (See directions for Finishing Concrete Surfaces, page 27.) A long trough is difficult to build because of the great amount of reinforcement required to prevent shrinkage cracks.

Where the trough is to be connected with an inlet and outlet pipe, it is best to place the necessary pipes and connections in the forms before laying the concrete. This will save a great deal of labor and trouble, but where these connections cannot be made before placing the concrete, the holes for them may be provided in the concrete by inserting greased wooden plugs in the forms in place of the pipes. These plugs can be easily withdrawn as soon as the concrete has set.

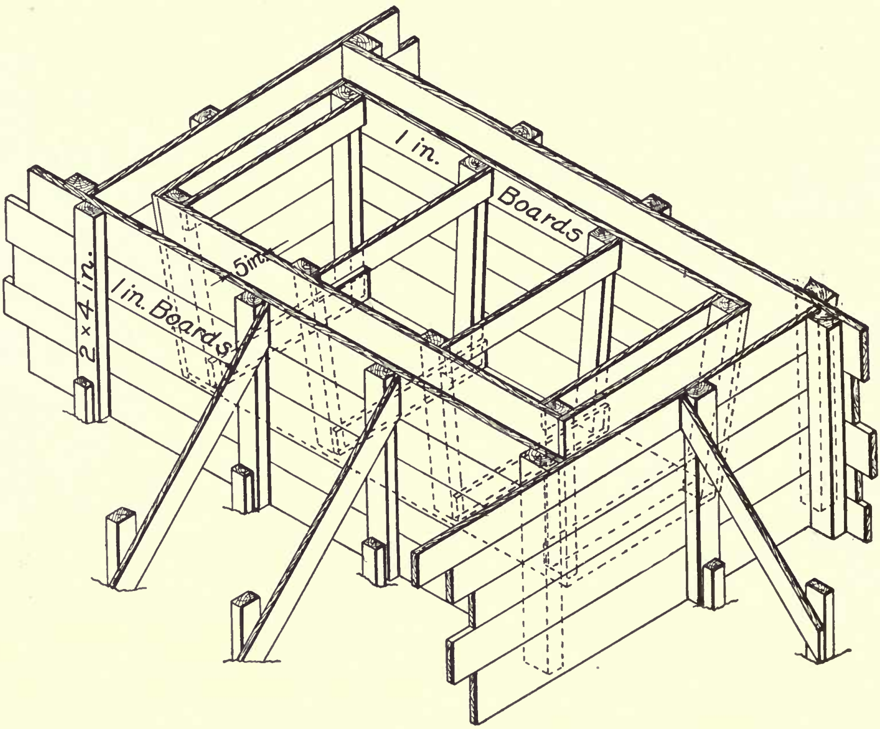
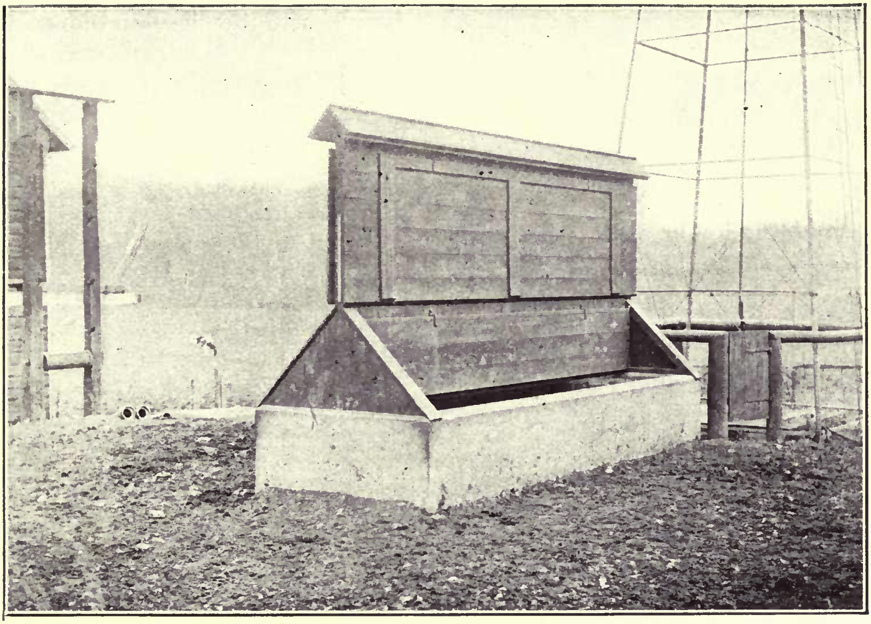
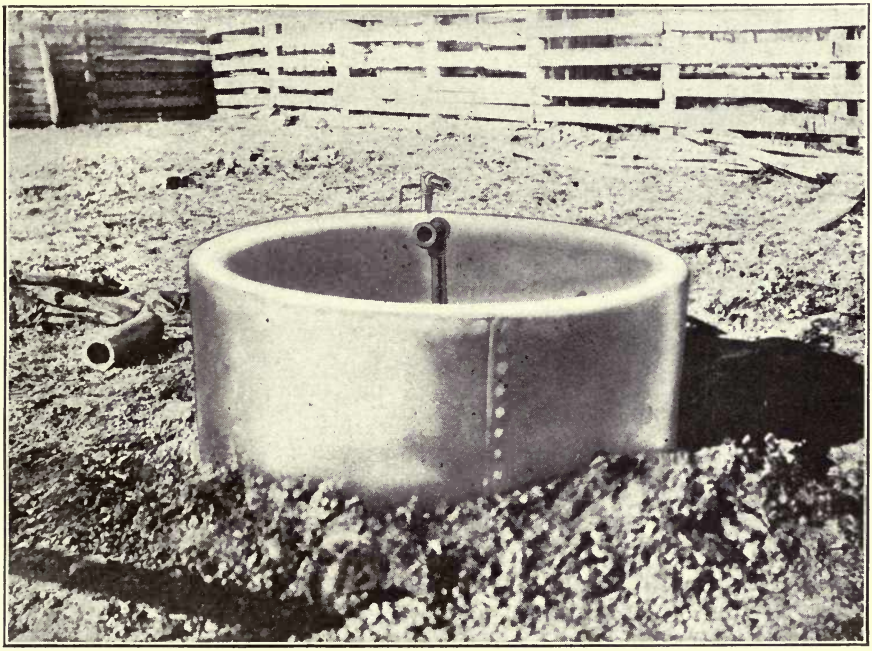


Fig. 11. Design of Forms for Rectangular Trough.

The design of forms for a rectangular trough, shown above, is economical in that the lumber for the outside forms does not need to be cut unless desired, and can therefore be used for any other purpose, being practically as good as new.



WATER TROUGH AT MONROE, N. J.



OLD BOILER TANK WATERING TROUGH AT COLUMBIA, MO.

Were it not for the more complicated form work, the circular shaped tank would be built oftener because of the attractive effects which can be produced.

A simple and attractive circular form for a small watering trough is shown in Fig. 12. It is made as follows:

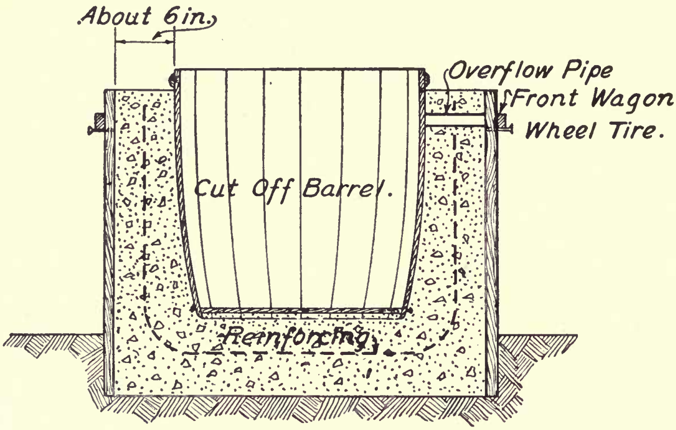


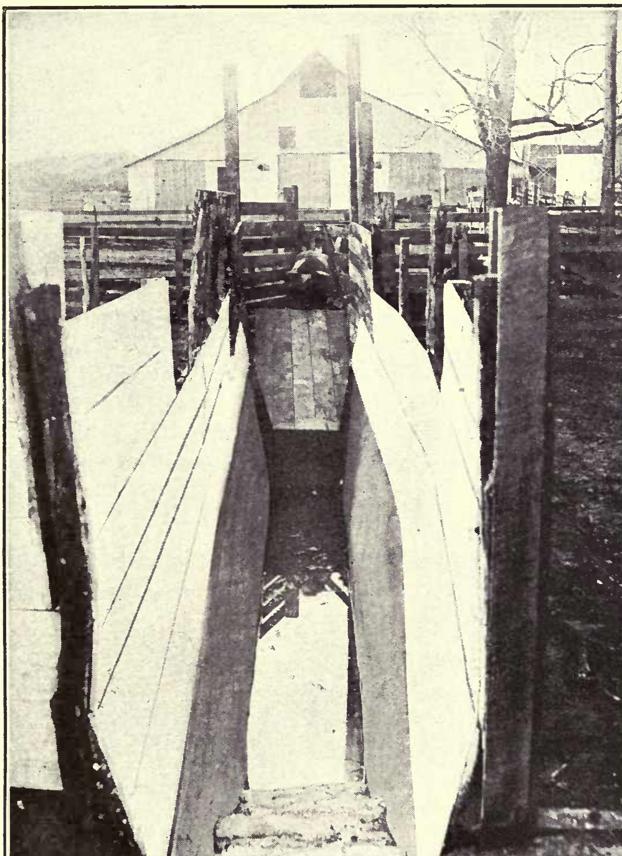
Fig. 12. Design of Forms for Circular Trough.

Take an old wagon or buggy tire, lay it on the ground, and mark a line on the inside of the tire. Excavate inside of tire 6 inches deep and place endwise three 1 by 2-inch stakes about 3 feet long on the inside of the tire. Raise the tire 2 feet above the ground to make the total inside depth of the trough 3 feet, and drive a nail in each of the three stakes under the tire to support it at this height. Fill in the circle between these three stakes with slats or flooring boards set on end and place a nail in each under the tire to hold them at the top. To hold them at the bottom tamp a little sand at the foot of the stakes. Mix one part "ATLAS" Portland Cement to one and one-half parts of clean, coarse sand to three parts of screened gravel or broken stone and lay about 4 inches of concrete. Place the reinforcement as described for rectangular troughs, running it up on the sides so that it is about 2 inches from the outside surface. After placing the reinforcement the rest of the operations are the same as for a rectangular trough. The inside form may be made by sawing a barrel in two, nailing each of the barrel staves to the head of the barrel, and removing all but the top hoop. The construction of the inside barrel form is clearly shown in Fig. 12. Oil the forms well before placing the concrete.

The materials required for a circular trough like this are 3½ bags of "ATLAS" Portland Cement and 1 single load of sand and gravel. Two men can make a trough in about one-half day each, and the cost is approximately $4.00 complete.

A single load of sand or gravel is considered as 20 cubic feet, or ¾ of a cubic yard, and a double load as 40 cubic feet, or nearly 1½ cubic yards.

A method of constructing a circular trough where a cut off section of an old boiler was used, not only for the exterior form, but also as the outside finish, is shown on page 49. This style of trough, although rather attractive, is more expensive than the one just described on account of the cut off boiler section, which in this case was about $10.00.



DIPPING TANK AT CHILLICOTHE, OHIO

HOG TROUGHS. A desirable hog trough can be made by building a bottomless box 6 feet long and 12 inches broad by 12 inches deep. From a 2-inch plank saw out two triangles having a base of 12 inches and a height of 8 inches. Place these 5 feet 6 inches apart and nail a plank 1 inch thick on each side of the triangle. Place the inverted V-shaped trough thus made inside the bottomless box and put small triangular strips around the edges to make a square edge. (See Fig. No. 13.) Grease the form thoroughly and fill the space left with concrete mixture, one part "ATLAS" Portland Cement and three parts clean sand or sandy gravel, tamp lightly, and smooth off to top of box. Let stand until dry. Remove the inner forms within 3 or 4 hours, and paint the inside with pure "ATLAS" Portland Cement, mixed as thick as cream.

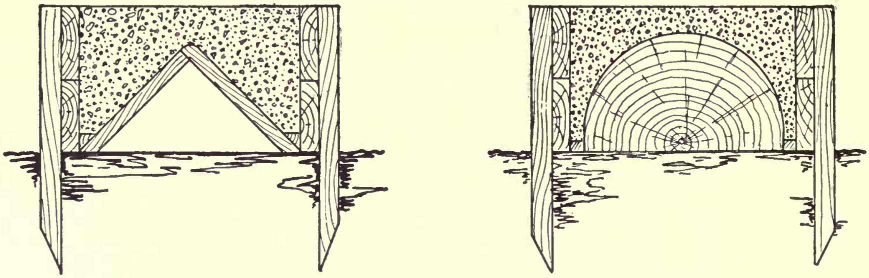


Fig. 13. Forms for Hog Troughs.

Should a trough with a round bottom be desired, an inner form can be made by sawing a log the right length, stripping it of bark, and splitting in half. Put this in the bottomless box described above, flat side down (Fig. No. 13), grease well and proceed as with triangular trough.

SLOP TANKS.

Every farm should have one or more slop tanks, in order to heat the slop and prevent it from freezing, so that the cattle can be fed no matter how cold it may be.

Slop tanks of concrete have proved satisfactory. A concrete slop tank should be made of one part "ATLAS" Portland Cement to two and one-half parts clean, coarse sand to five parts of screened gravel or stone. The size shown in Fig. 14 will require 12 bags of cement, 1½ single loads of sand (20 cubic feet per singe load) and 3 single loads of screened gravel, or better still, clean cinders.

A 36-inch iron kettle, having a capacity of 75 gallons, costs about $7.00 in the city market, to which the freight must be added. The forms are very simple, and can be easily made by a man in a day. The inner form need not be removed, but can be burnt out the first time a fire is built in it. The tank must be well reinforced in order to keep it from cracking, due to the difference in temperature to which the tank is subject. The firing is done from the door left in the front and the stack takes care of the draft. Do not build a fire in the tank until the concrete has set for at least two weeks.

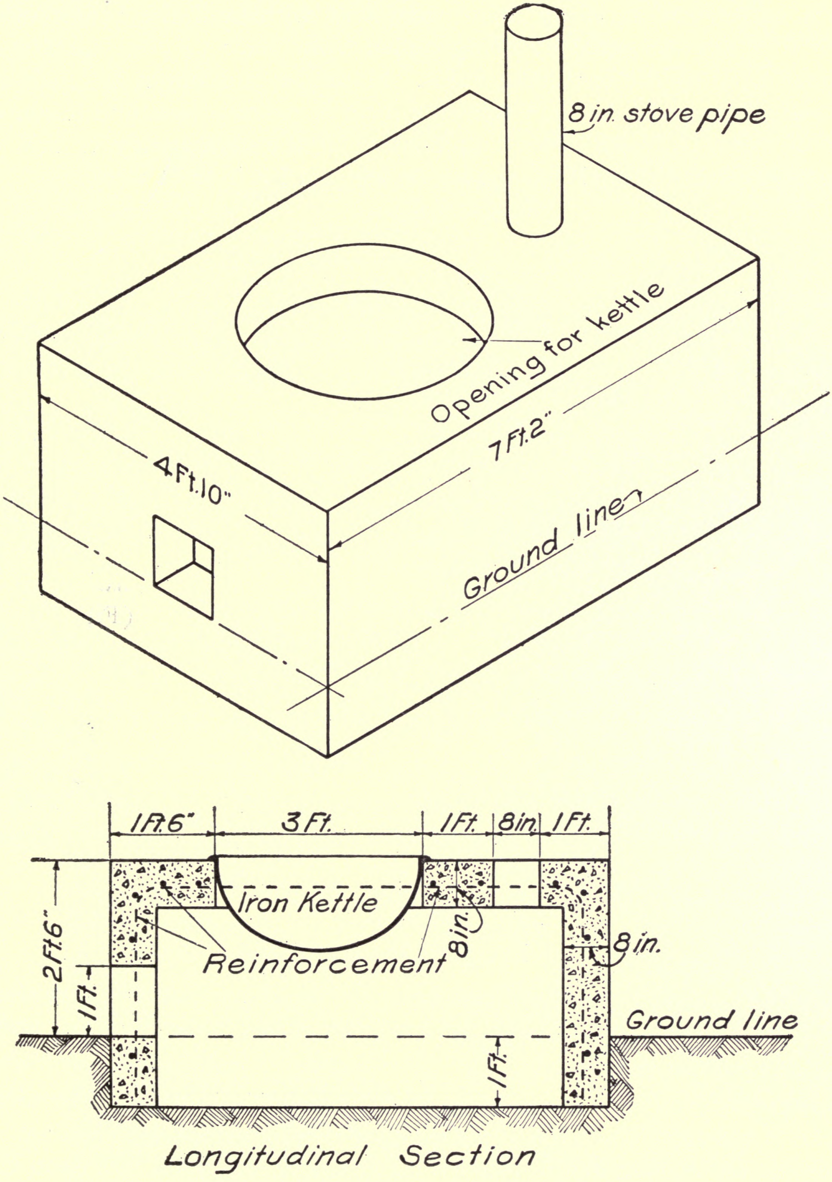
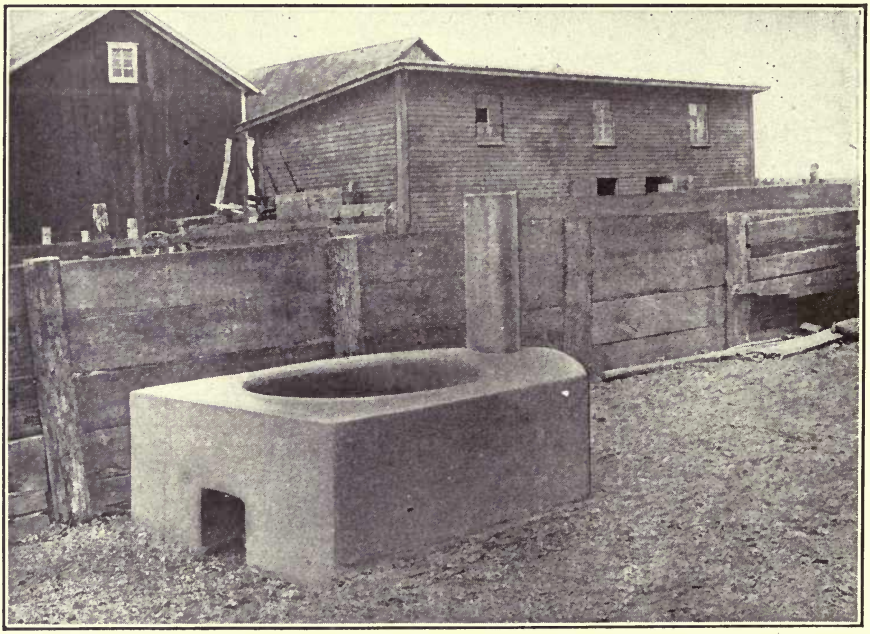


Fig. 14. Concrete Slop Tank.

FERTILIZING TANKS.

Fertilizing tanks should be made about the shape of and a little larger than a barrel. If carefully made they will withstand the rough usage to which they are subjected by being pulled from place to place on drags, and are unaffected by the fertilizing fluids. Make the tank about 2½ inches thick and well reinforced. As soon as inside form is removed wet and brush with a layer of pure "ATLAS" Portland Cement of the consistency of thin cream to make it water-tight. Keep the inside wet until it is to be used.

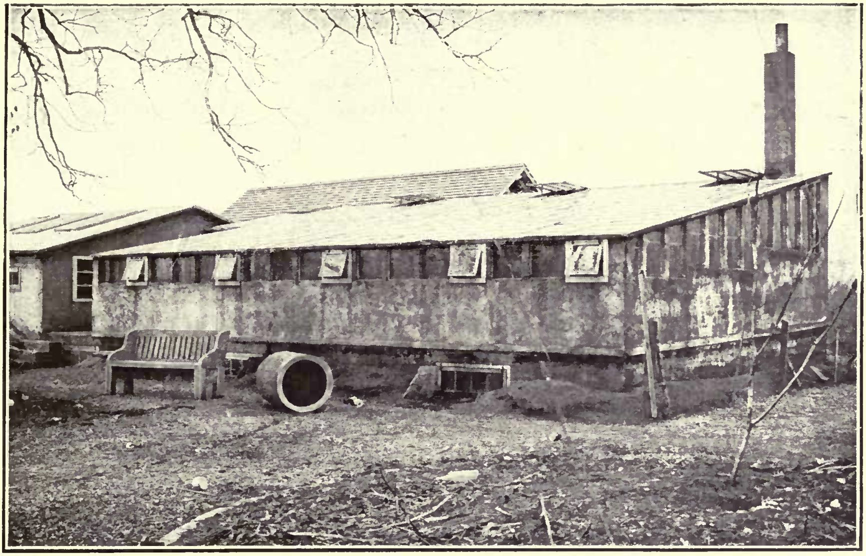


SLOP TANK AT MORTON, ILL.

RAIN LEADERS.

Rain leaders or gutters are best constructed of concrete because they can be made for a very small cost, need no forms, are indestructible, and very attractive.

Excavate a trench 4 inches deep by 9 inches wide in the sand or dirt from the end of the rain conductor to the required distance from the building. Make a small batch of concrete, in proportions one part "ATLAS" Portland Cement to four parts unscreened sand and gravel, and fill the trench, hollowing out the surface and troweling a little to form the trough. The water may be carried under the surface if desired by digging a deeper trench, placing it in a



FERTILIZING TANK, GREENHOUSE AND RUSTIC SEAT AT WESTWOOD, N. J.

RAIN LEADERS, DUMONT, N. J.

length of tin or sheet-iron pipe and surrounding this with concrete. When the pipe rusts out, the concrete tube will still remain.

RETAINING WALLS.

Concrete retaining walls in most localities cost much less than rubble masonry. The design of the retaining walls shown in Fig. 15 is what is known as the gravity section, which means that the earth pressure is resisted by the weight of the wall. The following table gives the necessary dimensions and

RETAINING WALL AT DUMONT, N. J.

the amount of materials per foot of length of wall. The amount of material is figured, assuming that the concrete is made of one part "ATLAS" Portland Cement, two and one-half parts of clean, coarse sand, and five parts of screened gravel or stone. The foundation, as shown, is taken 4 feet below the ground level. In the Southern States, 3 feet, or even 2 feet, will be sufficient to get below the frost line.

The exposed side or face of the retaining wall can be finished off in the same manner as described on page 27. The top surface must not be plastered or it will crack and is apt to peel off. The surface should be smoothed off with a trowel when the concrete is first laid, then as soon as it has begun to stiffen scrape off any light-colored scum with a wire brush or old curry comb, wet slightly, and trowel it, preferably with a wood float, but using no fresh mortar.

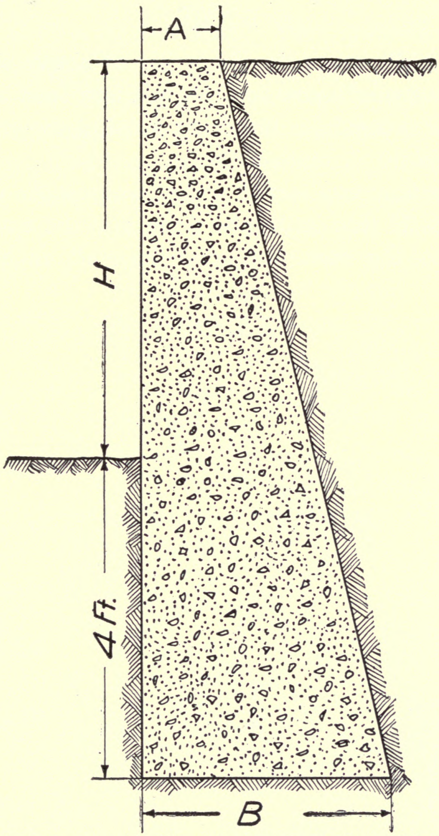


Fig. 15. Design for Retaining Wall.

DIMENSIONS OF RETAINING WALLS AND QUANTITY OF MATERIALS FOR DIFFERENT HEIGHTS OF WALL.

Proportions: 1 Part "Atlas" Portland Cement to 2½ Parts Sand to 5 Parts Gravel or Stone.
(See Figure 15.)

Height of Wall Above Ground H	Total Height of Wall	Thickness at Base B		Thickness at Ground Level		Thickness at Top A	Amount of Materials per One Ft. Length of Wall		
							Cement	Sand	Gravel or Stone
Feet	Feet	Ft.	In.	Ft.	In.	Inches	Bags	Cu. Ft.	Cu. Ft.
2	6	2	2	1	6	10	1¾	4½	9
3	7	2	5	1	7½	10	2½	5½	11
4	8	2	9	1	11	12	3	7	14
5	9	3	2	2	1	12	3½	9	19
6	10	3	6	2	4½	15	4¾	11½	23
7	11	3	10	2	8	18	6	14	28
8	12	4	2	2	10	18	7	16½	33

Note:—A large single load of sand or gravel is about 20 cubic feet.
A large double load of sand or gravel is about 40 cubic feet.

If a dam is to be built more than 4 or 5 feet above the bed of the stream, an engineer should be called upon to design it and look after the construction.

For an ice pond or a pond for watering stock a concrete dam may be built across a brook without difficulty.

If possible, dig a temporary trench so as to carry the water around the dam while it is being built. If this cannot be done, run the water through a wooden trough in the middle of the dam, and after the wall, each side of it, is finished,

DAM AT ARLINGTON, VA.

carry the forms across the opening, and make these tight enough so that the water is quiet between them; then place the concrete as described on page 26.

Dig a trench across the stream slightly wider than the width of the base of the dam, carrying it down about 18 inches or 2 feet below the bed of the brook, or if the ground is soft, deep enough to reach good, hard bottom. In case the earth is firm enough for a foundation, but is porous either under the dam or each side of it, sheet piling consisting of 2-inch tongued-and-grooved plank can be pointed and driven with a heavy wooden mallet so as to prevent the water flowing under or around the dam. Build the forms so as to make the wall of the dimensions shown in the table. Wet them thoroughly, then mix and place the concrete as described on page 24.

Use proportions one part "ATLAS" Portland Cement to two parts clean, coarse sand to four parts screened gravel or broken stone.

Take special care to make the concrete water-tight by using a wet mix. If possible, lay the entire dam on one day, not allowing one layer to set before the next one is placed. If it is necessary to lay the concrete on two different days, scrape off the top surface of the old concrete in the morning, thoroughly soak it with water, and spread on a layer about ¼ inch thick of pure cement of the consistency of thick cream, then place the fresh concrete before this cement has begun to stiffen.

If the forms on the lower side of the dam are well braced, the forms on the upstream side may be removed in three or four days, and the pond allowed to fill. The forms on the downstream face should be left in place well braced for two or three weeks. No finish need be given to the surface.

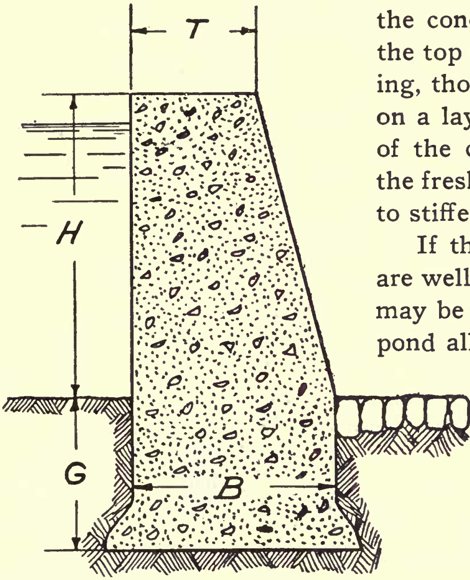


Fig. 16. Design for Dam.

DIMENSIONS FOR SMALL DAMS AND QUANTITY OF MATERIALS FOR DIFFERENT HEIGHTS OF DAMS.

Proportions: 1 Part "Atlas" Portland Cement to 2 Parts Sand to 4 Parts Gravel or Stone. (See Fig. 16.)

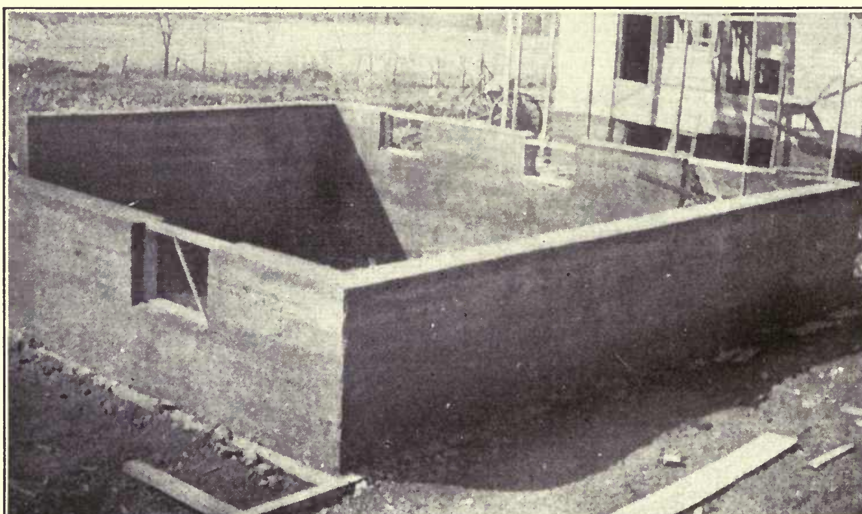
Height Above Bed of Stream	Depth Below Bed of Stream*	Thickness at Base	Thickness at Top	Amount of Materials per Foot of Length of Dam		
				Cement	Sand	Gravel or Stone
Feet H	Feet G	Feet B	Feet T	Bags	Cu. Ft.	Cu. Ft.
1	1½	1	1	½	¾	1½
2	1½	1	1	1	1½	3
3	1½	2	1½	1¾	4	8
4	2	2	1½	2¾	5	10
5	2	2½	1½	3½	6¾	13½
6	2	3	1½	4½	8¾	17½

* Make deeper if necessary to get a good foundation.
Note:—A large single load of sand or gravel is about 20 cubic feet.
A large double load of sand or gravel is about 40 cubic feet.

WALLS.

Concrete walls are everywhere being built in preference to stone, on account of the lower cost and thinner walls which are usually required. Unless stone can be laid at practically no expense, the concrete is cheaper.

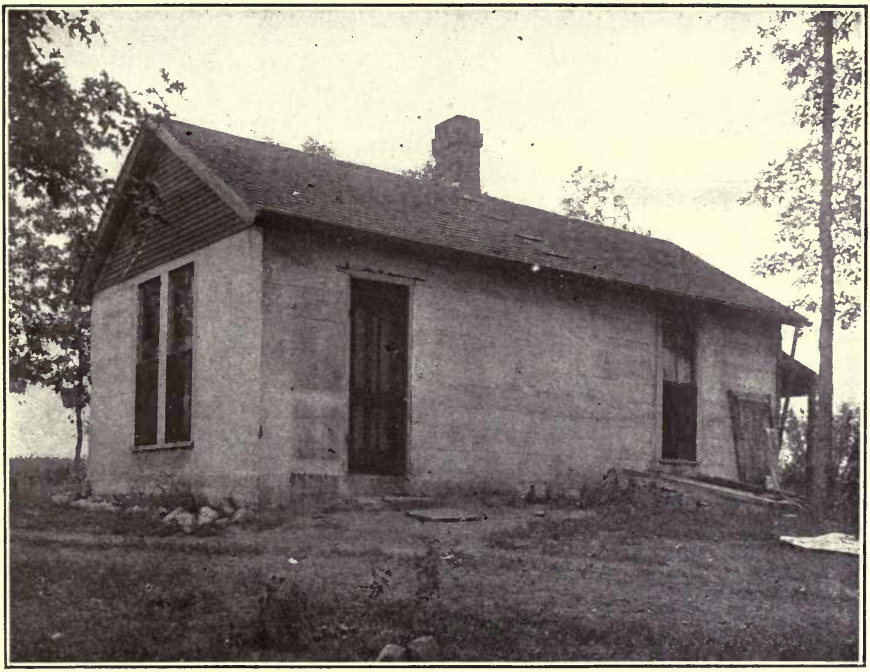
Every wall should have a footing, that is, a base wider than the wall it supports, and must be carried down below the frost line. The depth of such footings, therefore, must be varied according to the section of country in which the work is being done. In general, they should be about 4 feet below the ground level in the Northern and Middle States, and about 3 feet in the Southern States, while in very mild climates 2 feet will be sufficient. The footing should be not less than 4 to 6 inches thick and should extend about the same distance each side of the wall.



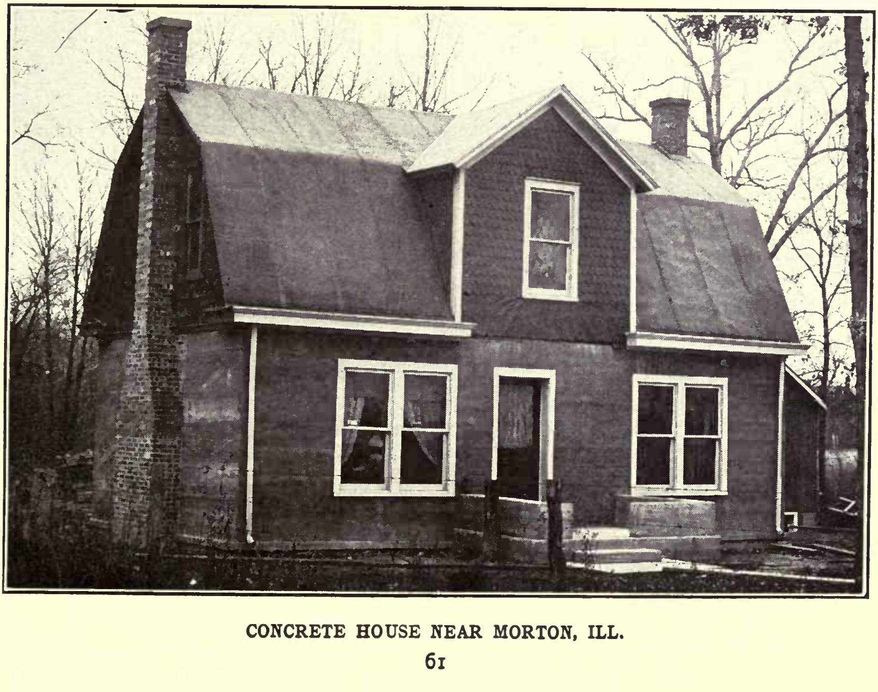
HOUSE FOUNDATION AT SUMMIT, N. J.

Care must be taken to see that the foundation is not placed on a soft and yielding soil. Where the soil is unsuitable, either excavate until rock or a better material is found, fill in up to frost line with gravel and tamp it well while placing. When there is any danger of this filling of gravel forming a pocket in which the water will accumulate, dig a ditch away from the wall so that the water will run off.

CELLAR AND BASEMENT WALLS. Cellar or basement walls must withstand the earth pressure that comes upon them. This pressure varies with the depth of the cellar or basement, and hence the thickness of the walls



CONCRETE HOUSE AT DECATUR, ILL.



CONCRETE HOUSE NEAR MORTON, ILL.

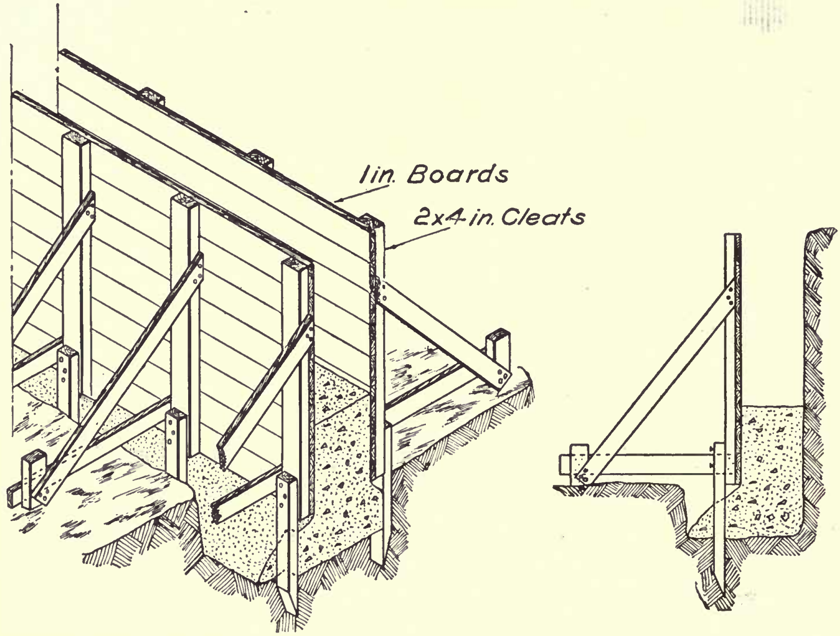
should vary with the depth as shown in the following table:

THICKNESSES OF WALLS AND QUANTITIES OF MATERIALS FOR DIFFERENT HEIGHTS OF BASEMENTS.

Proportions: 1 Part "Atlas" Portland Cement to 2½ Parts of Sand to 5 Parts of Gravel or Stone.

Height of Basement	Depth of Foundation Below Ground Level	Thickness of Wall at Bottom	Thickness of Wall at Top	Cement per 10 Ft. of Length of Wall	Sand per 10 Ft. of Length of Wall	Gravel or Stone per 10 Ft. of Length of Wall
Feet	Feet	Inches	Inches	Bags	Cubic Feet	Cubic Feet
6	4	6	6	6	14½	29
8	6	10	8	12	29	58
10	8	15	10	24	57	114

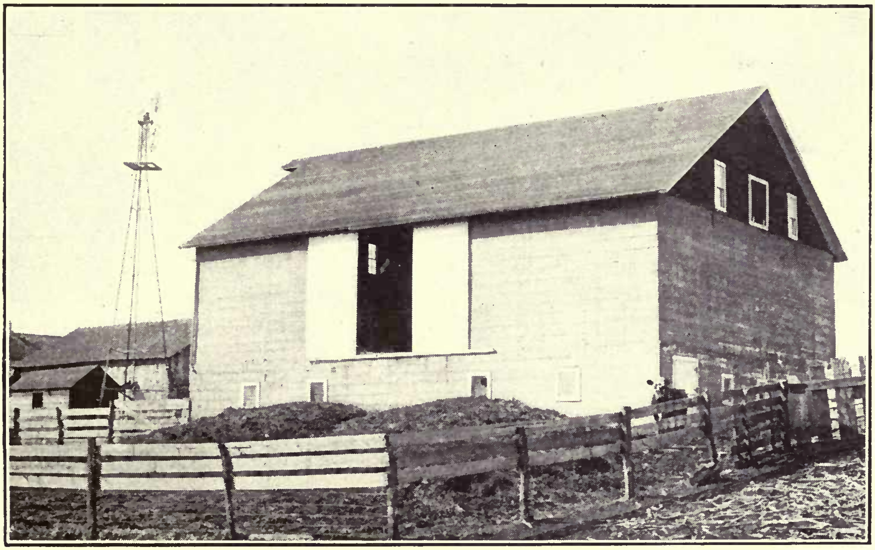
The thicknesses are less than for a retaining wall out of doors because the weight of the building and the floor timbers strengthen it. The back of the wall may batter or slope to save concrete. If vertical use bottom thickness for the full height. The earth must not be filled in against the back of the wall until three or four weeks after placing the concrete unless the forms and bracing are left in place in front.



a Fig. 17. Cellar Wall Forms. *b*

Where there is no earth pressure against the wall let the forms remain not less than 24 hours, or until the concrete will withstand the pressure of the thumb.

Fig. 17 illustrates a simple design for cellar or foundation walls: (a) of the figure represents view of an ordinary form, 2-inch by 4-inch braces being attached to the studs as braces; the form sides do not extend to the bottom so as to allow the concrete to flow out and form a spread footing; (b) represents a wall for which the bank of earth serves as one side of the form. This condition may occur when the soil is of a clayey nature, which does not cave in, or where the new wall is being built against an old one.



CONCRETE BARN AT TAMPICO, ILL.

Cellar or basement walls should be laid with one part "ATLAS" Portland Cement to two and one-half parts coarse sand and five parts of broken stone or screened gravel.

As concrete is the best material for cellar walls or footings of any kind, it is often used for this purpose even where the rest of the building is of wood or any other material. The building foundation should be brought up to the required height above the ground level. To attach the wood superstructure to the concrete foundation place on the concrete, imbedding it in mortar, the wood sill, which is made with the ends halved and bolted together. In the West, where the winds are very strong, this sill must be bolted to the concrete; this is done by placing occasional bolts in the concrete when laying it, letting the nut end protrude above the foundation to bolt through the sill. Holes can then be bored in the sill to fit over the protruding bolts and the nuts placed, thus firmly securing it.

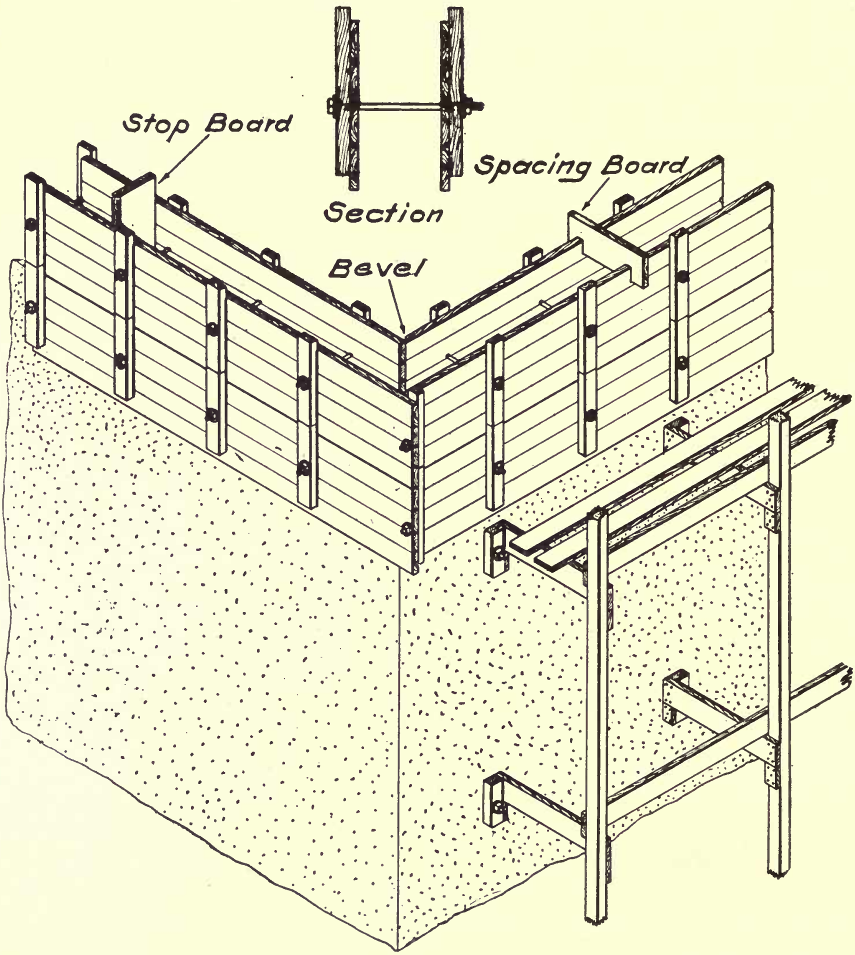


Fig. 18. Wall Forms.

WALLS ABOVE CELLAR OR BASEMENT. Concrete walls above the cellar may be built either as a single solid wall or as two walls with an air space between them. Such an air space renders the building less subject to changes of temperature and more completely moisture proof, but it is more expensive.

A solid concrete wall 6 inches thick is at least equivalent to 12 inches of brick. Walls 6 inches in thickness should be reinforced with vertical rods

WARNING

Many people have been confused by the meaning of Portland Cement and accept any cement bearing the word "Portland." The word "Portland" signifies only the kind of cement, *but does not designate the brand*.

Specify the word "ATLAS" when buying cement and you will get the best.

There is but one grade of ATLAS Portland CEMENT—the best that can be made—the same for everybody.

¼ inch in diameter placed 18 inches apart and with horizontal rods ¼ inch in diameter placed 12 inches apart. Additional rods must be placed at corners and diagonally across the corners of all openings. Walls of small buildings, such as hen houses, may be made 4 inches thick with the same reinforcement described. Where hollow wall construction is used, make each of the walls 4 inches thick and about 9 inches apart, and tie together with galvanized-iron strips, or place piers of concrete 4 feet apart to connect the two together. Where such piers are used they are built at the same time as the two walls, making practically one wall with air chambers at regular intervals. A very simple method to construct a hollow wall is by using 2-inch planed plank, as shown in Fig. 31 (p. 102).

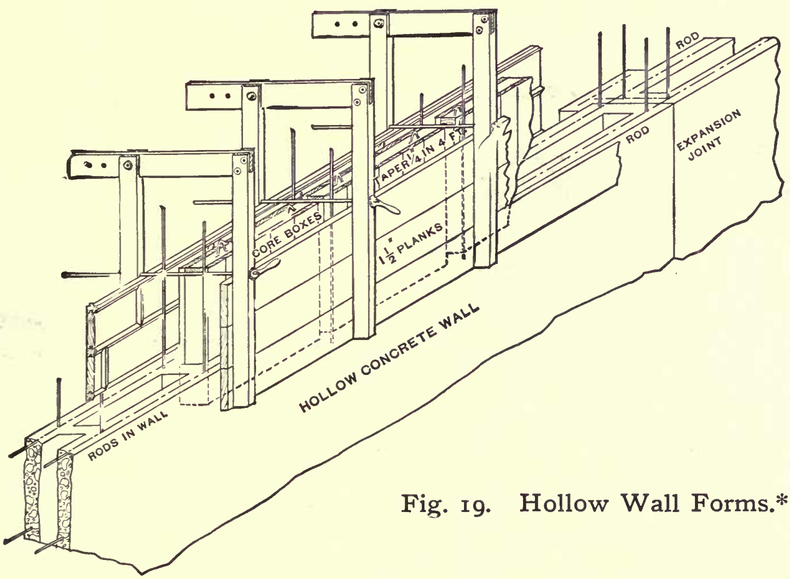
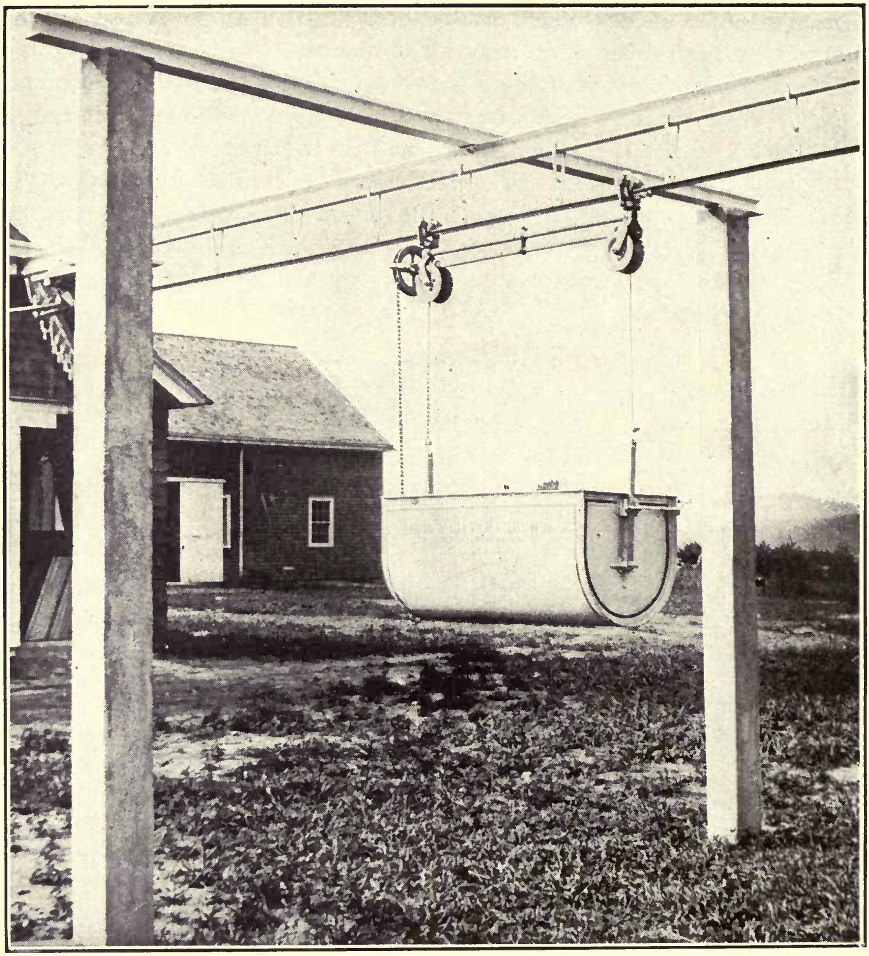


Fig. 19. Hollow Wall Forms.*

Fig. 18 shows a design of wall forms for building a solid wall of any height. The form sections are each made 2 feet high and the length depends upon the length of boards at hand. A 2-foot section made of 1-inch boards 10 feet long weighs 55 pounds, which can therefore be handled easily by one man. The cleats are made to lap over the top of the form 1½ to 2 inches, in order to catch the next section placed on top of the one just filled with concrete. Notice, also, that the cleat at one end projects beyond the form bracing so as to catch the next section and hold it in place. Use bolts for holding the forms together, as they are better than wires, which cut into the cleats and spring the forms apart. The bolt holes left in the wall, as shown in Fig. 18, are a means of constructing a very efficient and cheap scaffolding. All bolts should

*See Footnote p. 18.



CONCRETE POSTS FOR SUPPORTING TROLLEY FOR LITTER CARRIER AT NEWBURGH, N. Y.

be well greased so that they can be readily removed. After completing the wall the bolt holes can be filled with mortar mixed in the same proportion as the concrete so that the color will be the same as the wall.

Sometimes a building is built with a wood superstructure on top of concrete walls which are only from four to eight feet above the ground. In this case the wood superstructure can be attached to the concrete walls in the same manner as described on page 63 for connecting a wood building to a concrete foundation.

COLUMNS.

Excavate below frost and build forms 2 feet square to within 6 inches of surface of ground. Fill with concrete, one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand and five parts broken stone or screened gravel, not over one inch in size, and tamp or puddle carefully. From the center of this foundation build a hollow form one foot square and to desired height, and fill with concrete of same mixture. Before the form is filled—in fact, before setting it—place four steel bars ¾ inch in diameter vertically so that they are about 2 inches inside the corners, and around them,

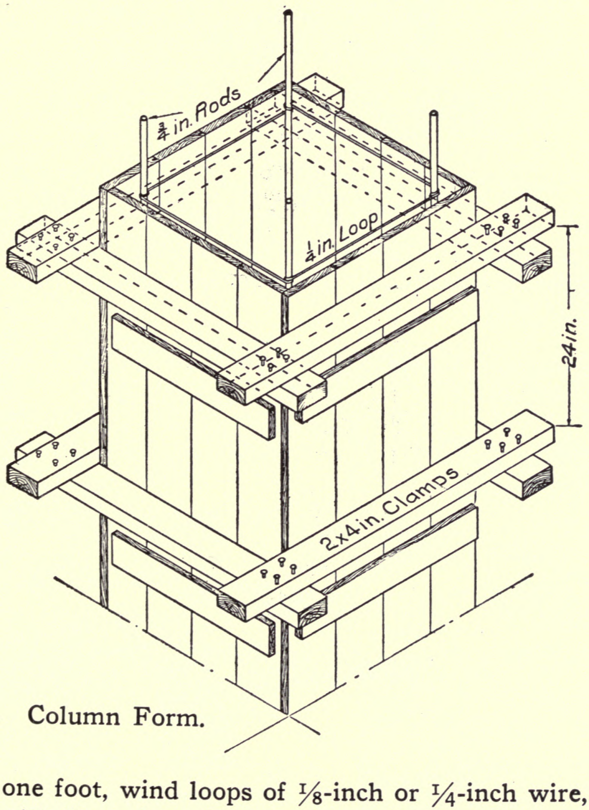
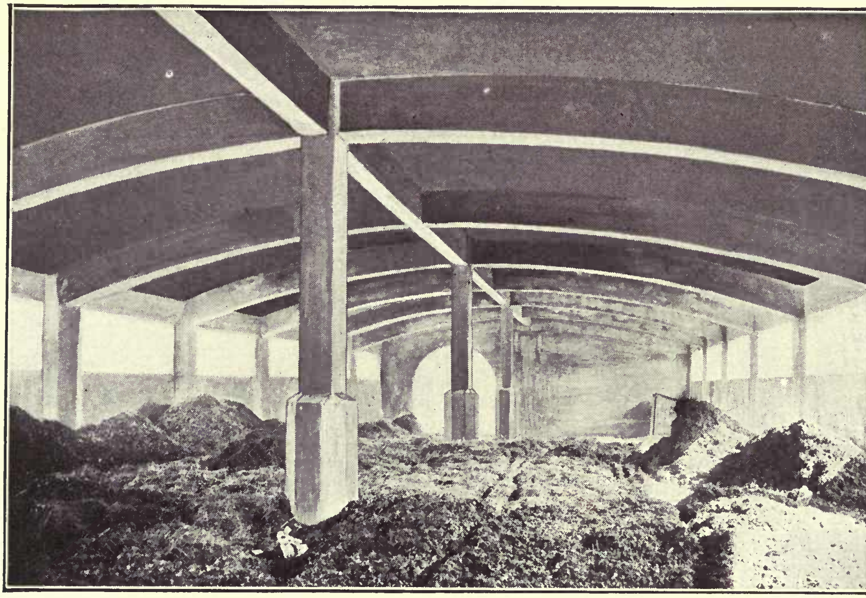


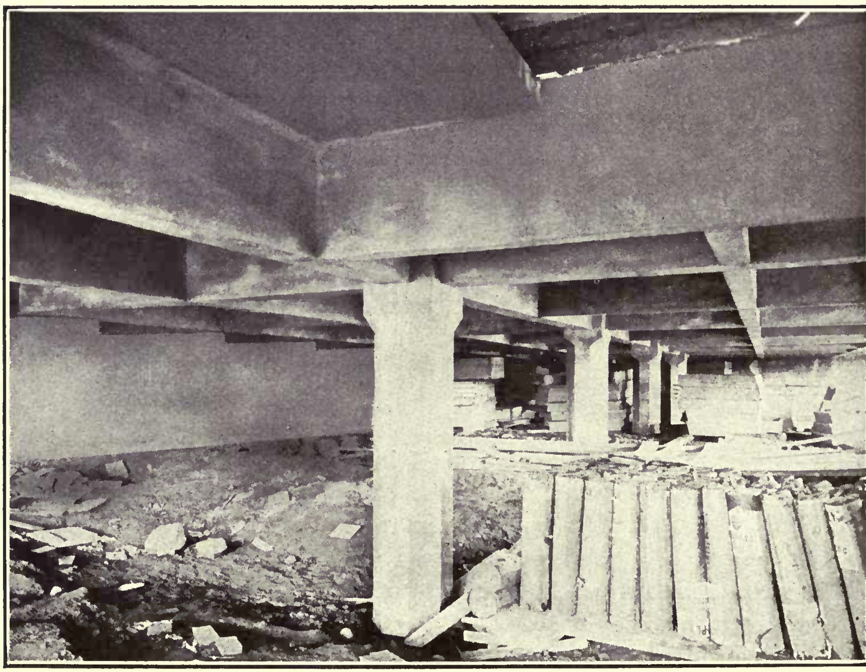
Fig. 20. Column Form.

at intervals of one foot, wind loops of ⅛-inch or ¼-inch wire, tying these to the steel rods with fine wire. Make the concrete soft and mushy, so that it will just flow, and, as it is poured into the top of the mold, work a long paddle, made like the oar of a rowboat, against the forms to force the stones away from the surface and drive out bubbles of air which tend to adhere to the boards and form pockets of stone.

A column 10 inches square, the smallest size it is usually desirable to build unless it is quite short, will safely support 15 tons, or 30,000 pounds.



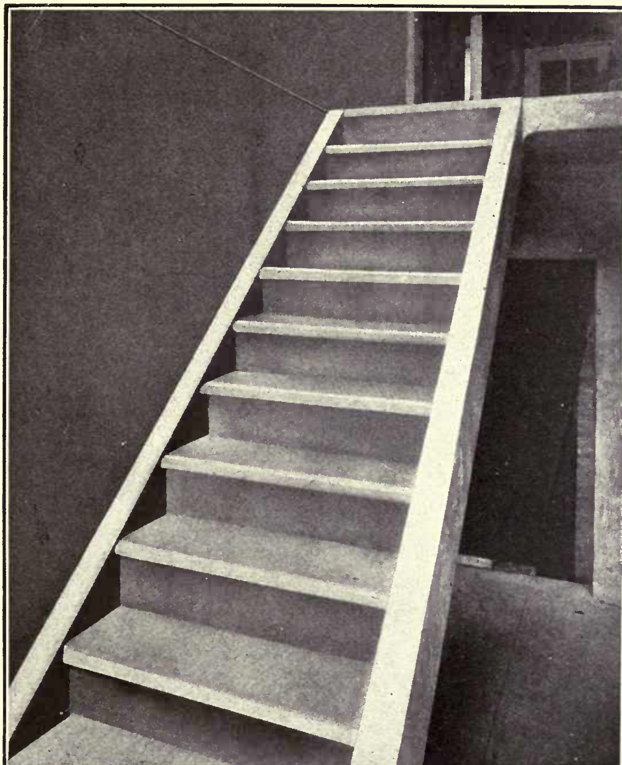
INTERIOR VIEW OF MANURE PIT AT GEDNEY FARMS, WHITE PLAINS, N. Y.



DETAILS OF PIERS AND FLOOR BEAMS UNDER HORSE BARN AT GEDNEY FARMS, WHITE PLAINS, N. Y.

STEPS AND STAIRS.

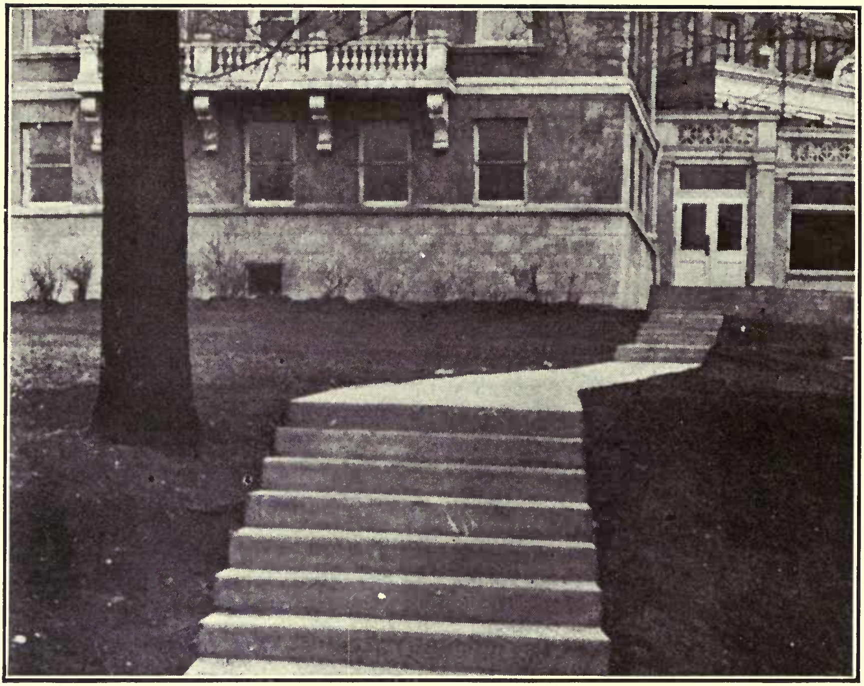
Steps and stairs are of two kinds: those made in one piece, monolithic, and those cast in separate moulds and put into place. There are numerous ways of arriving at the same end, and each man in charge of such work must use his ingenuity in the use of the materials at hand, and adopt the method best suited to his requirements. Specifications are given for four ways of making steps and stairs, all of which have proved successful.



FLYING STAIRS, DAIRY HOUSE AT GEDNEY FARMS, WHITE PLAINS, N. Y.

The rises on all steps and stairs should not be less than 6 inches nor more than 8 inches, while the tread should be from 9 inches to 12 inches, except where it is intended that more than one step should be taken on the tread, in which case 30 inches should be the minimum width.

Foundations for all steps out of doors should extend below frost line or have a porous base with a drain situated at the lowest point to allow the water to run off. Steps should be wider than the walk or opening from which they



SIDEWALK AND STEPS AT WEST HAVEN, CONN.

lead, to avoid looking cramped, and, in order to secure an artistic effect, should have some sort of projection, or moulding, at the upper edge. A slight slope to allow the water to run off is also desirable.

Let us first consider steps to areas or terraced grounds. Excavate the earth on the slope to the desired depth (see Foundations for Sidewalks) and put in

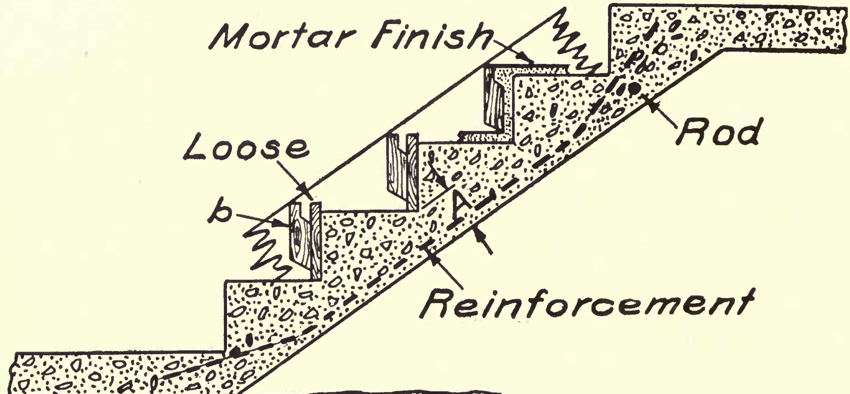
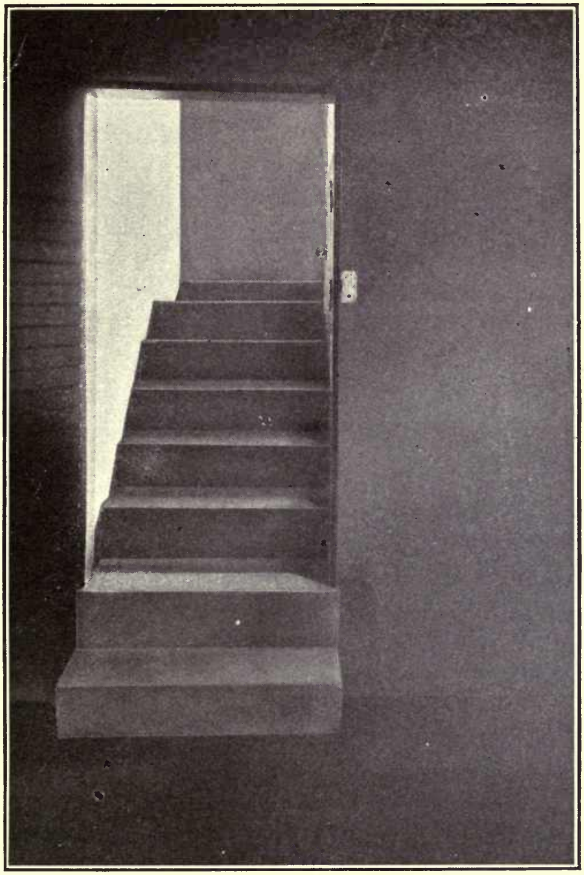


Fig. 21. Concrete Steps.

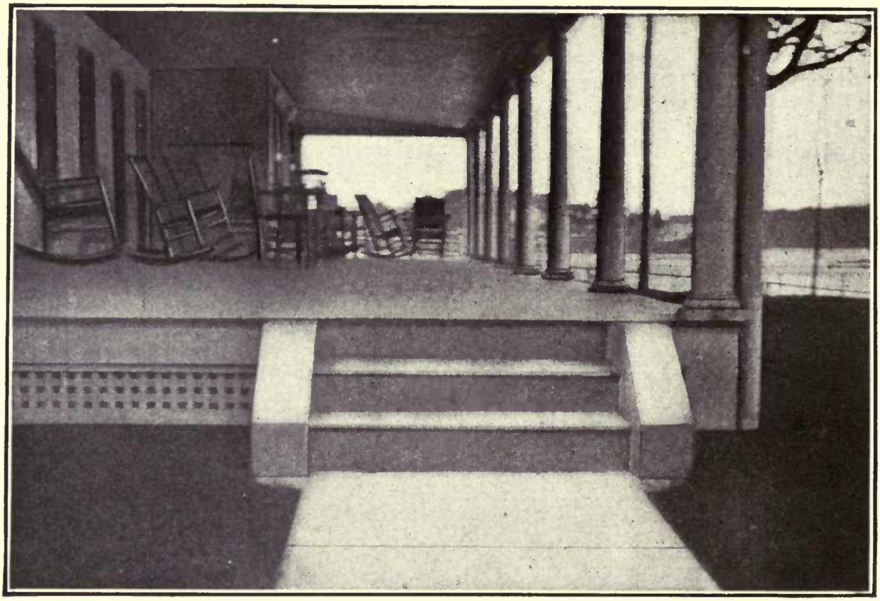
porous foundation with a drain at the lower end to dispose of any water that may accumulate.

Take two planks the length of the flight of steps on the slope, and wide enough to house each step, and mark upon them the location of the riser for each step. Place these planks edgewise on each side on the slope, and brace



CELLAR STEPS AND ICE BOX AT WESTWOOD, N. J.

well on the outside. Place the necessary reinforcement, as given in the table, the full length of the steps on the slope. Now set planks marked (b.) Fig. 21, across these housings to form the rise of each step on the lines previously marked, placing them so that there will be a space below them for a continuous slab of concrete. The thickness of the slab is given in the table under column marked "A." These planks should be arranged with a groove at the top, as shown, to form the projection or moulding at the top of each step. They should be fastened to the housing planks with cleats in such a way that they can be removed without disturbing them. Inside of each of these riser forms place a loose piece of board, well greased, as described for facing curbing on page 79, so as to provide a space which can later be filled with mortar. Now pour into the forms thus made concrete in proportions one part "ATLAS" Portland Cement, two parts clean, coarse sand, and four parts broken stone or screened gravel, filling each step to within 1 inch of the top of the riser. As soon as this concrete has stiffened, but before it has set, carefully draw out



PORCH STEPS AT GREENPORT, L. I., N. Y.

the loose facing board and fill the spaces with mortar one part "ATLAS" Portland Cement to one and one-half parts clean, coarse sand, and also cover over the top of the step to the depth of 1 inch with the same mortar, so that it will come flush with the top of the riser plank. Float the surface lightly with a wooden float, and as soon as it has stiffened hard enough to work, trowel it thoroughly. Early next day remove the riser form, the bottom of which, as shown in the figure, is beveled and comes only to the top of the mortar surface, and trowel the face of each riser. A skilled plasterer should be employed for this work, as the surface is likely to crack if not handled in a workmanlike manner.

Porch steps, and other short flights, can be built as follows: Build two 8-inch walls to a depth below frost, the upper surface conforming to the desired pitch of the steps, but 3 inches below the points where the inner edges of the treads meet the risers. Carry the outside form, however, on the same slope to

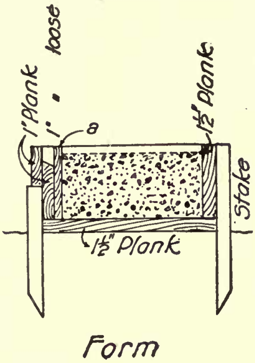


Fig. 22.

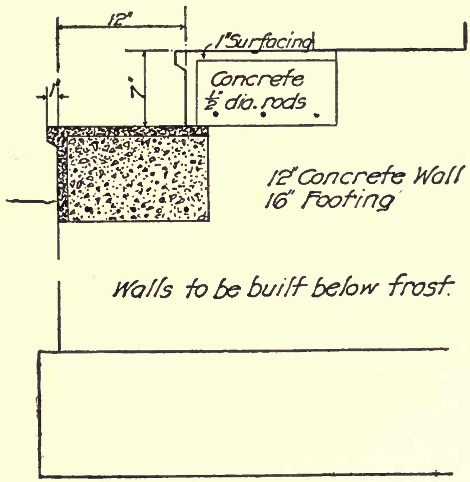


Fig. 23.

Fig. 22. Form for a Single Step.

Fig. 23. Single Steps in Place.

the line of the top of the risers. Between the walls build a sloping platform out of 1-inch boards supported by 2 x 4-inch stuff, well braced and conforming to the slope of the walls. Upon this sloping platform place ¼-inch steel bars 12 inches apart running from top to bottom. Also, crossways place one ⅜-inch bar just at the foot of each rise, and fasten these to the ¼-inch bars by soft wire. Next mark for the location of the risers the side forms which project above the 8-inch walls, place cross plank on each to form these risers, and proceed in the same manner as has been described for area steps. Forms should not be removed from under the steps for 28 days. Should the steps be more than 6 feet wide, a wall similar to the two side walls may be built in the center.

Sometimes it is easier to build a wall at the top and bottom of the steps instead of at the sides, and run the principal rods lengthwise of the flight, so that it is supported at top and bottom. In this case the supporting slab, whose thickness must be considered as the thinnest place in the steps, is designated in Fig. 21 by "A." The span, that is, the "distance apart of the beams," in the table is taken as the length of the horizontal projection of the stairs. The thickness of the slab and the diameter and spacing of the rods are given in the table following.

DIMENSIONS OF STAIRS

(See Fig. 21, Page 70.)

Distance Between Floors Feet	Rise Inches	Tread Inches	A Inches	Size of Rods* Inches	Spacing* Inches	No. of Rods in Top Beam	Size of Rods in Top Beam Inches	No. of Steps
10	7½	10	7¼	½ or ⅝	4 6½	1	⅝	16
9	7¼	10	6½	½ or ⅝	4¾ 7½	1	⅝	15
8	7½	10	6	½ or ⅝	5½ 8½	1	⅝	13
7	7	10	5½	½ or ⅝	5¾ 9	1	⅝	12
6	7¼	10	4½	⅜ or ½	4 7	1	⅝	10
5	7½	10	3¾	⅜ or ½	5½ 9¾	1	½	8
4	7	10	3¼	⅜ or ½	6 11	1	½	7
3	7¼	10	2½	⅜	9	1	½	5

* Select either size and spacing preferred.

Steps cast separate from supporting walls should be made in advance and allowed to season. The sectional drawing illustrates this form of step. To build a single step, make form shown in Fig. 22, 14 inches x 7 inches inside measurement and 1 inch for projection, and fill as shown to within 1 inch of top with concrete, one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone, tamped hard. As soon as this has stiffened, but before it has set, remove the board "a" next to the face of the concrete, which should not be fastened to the form, but simply set in and well greased. This will leave a space on the side and top of step, also a small mould for the projection at top of step. Fill this with wet mortar, one part "ATLAS" Portland Cement and one and one-half parts clean, coarse sand, and let set. The side forms may then be removed and used again. The two side walls for these steps may be 8 inches wide, spread at the base by allowing the concrete to flow out under the forms. The top is stepped off to conform to the bottom and back of steps (Fig. 23.) Place the steps on the walls thus made, after covering all joints with cement mortar, so that they overlap one another 2 inches. Reinforce all steps and stairs cast separately by iron bars placed about 1 inch above the bottom of the slab.

SIDEWALKS.

Before laying the concrete a foundation of porous material, such as cinders or screened gravel, must be placed and as much care should be taken in laying this as the walk itself. Foundations should generally be 6 inches to 12 inches deep, depending upon the climate and character of the soil. In sections where there is a porous soil and a mild climate, foundations are sometimes omitted entirely. If the soil is clayey, blind drains of coarse gravel or tile pipe should be laid at the lowest points in the excavation, to carry off any water that might accumulate in the porous material of the foundation. Walks are frequently ruined by water freezing in the foundations and heaving them out of position.

Excavate to the sub-grade previously determined upon, 3 inches wider on each side than the proposed walk, and fill with broken stone, gravel or cinders to within 4 inches of the proposed finished surface, wetting well and tamping in layers, so that when complete it will be even and firm, but porous. Place 2-inch x 4-inch scantlings (preferably dressed on inside and edge and perfectly straight) on top of the cinder foundation, the proper distance apart to form the inner and outer edges of the walk. The outside or curb strips must be 1 inch to 2 inches lower than the inner edge of the walk. This will give a slight incline to the finished surface and allow the water to run off. A good rule to follow is to allow ⅜-inch slope to every foot of width of walk. For wide walks lay off the space between the scantlings into equal sections not larger than 6 feet square, put 2-inch x 4-inch scantlings crosswise and in the center, as shown in Fig. 24—this will make every alternate space, shown in figure by *diagonal line,* the size desired. Fill these spaces with concrete to a depth of 3 inches (this depth should be 4 inches where there is more than ordinary traffic, or where the blocks are 6 feet square)—one part "ATLAS" Portland Cement, two parts clean, coarse sand, and four to five parts broken stone or screened gravel—then tamp until water begins to show on top. On the same day, as soon as the concrete has set, remove crosswise and center scantlings, place a sheet of tar paper on the edges to separate them from all other squares and fill in the spaces thus left with 3-inch concrete as before. Mark the scantling to show where the joints come.

The finishing coat should be 1 inch thick, of one part "ATLAS" Portland Cement and one and one-half parts clean, coarse sand, or crushed stone screenings. This coat should be spread on before the concrete has taken its set, and smoothed off with a screed or straight edge run over the 2 x 4 scantlings, the object being to thoroughly bond the finishing coat to the concrete base. If the bond between the finishing coat and the concrete is imperfect, the walk gives a hollow sound under the feet, and is liable to crack after having been down

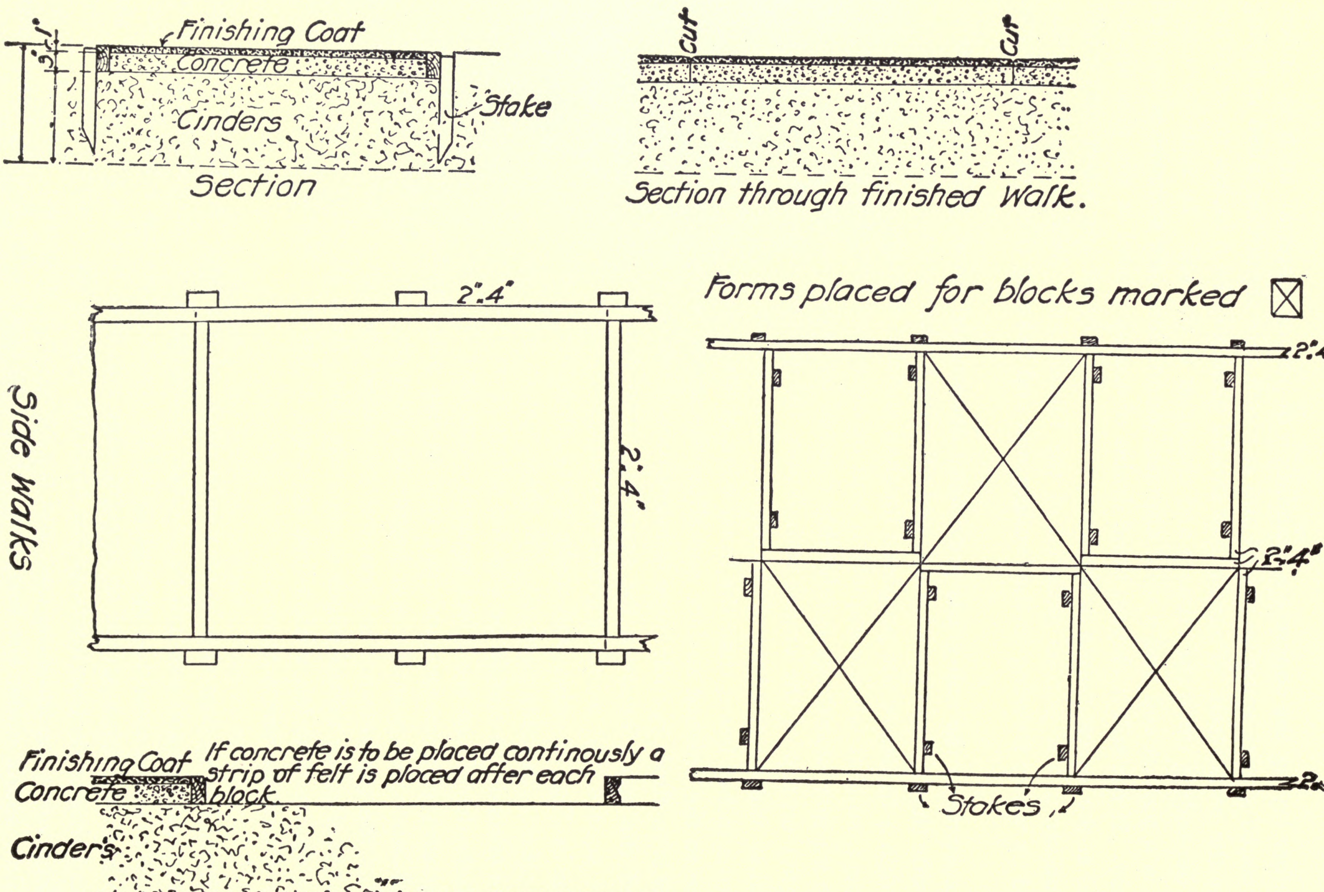


Fig. 24. Sidewalk Construction.

one or two years. Smooth with a wooden float, and groove exactly over the joints between the concrete (Fig. 24), so as to bevel the edges of all blocks. Do not trowel the finishing coat too much, nor until it has begun to stiffen, as this tends to separate the cement from the sand, producing hair cracks, and giving a poor wearing surface. Keep the finished walks protected from dust, dirt, currents of air and the hot sun during the process of setting, and further

MATERIALS FOR 100 SQ. FT. OF CONCRETE.

Bags of Cement to 100 Sq. Ft. of Concrete Surface				Bags of Cement to 100 Sq. Ft. of Mortar Surface			
Thickness Inches	Proportions			Thickness Inches	Proportions		
	1:1½:3	1:2:4	1:3:6		1:1	1:1½	1:2
3	8½	6½	4¾	½	3½	2¾	2¼
4	11	8¾	6	¾	5	4	3½
5	14½	11	7½	1	7	5¼	4½
6	16¾	13¼	9½	1¼	8¼	7	5¾
8	22¾	18	12	1½	10	8	6¾
10	28¾	21½	15½	1¾	12	9¼	7¾
12	34¾	26½	18½	2	14	11	9

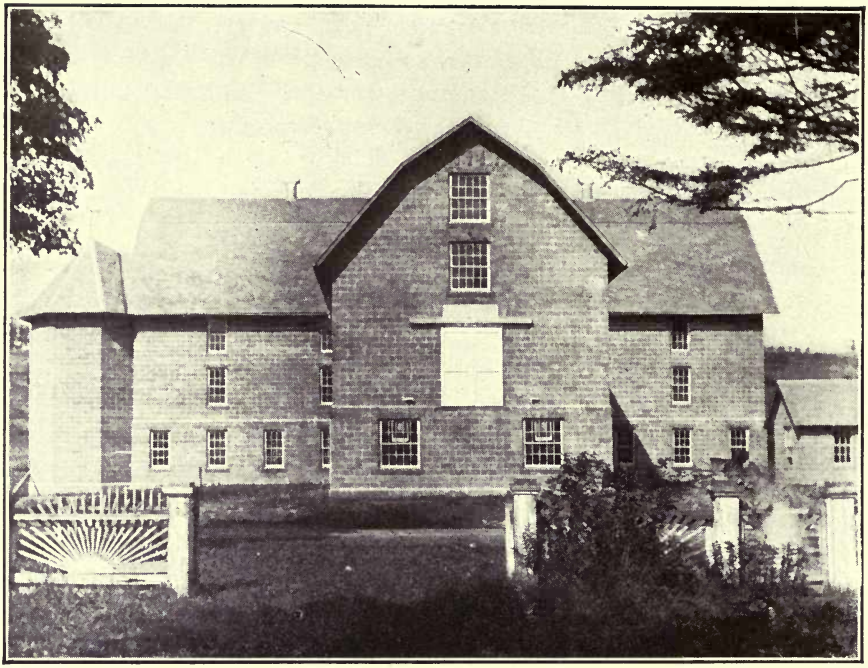
SURFACES LAID WITH ONE BARREL OF CEMENT.

No. of Sq. Ft. of Concrete (Base) Laid with 4 Bags (1 Bbl.) of Cement				No. of Sq. Ft. of Mortar Surface Laid with 4 Bags (1 Bbl.) of Cement			
Thickness Inches	Proportions			Thickness Inches	Proportions		
	1:1½:3	1:2:4	1:3:6		1:1	1:1½	1:2
3	47	60	83	½	114	146	178
4	36	46	66	¾	80	100	114
5	27	36	52	1	57	73	89
6	24	30	41	1¼	48	60	70
8	17	22	33	1½	40	50	59
10	14	19	26	1¾	33	43	52
12	12	15	21	2	29	36	44

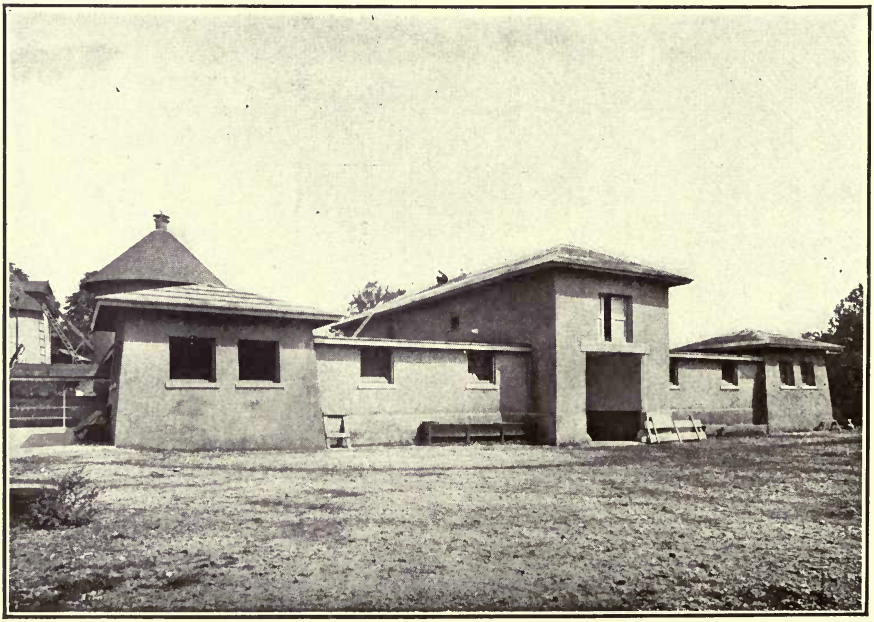
Note.—Four bags of cement equal 1 barrel.
For proportions 1:1½:3 use for every 33 bags of cement 1 large double load of sand and 2 of gravel.
For proportions 1:2:4 use for every 23 bags of cement 1 large double load of sand and 2 of gravel.
For proportions 1:3:6 use for every 15 bags of cement 1 large double load of sand and 2 of gravel.
One large double load contains 40 cubic feet or 1½ cubic yards.

protect from the sun and traffic for three or four days, and keep moist by sprinkling. The covering may be whatever is most convenient—sand, straw, sawdust, grass, or boards.

Most walks are made the width of a single block, and should be constructed as shown in Fig. 24. In a walk the width of a single block, make every alternate block and then go back and fill in the blocks between.



CONCRETE BLOCK BARN AT HARPERSVILLE, N. Y.



COW BARN AT U. S. SOLDIERS' HOME, WASHINGTON, D. C.

CURB AND GUTTER.

The foundation for curbs and gutters, like sidewalks, should be governed by the soil and climate.

Concrete curbing should be built in advance of the walk in sectional pieces 6 feet to 8 feet long, and separated from each other and from the walk by tar paper or a cut joint, in the same manner as the walk is divided into blocks.

Curbs should be 4 inches to 7 inches wide at the top and 5 inches to 8 inches at the bottom, with a face 6 inches to 7 inches above the gutter. The curb should stand on a concrete base 5 inches to 8 inches thick, which in turn should have a sub-base of porous material at least 12 inches thick. The

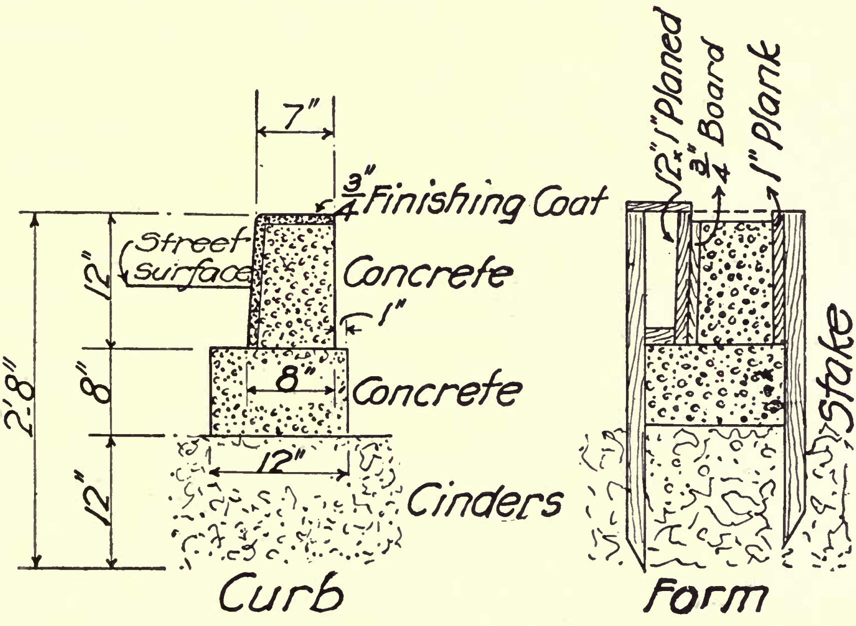


Fig. 25. Concrete Curb and Gutters.

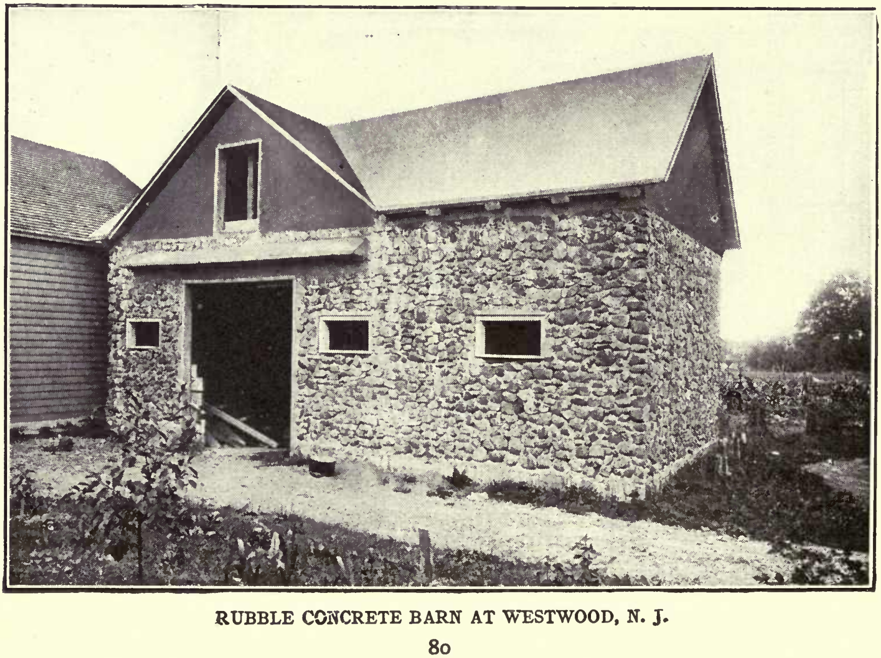
gutter should be 16 inches to 20 inches broad, and 6 inches to 9 inches thick, and should also have a porous foundation at least 12 inches thick.

Keeping the above dimensions in mind, excavate a trench the combined width of the gutter and curb and put in the sub-base of porous material. On top of this place forms and fill with a layer of concrete, one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone, thick enough to fill the forms to about 3 inches below the street level. As soon as the concrete is sufficiently set to withstand pressure, place forms for the curb, and, after carefully cleaning the concrete between the forms and thoroughly wetting, fill with concrete, one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand and five parts broken stone. When the curb has sufficiently set to withstand its own weight without bulging, remove the ¾-inch board shown in Fig. 25, and with the aid of a trowel fill in the space between the concrete and the form with cement mortar, one part "ATLAS" Portland Cement and one part clean, coarse sand. The finishing coat at the top of the curb should be put on at the same time. Trowel thoroughly and smooth with a wooden float, removing face form the following day. Sprinkle often and protect from sun.

In making curbs alone, specifications given below and illustrated in sectional drawing should be followed.

Excavate 32 inches below the level of the curb and fill with cinders, broken stone, gravel or broken brick to depth of 12 inches. Build a foundation 8 inches deep by 12 inches broad, one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone, and from the top of this and nearly flush with the rear, build a concrete wall 11¼ inches high, 7¼ inches broad at the base and 6¼ inches at the top, the 1-inch slope to be on the face. Forms should be built as in Fig. 25.

Remove the forms as soon as the concrete will withstand its own weight without bulging, and proceed as per directions given on this page (Fig. 25). Keep moist for several days and protect from the sun. The above measurements may be varied to suit local conditions.



RUBBLE CONCRETE BARN AT WESTWOOD, N. J.

BARNS.

Each year dairymen are realizing more and more the necessity of improving and changing their methods in order to produce a milk which contains less bacteria than that of their neighbor or competitor. A number of factors enter into the accomplishment of this result.

It is stated by experienced dairymen that the material of which the barn is made is of the most vital importance, for this may be the breeding place of germs. With the use of concrete this question is solved, because a building so constructed offers no chance for the germs to nest. If one goes a step further and constructs the floors, troughs, stalls and other fixtures all of concrete, perfect hygienic conditions are realized, and the road is clear to securing a germ-proof milk.

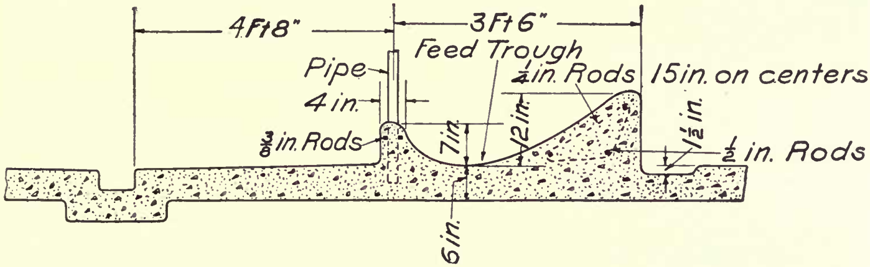
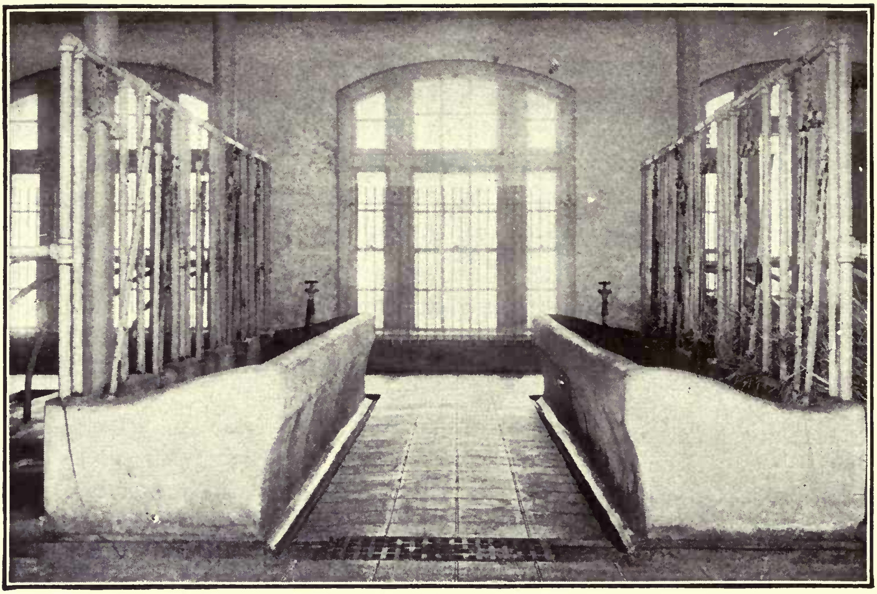


Fig. 26. Section of Cow Barn Floor.

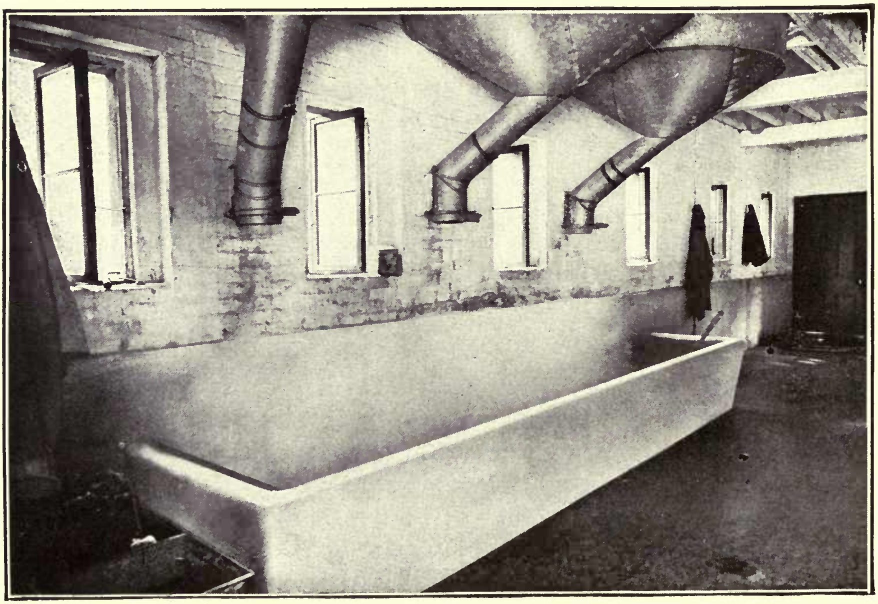
FEED TROUGHS.

Many designs of feeding troughs have been used, but most of them are objectionable from a hygienic standpoint. A concrete feeding trough, shown in section in Fig. 26, is similar to the trough developed after considerable study by the well-known dairy expert, Mr. S. L. Stewart, and used by him at Somers Center, N. Y., and elsewhere.

This design has a high front end, slanting instead of straight, in order to avoid scratching and bumping it with the carts and to keep them out of the drain in front. Use the same design of forms for the slanting front as that shown in the figure, except place the bottom of the form 8 inches in from the vertical. Make the inside of the trough at the center either on a level with the top of the finished floor or about 2 inches above it, and give it a slope of 3 inches in 50 feet in order to readily drain the water at the lower end.



INTERIOR VIEW OF BARN AT GLEN COVE, L. I.



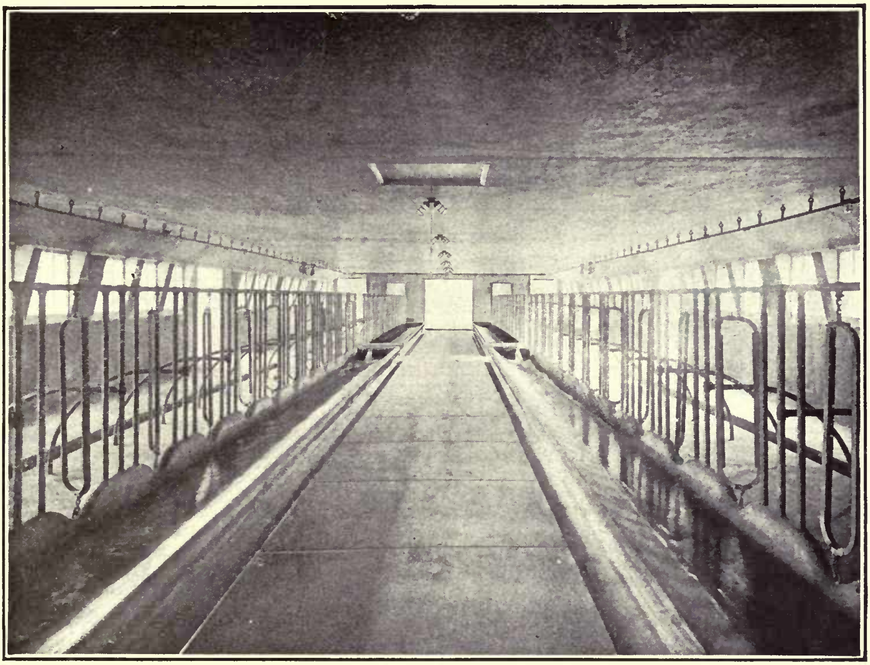
FEED-MIXING TROUGH AT U. S. SOLDIERS' HOME, WASHINGTON, D. C.

Some of the features which this trough incorporates are:

(1) The front of the trough is low so that it does not catch the breath of the cow, and still is high enough to prevent the material from being spilled out unnecessarily.

(2) Only a minimum amount of water need be run into the trough, and still it will be deep enough to allow the cattle to drink freely.

(3) The trough is of such a width that the least amount of material is apt to be thrown out of the trough by the cattle.

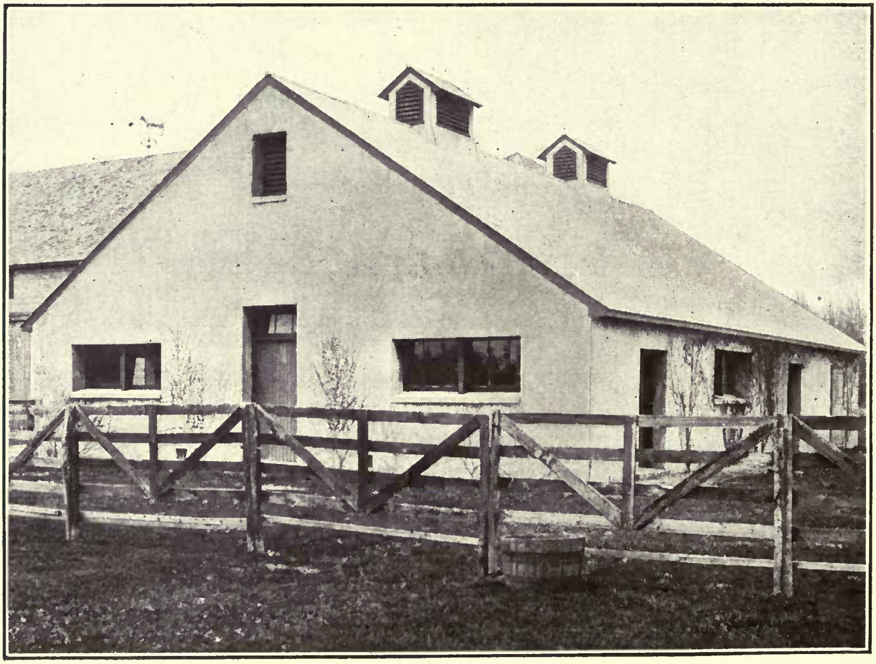


INTERIOR VIEW OF BARN AT BROOKSIDE FARM, NEWBURGH, N. Y.

The following costs of concrete troughs are figured from actual data taken by a contractor on a job in New York. These values checked almost exactly with those given by another contractor in a different section of the country. The comparison was made possible, of course, by assuming the unit cost of material and labor the same for both jobs, thus placing them on the same basis.

A trough such as is shown in Fig. 26 contains about 3½ cubic feet of concrete per running foot of trough. It should be made with one part "ATLAS" Portland Cement to two and one-half parts clean, coarse sand, to five parts of stone, and finished with a one-inch coat of one part "ATLAS" Portland Cement to one and one-half parts of sand. The amount of material needed

CONCRETE HORSE BARN AT GEDNEY FARMS, WHITE PLAINS, N. Y.



COW BARN AT BABYLON, L. I.

per 10 linear or running feet of trough, including the top finish, is ten bags of cement, one single load of sand (20 cubic feet per load), and one and three quarters of a single load of gravel. Thus the cost per running foot of trough for material only is about 70 cents, considering cement at $2.00 per barrel, sand at 75 cents per cubic yard, and gravel at $1.25 per cubic yard. The cost of labor is about 44 cents per running foot, considering labor at $2.00 per day. This makes the total cost for labor and material per linear foot of trough about $1.14. When the price of labor or material is higher, the cost will naturaly be greater, and vice versa. The cost of the stanchions and pipe work is about $8.00 per stall, but this price varies with the local market and the kind of stanchion bought.

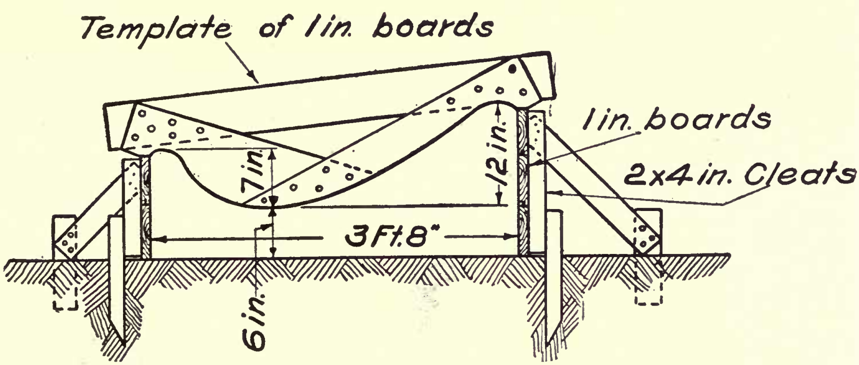
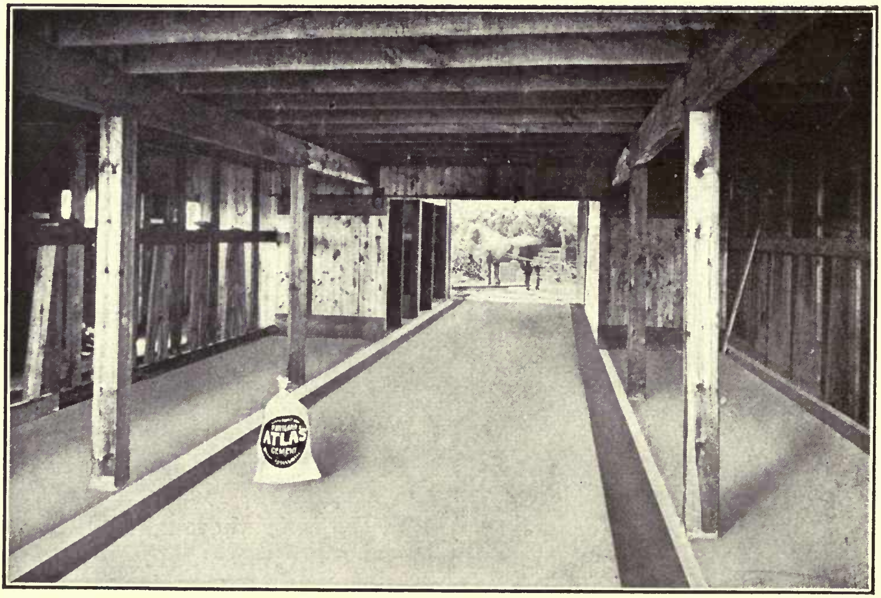


Fig. 27. Forms for Concrete Trough.

The forms for a trough are very simple. Two forms and a screed or templet are all that is required (see Fig. 27). Oil the foms thoroughly, then set up the front and back forms as shown and brace them well. Plaster the forms with a 1-inch coat of one part "ATLAS" Portland Cement to one and one-half parts of sand, and before this has begun to stiffen place the concrete. It is absolutely necessary that the mortar finish does not set before placing the concrete, for otherwise there will be no bond between the body of the concrete and the mortar face, which will be sure to crack off, especially if kicked or jarred. The screed or templet is cut from boards nailed together, as shown in the figure, and is used to screed off the concrete and make it the desired shape. The reinforcement and the pipes for the stanchions are placed as shown.

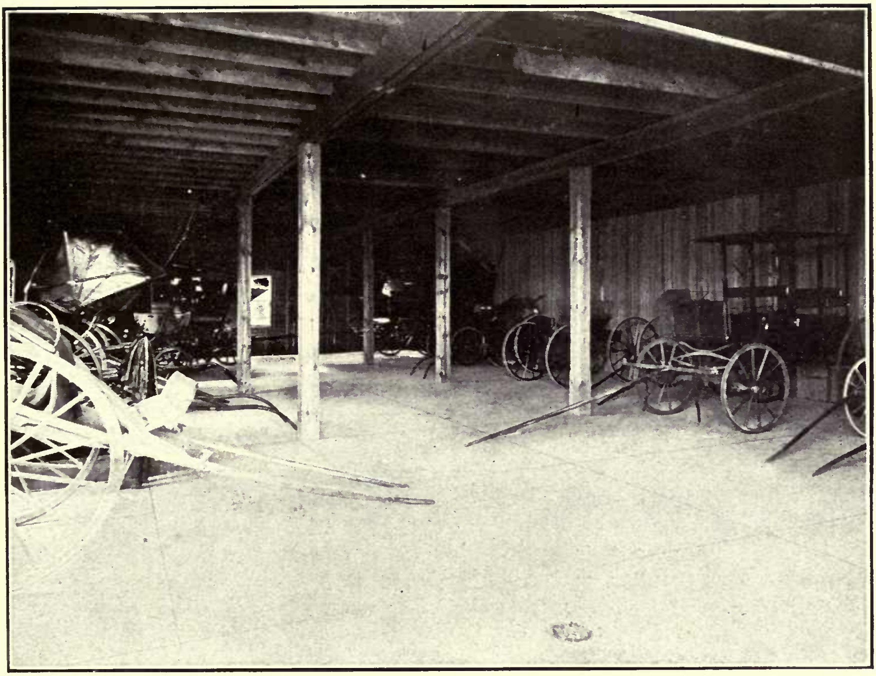
FLOORS.

CELLAR FLOORS. Cellar floors may be laid without foundations, except in places where there is danger of frost getting into the ground below the floor. The dirt should be evened off and tamped hard, and the concrete, one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand and five parts broken stone, spread over the surface in one continuous slab 3 inches to 4 inches thick and lightly tamped to bring the water to the surface, and screeded with a straight edge resting upon scantlings placed about 12 feet apart. The scantlings are then withdrawn and their places filled with concrete. No finishing coat is needed unless the floor is to have excessive wear. The surface of the concrete, however, should be troweled as soon as it has begun to stiffen. Joints about 12 feet apart should be made if the surface is more than 500 feet long, or if it is to be subjected to extreme temperatures. (See "Side Walks," p. 75.)

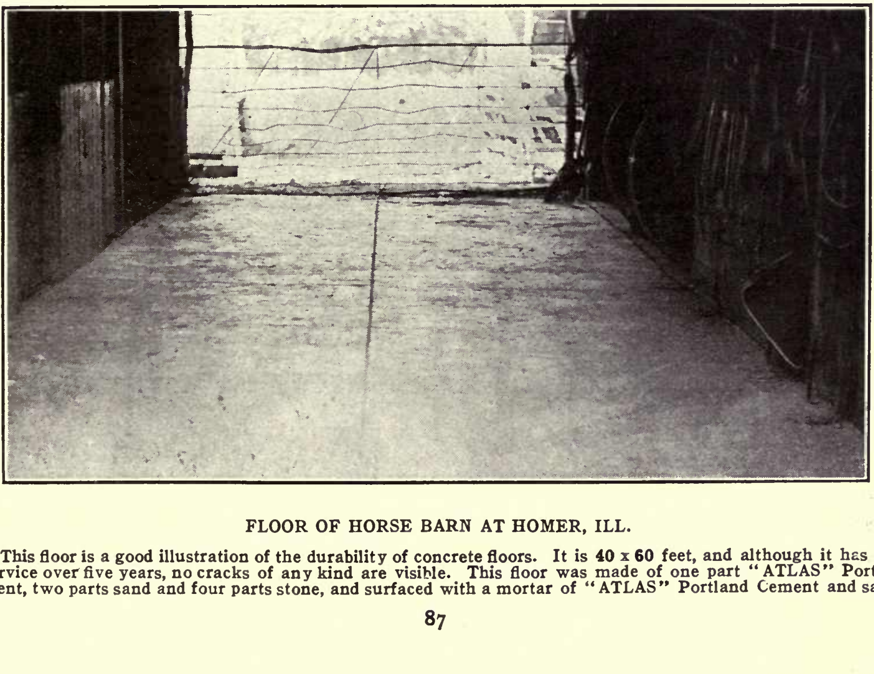


CONCRETE FLOOR IN COW STABLE AT ST. CHARLES, ILL.

BARN FLOORS. Barn floors are laid in the same manner as sidewalks. The thickness of the porous sub-base varies with conditions, but generally 6 to 12 inches is sufficient. The floor itself should be about 4 inches thick, of concrete in proportions one part "ATLAS" Portland Cement, two and one-half parts



INTERIOR VIEW OF CARRIAGE HOUSE AT WASCO, ILL.



FLOOR OF HORSE BARN AT HOMER, ILL.

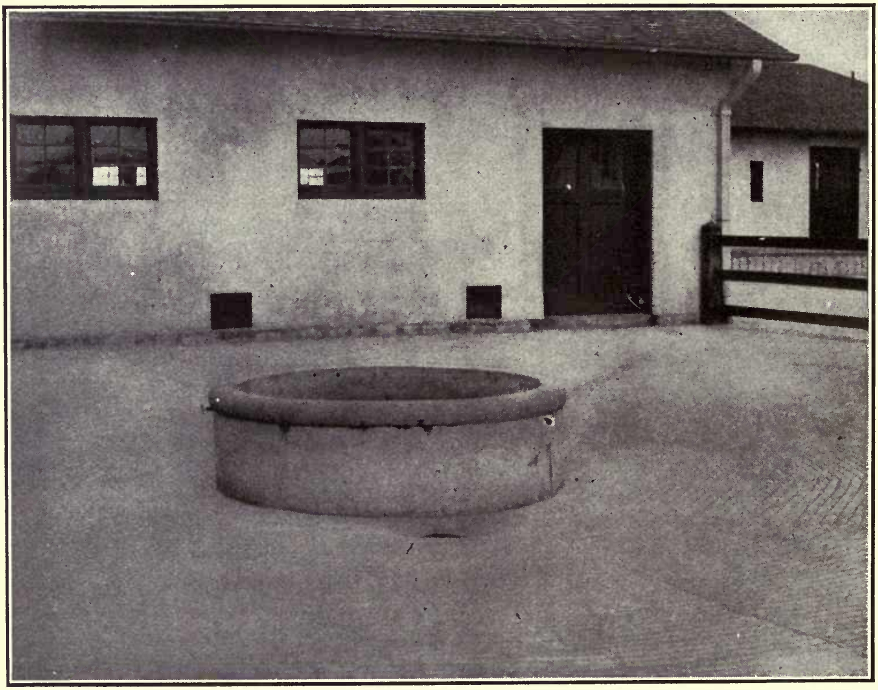
(This floor is a good illustration of the durability of concrete floors. It is 40 x 60 feet, and although it has been in service over five years, no cracks of any kind are visible. This floor was made of one part "ATLAS" Portland Cement, two parts sand and four parts stone, and surfaced with a mortar of "ATLAS" Portland Cement and sand.)

clean, coarse sand, and five parts screened gravel or broken stone, and be finished before the concrete has set with a 1-inch mortar surface of one part "ATLAS" Portland Cement to one and one-half parts clean, coarse sand.

The surface of the floor should have sufficient slope to carry liquids to the drains, and in order to prevent the animals from slipping the floor may be scored or grooved into blocks before the concrete has hardened. These sections may be about 6 inches square.

Some builders make a practice of waterproofing the stable floor. This is not necessary in most cases, but where there is any great danger of the ground water causing the barn to become damp, the floor should be laid as follows:

Place a 2-inch layer of concrete, mop on a 3-ply layer of tar and felt waterproofing, and then upon this the rest of the concrete.



CONCRETE FEEDING FLOOR AND WATERING TROUGH AT EAST NORWICH, L. I.

FEEDING FLOORS. The immense advantage of concrete feeding floors over the old method of placing fodder on the ground is apparent to all who have given the subject any thought.

Feeding floors should be built the same as sidewalks (see Walks). The finishing coat is optional, although it has the advantage of being much easier to keep clean. Many farmers prefer an unfinished surface on account of its giving cattle a firmer footing in slippery weather.

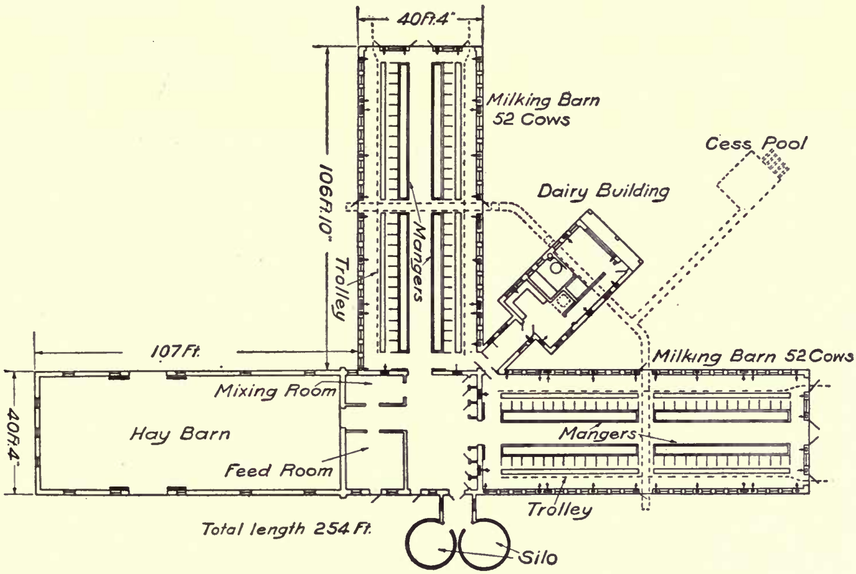


Fig. 28. Plan of the Farm Building at the New York Catholic Protectory, Somers Center, N. Y.

RUNWAYS FROM STABLES.

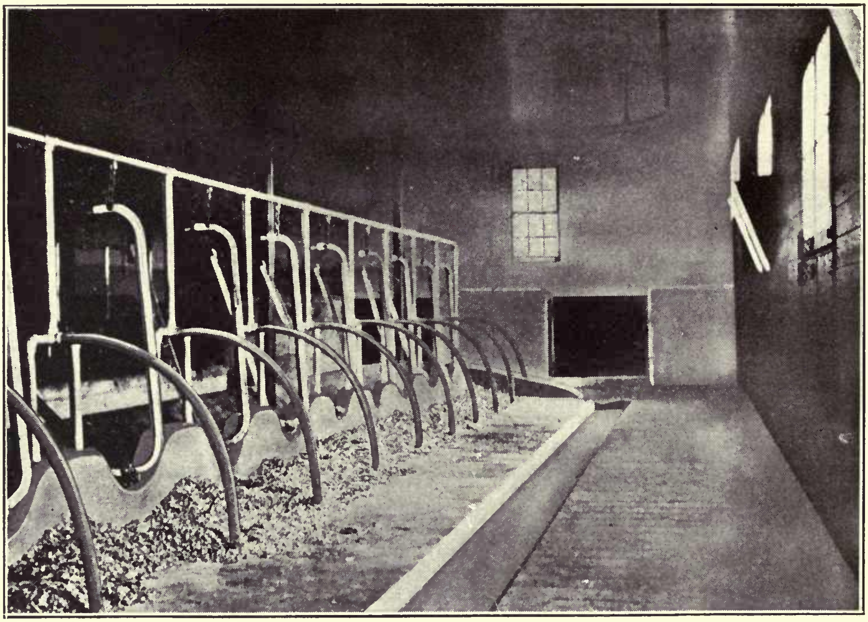
To construct a runway from a stable make up two or three batches of concrete in proportions one part "ATLAS" Portland Cement to two parts sand to four parts gravel or broken stone, spread it in place, and roughly trowel the surface. If a fine, smooth surface is desired, it may be built like a sidewalk (see p. 75) with a 4-inch base of concrete and one inch wearing surface of mortar of one part "ATLAS" Portland Cement to two parts sand.

If the runway is built on a slope which consists of filled ground, care must be taken to see that the fill is well tamped and not liable to settle. If there is any danger of the filling settling from under the runway, it must be designed as a flat slab. In this case the thickness of slab and amount of reinforcement necessary for the width and span of the runway can be taken directly from the table on page 30, using the heaviest loading. For example, if the length to be supported is 8 feet, place ½-inch rods in bottom of slab, 7½ inches apart.

DRAINS.

Since well-made concrete, after it has hardened, is not injured by manure, concrete is being used to replace wooden or masonry drains which are continually rotting or leaking.

Drains may be made either in place, or tile, described below, may be used. In any case lay the drain with enough slope to flush properly, and if it is to receive material liable to clog, make it open or with a removable cover.



INTERIOR VIEW OF BARN AT EAST NORWICH, L. I.

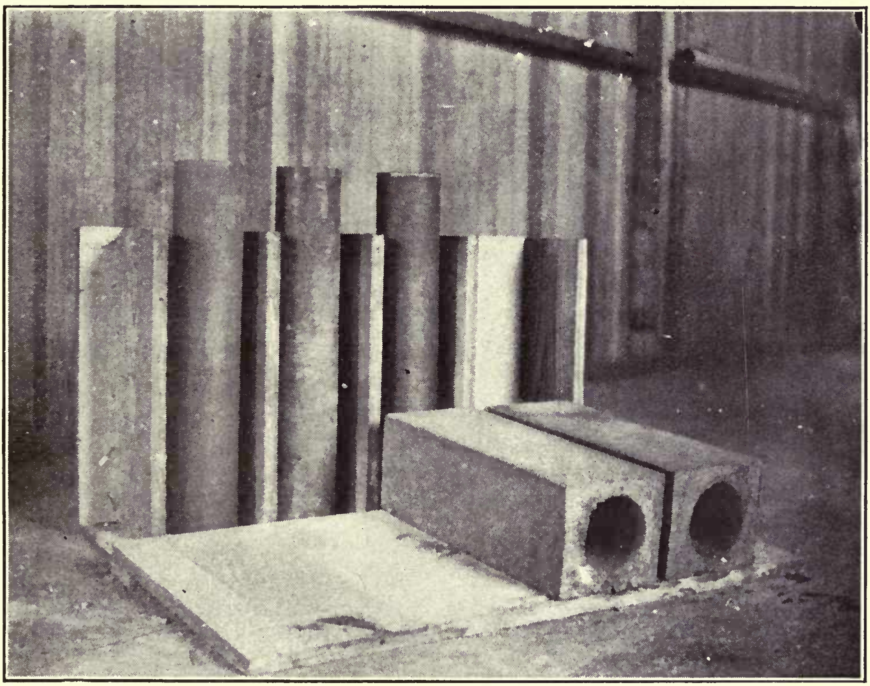
To make a drain in place, dig a trench on the proper slope. Set sections of form the shape of the inside of the drain so that the concrete will be 3 or 4 inches thick. Pour the concrete, mixed in proportions one part "ATLAS" Portland Cement to three parts coarse gravelly sand, into the trench under the form. Remove the form when the concrete has hardened for about one or two hours, and gently trowel the surface to make it smooth and bring the cement to the surface.

If the drain is to have lids, the concrete of the sides is left down so as to leave room for the lid and have the top sunk about ¼ inch below the level of the floor.

TILE DRAINS

Concrete land tile drains, when made of one part "ATLAS" Portland Cement to three parts clean, coarse sand which has been sifted through a ½-inch mesh screen and of a soft, mushy consistency like mortar used for laying brick, can be depended upon to resist the chemical action of even the most alkaline ground water. The tile may be made 12 or 18 inches long, and the inside diameter anywhere from 4 to 12 inches.

The forms for making concrete land tile are simple and inexpensive. One or two sets of forms with four or six tile each may be made so that they can

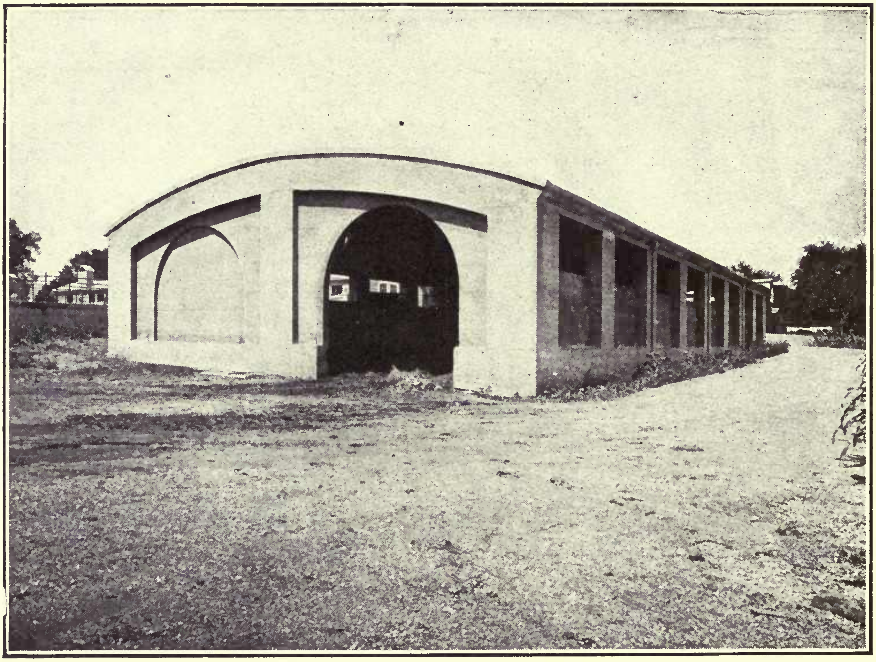


MOLDING TILE DRAINS

be filled every morning, and in this way enough tiles can be soon on hand to drain a large acreage of land. The concrete tile should be made with a circular bore, and may be either circular or square on the outside. A photograph of a tier of four forms, with two of the tile on a board, is shown above.

Use ordinary stove pipe of the required diameter for the inside mold; this should project far enough above the top of the wood form so that a good grip can be had on it in order to remove it from the concrete. If desired, holes can be punched through the stove pipe near the top and a rod placed through these holes in order to more easily draw the pipes. To keep the pipes in place when pouring the concrete for each tile, drive four nails in the floor or platform on which the tile are to be cast, leaving them projecting so as to locate the end of the pipe and keep it from getting out of position but yet not hindering its removal. The stove pipes must be thoroughly cleaned and greased each time they are used, and must not be dented or have any irregularities on them to make them catch.

As shown in the photograph, the wood partitions are permanently attached to one of the long sides, but the other side is only nailed on temporarily and the heads of the nails left so that they can be readily withdrawn with a claw



MANURE PIT AT GEDNEY FARMS, WHITE PLAINS, N. Y.

hammer and without jarring the forms unnecessarily. The wood partitions are spaced far enough apart so that there is one inch of concrete between stove pipe and the wood, hence make the distance between the sides equal to the diameter of the stove pipe, plus 2 inches. In order to readily remove the wood forms, clean and oil them thoroughly before each time using. Mix the concrete to proportions and consistency given above and place in the mold, ramming with a stick. The time to remove the stove pipe core varies with the wetness of the mix and the temperature, but it should be pulled as soon as the top of the concrete begins to harden, which generally is from one-half to one hour; if left too long it is very hard to get them out. The outside forms can usually be removed after two or three hours, or may be left until the next morning. To remove the wood forms, pull the protruding nails with a claw hammer, and carefully remove this side. Place this sideboard back again in position, and carefully turn the whole tier on the side. Next draw out the other side with the partitions attached. If any of the forms stick, they can generally be started by tapping them lightly with a hammer; this applies as well to the stove pipe cores. Scrape the form carefully, re-oil, attach the long side and they are ready for a second filling.

To save material the outside of the tile may be made round or octagonal. For the latter tack triangular strips in all corners of the mold.

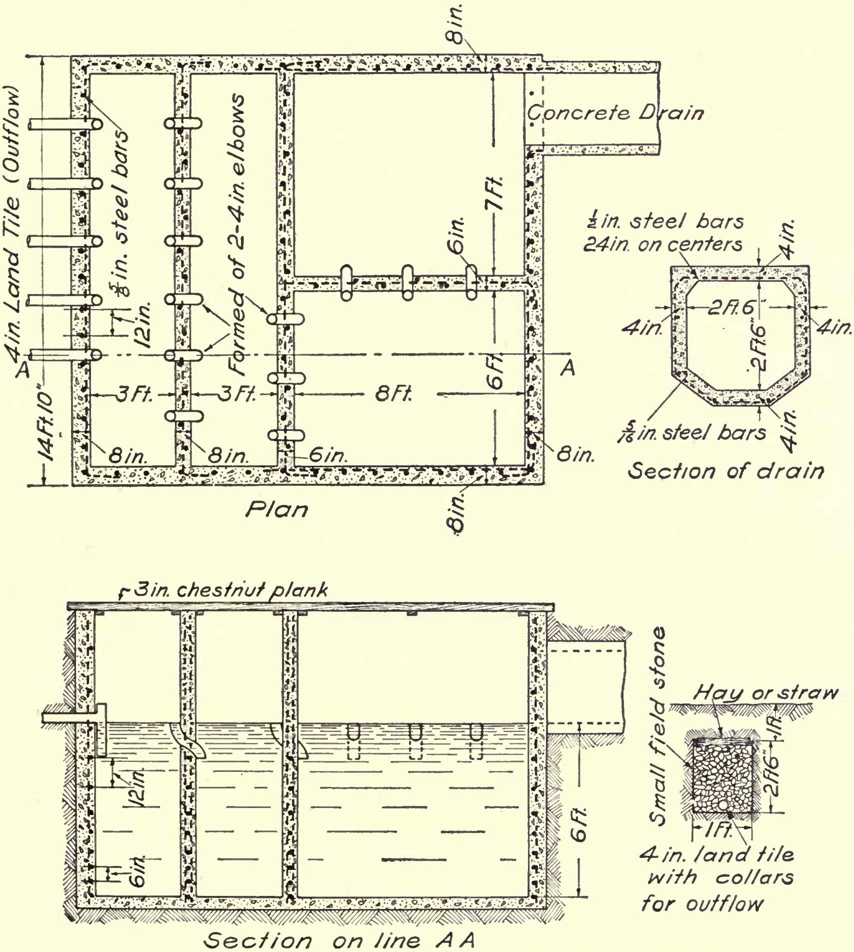
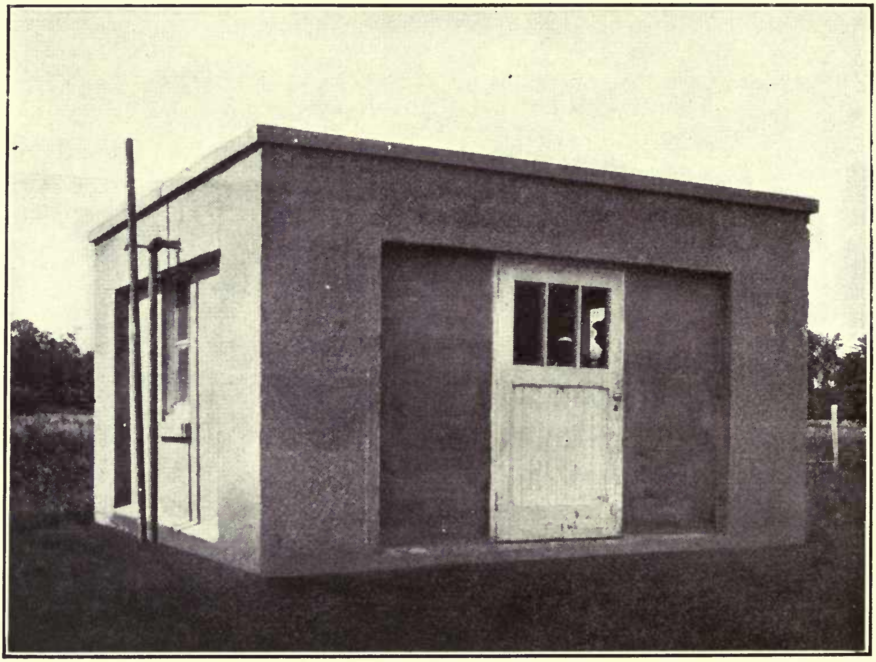


Fig. 29. Concrete Cess Pool and Drains at New York Catholic Protectory, Somers Center, N. Y.

CESS POOLS.

A cess pool for either a house or a barn may be made in the manner described for cisterns on page 119. A single chamber may be made with over-flow drains laid with loose joints and leading under the surface of the ground so as to fertilize the lawn or garden.

The cess pool shown in Fig. 29 is built in several sections so that the manure may settle and overflow into the series of tanks. The sewage from the drains empties into the first tank where the heavy material settles, leaving the water on top. When the water level rises up to the outlet of the pipes leading

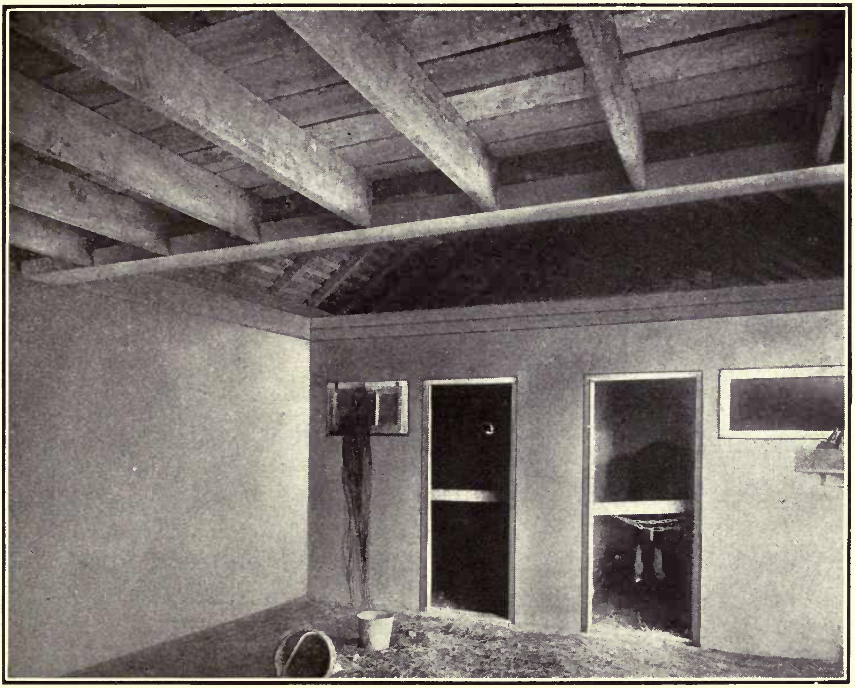


PUMP HOUSE AT GEDNEY FARMS, WHITE PLAINS, N. Y.

from the first to the second chamber, the cleaner water is drained into the second chamber, leaving the heavy material in the first. This same process takes place in each of the other three chambers, the water finally draining into the concrete tile drains, and being distributed by them over a considerable land area. The cess pool is covered with a chestnut plank cover so as to facilitate cleaning if this ever became necessary. A 5-inch concrete slab reinforced in the bottom with ½-inch rods placed 6 inches apart might be used instead, leaving openings in it for trap doors.

BOX STALLS.

Concrete box stalls offer a great advantage over stalls of other material, for they are warmer in winter and cooler in summer, and thus help to prevent horses becoming restive and ill-tempered. They may be built of concrete one part "ATLAS" Portland Cement to two and one-half parts clean, coarse sand to five parts broken stone or screened gravel, and should have walls 4 inches thick and reinforced as described in the wall specifications. The surface can be finished off the same as outer walls.



BOX STALLS AT WESTWOOD, N. J.

VENTILATION.

Concrete barns, like houses, are built either with a single solid wall or with a hollow wall. Each type offers advantages and disadvantages. For instance, it is easier and cheaper to build a single wall on account of having no core to make or handle; but, on the other hand, these openings between the walls may be utilized for the air ducts or vents through which the ventilation in the barn is taken care of.

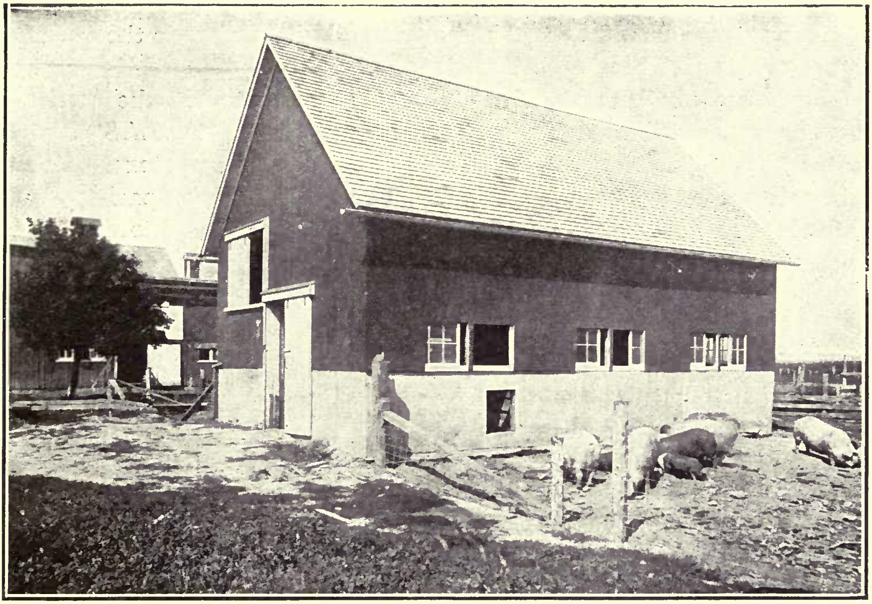
In designing a barn it is of the utmost importance to secure perfect ventilation, and this means (1) a constant change of air; (2) the introduction and distribution of fresh air without drafts; (3) the introduction of outside air, but not at the expense of the proper temperature, and (4) the removal of foul air without condensation.

The intake registers for the removal of the foul air should be placed in the walls near the floor. The foul air passes from the registers through the hollow spaces in the walls and from there into the chimney. The chimney is best located near the center of the barn, and should be high enough to extend above the roofs of any nearby building. The fresh air should be admitted by registers located near the ceiling. The air near the ceiling is usually the warmest; hence, the fresh air is heated somewhat before striking the cattle.

PIGGERY AT GEDNEY FARMS, WHITE PLAINS, N. Y.

HOG PENS.

To construct a concrete hog pen excavate a trench, the size and shape desired for finished pen, 10 inches wide, and to a depth below frost, and fill with concrete mixture, one part "ATLAS" Portland Cement, four parts clean, coarse sand, and eight parts broken stone or screened gravel. On top of this foundation build a wall (See "Walls"), at equal distance from edge, 4 inches thick and 4 feet high, reinforced with wire fabric or else with ¼-inch rods placed about 18 inches apart both ways. The reinforcement must be carefully bent around the corners. Proportions for wall, one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand, and five parts broken stone.



HOG HOUSE AT BRICELYN, MINN.

INTERIOR OF PIGGERY AT GEDNEY FARMS, WHITE PLAINS, N. Y.

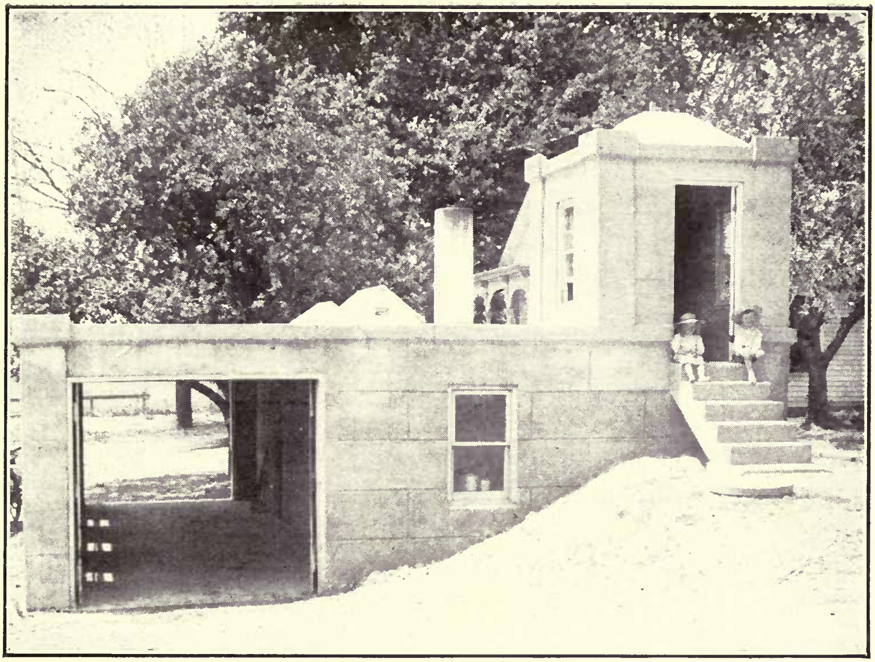
Space for a gate should be left, and a trough built similar to the one shown in picture or described in "Hog Troughs."

A hog house can be added by building another wall in the corner and roofing the space with 2½ inches concrete, one part "ATLAS" Portland Cement, two parts clean, coarse sand, and four parts broken stone. This slab must be reinforced with wire mesh or steel rods of size and spacing given in Table for Designing Reinforced Concrete Beams and Slabs. Flooring may be put in same as in "Cellar Floors" (see page 86).

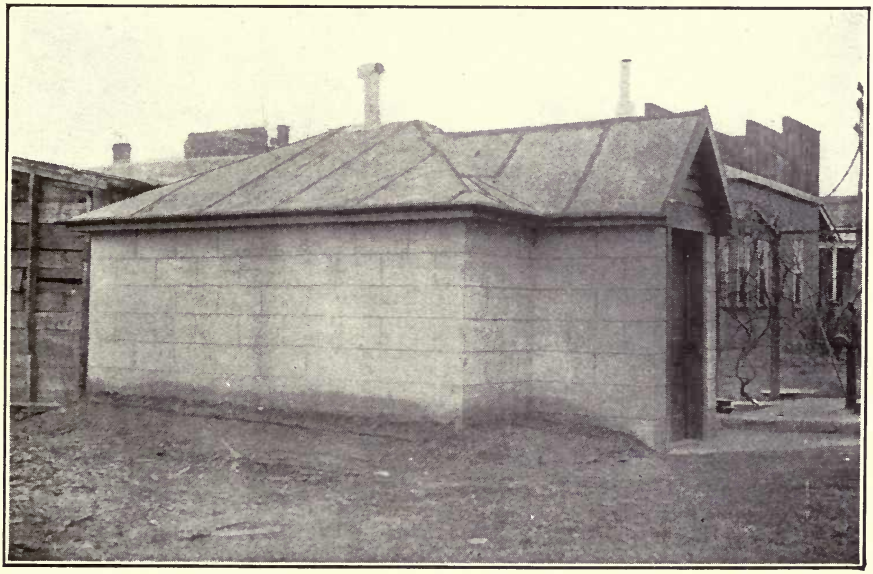
BOTTLING ROOM IN DAIRY HOUSE AT BROOKSIDE FARMS, NEWBURGH, N. Y.

DAIRIES.

The dairy may be connected by a passage way with the barns or may be in a building by itself. In either case, concrete had best be used throughout for the various rooms: the receiving room, the bottling room, the closets, the refrigerator, the cold storage room, the shower baths and the clothes closet; also for all the various accessories, such as the troughs for the milk cans and bottles.



23 BY 30-FOOT REINFORCED CONCRETE MILK HOUSE AT BEACH FARM DAIRY, AT COLDWATER, MICH.



WELL AND CELLAR AT MARSHFIELD, MO.

Since concrete is a poor conductor of heat and cold, it is a good material for an ice box. It may also readily be made with one or two air spaces in the walls so as to make an economical storage box. Ice boxes are sometimes built as a part of a new building, and sometimes are built onto an old building. An ice box is not in the least affected by the hard usage it receives by having heavy milk cans thrown against it.

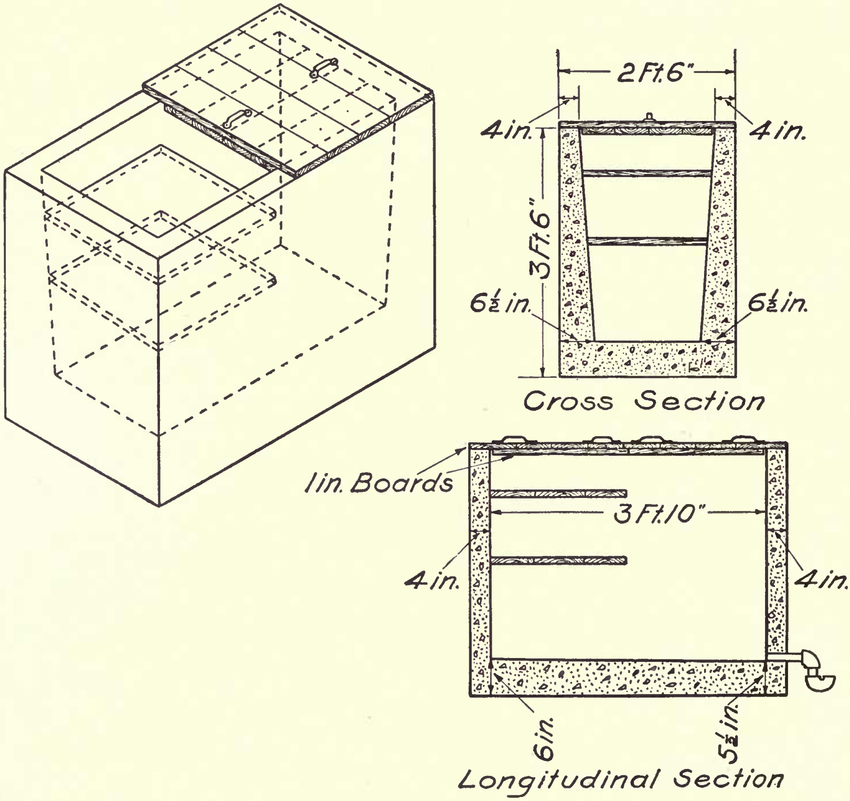
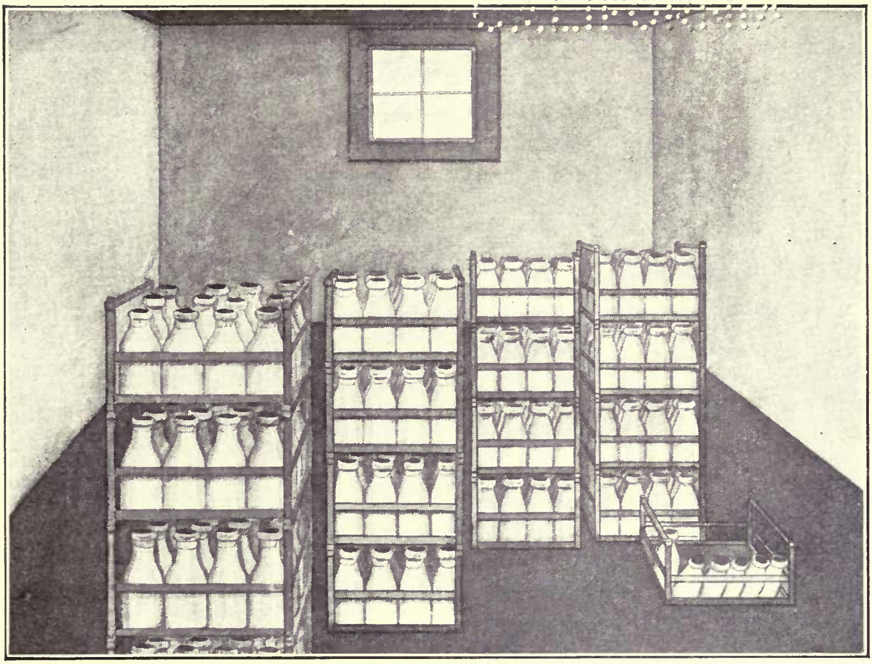
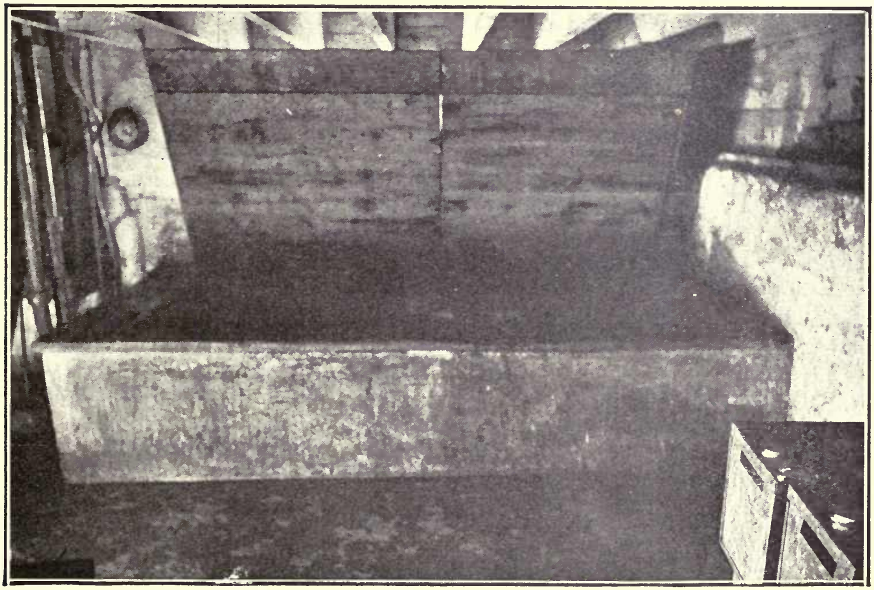


Fig. 30. Solid Wall Concrete Ice Box.

An ice box should be made in the place where it is to set, as it will be too heavy to move. Build outside forms of 1-inch tongued-and-grooved and planed boards. Cleat these lightly together and run a brace back to hold in place. Make a light box or use one already made for the inside forms, oiling or greasing it well before placing the concrete. Make the wall 8 inches thick if one air space is required, or 10 inches thick for two air spaces. To form the air space, place 2-inch plank on end 2 inches from the form and in pairs so that each thickness of wall will be 2 inches and these 2-inch walls will be con-



INTERIOR OF CONCRETE ICE BOX AT BROOKSIDE FARMS, NEWBURGH, N. Y.



CONCRETE ICE BOX IN A DAIRY AT CHICAGO, ILL.

nected by about 4 inches of concrete at the ends of each pair of plank. By greasing the plank thoroughly, they may be pulled out after the concrete has begun to stiffen. The time for doing this will be about an hour after the concrete is placed if it is made about the consistency of mortar for laying brick, or about two hours after placing if it is made thinner than this. Pull plank just as soon as the surface of the concrete has dried off. Leave the inside and outside forms in place for two or three days. To furnish a place for a double cover, which should always be used with a double wall, make the inside section of wall lower than the outside, as shown in Fig. 31. There should be from ½ inch to 1 inch space between the two wood covers. The hollow spaces in the walls may be filled either with cork or mineral wool, which helps considerably to keep the inside of the ice box at a low temperature with the least amount of ice.

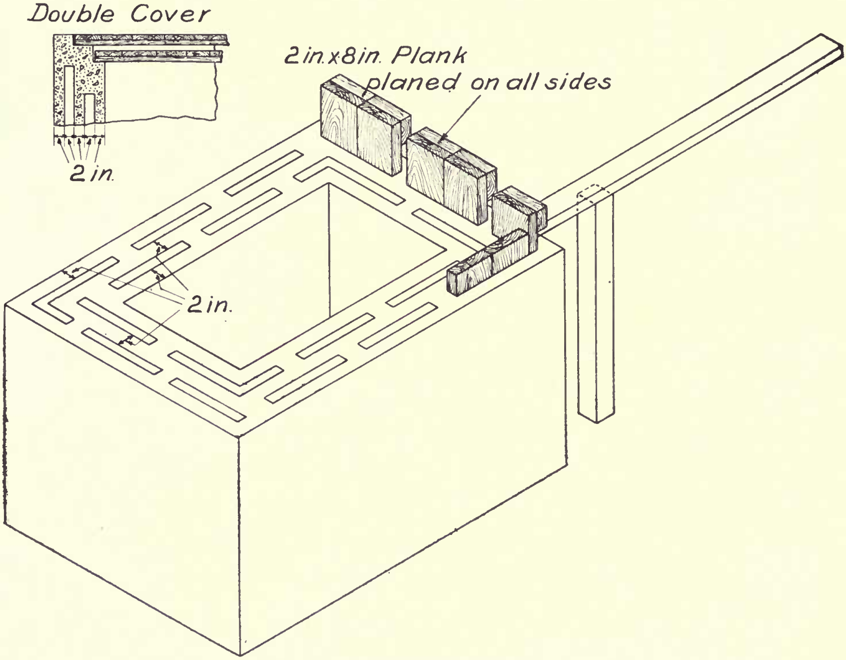


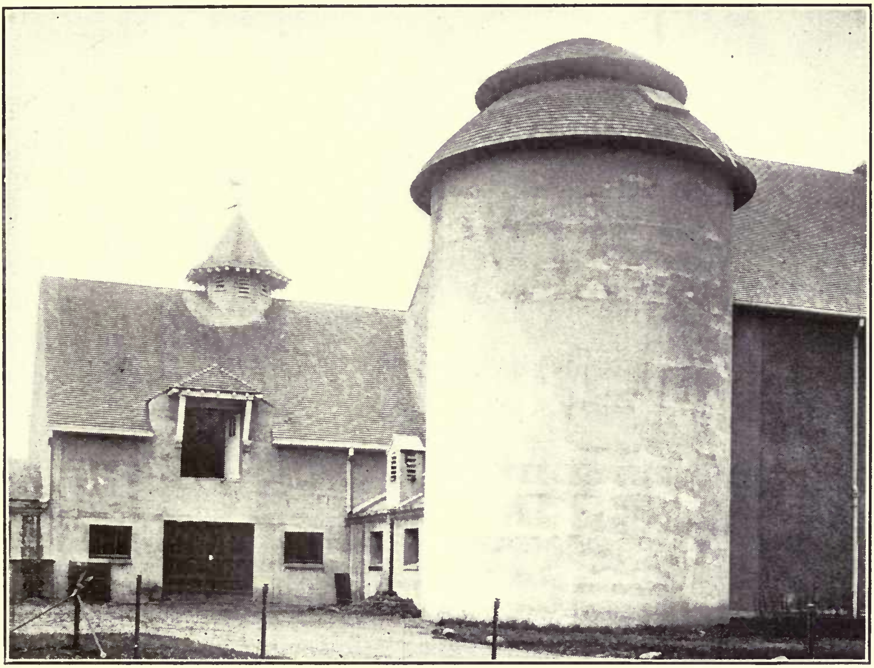
Fig. 31. Hollow Wall Concrete Ice Box.

In Fig. 30 is shown an ice box in which two sides have a taper so as to catch the wood trays. The other two sides need not be tapered. The cover is made in two sections so that only one need be removed in order to place or take anything from the trays. The bottom of the box should be made sloping toward a drain pipe, which may be fitted with an elbow and an upward bend which fills with water and traps the air from entering the ice box, while it allows the water from the melting ice to drain from the box.

SILOS.

A silo, which is a tank or chamber for preserving fodder or ensilage by the exclusion of air and water, is a practical necessity on every farm.

Concrete silos are without question the most satisfactory, for they are water-tight, practically air-tight and vermin or rat-proof; they cannot shrink, rot, rust or burn up; they will not blow over on account of their weight nor collapse when empty. Concrete is a good non-conductor of heat and cold and



ONE OF THE SILOS AT GEDNEY FARMS, WHITE PLAINS, N. Y.

the temperature inside such a silo will be fairly uniform so that the ensilage will never freeze to any extent.

Silos are generally made circular, and the height may be about two or three times the diameter.

There are three ways of building concrete silos: With monolithic or solid walls; with hollow monolithic walls; and with concrete block walls.

Concrete silos are more economical than wood because of their durability. The expense varies, of course, with the prices of the ingredients composing the concrete and the cost of the form work. The cost of the gravel and sand is generally small, for there are comparatively few farms without a gravel pit suitable for making good concrete; hence, it is in the handling of these materials and the making of the forms that the principal outlay is involved. A reinforced silo can be built cheaper than one which is not reinforced, because of the thinner walls which can be used.

A design for forms and staging for a concrete silo is shown in Fig. 32.

The table gives the necessary data for constructing silos of different heights and diameters.

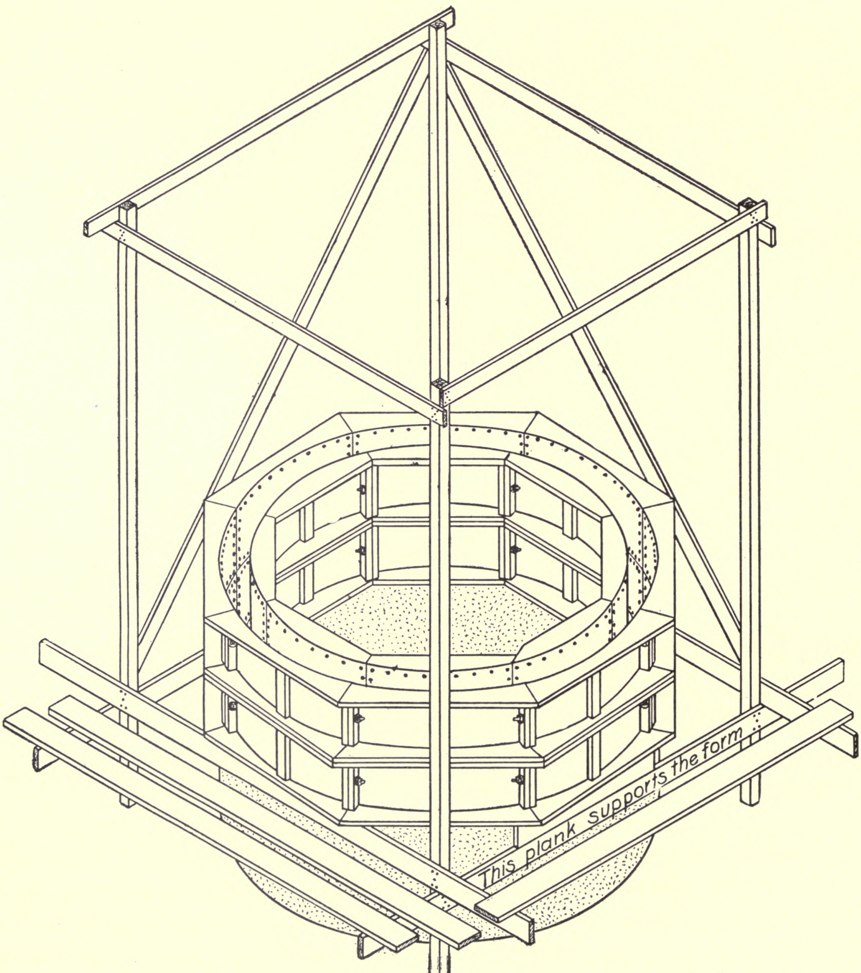


Fig. 32.—Forms and Staging for Silos.

DATA FOR REINFORCED CONCRETE SILOS.

(Including 6-Inch Floor).

Proportions: 1 Part "Atlas" Portland Cement to 2 Parts Sand to 4 Parts Gravel or Stone

Height	Inside Diameter	Thickness of Wall	Horizontal Reinforcement		Cement	Sand	Stone
			Size	Spacing C. to C.			
Feet	Feet	Inches	Inches	Inches	Bbl.	Cu. Yd.	Cu. Yd.
10	5	6	¼	12	6½	2	4
10	10	6	¼	12	18½	4	8
15	5	6	¼	12	9½	3	6
15	8	6	⅜	12	14½	4	8
15	12	6	⅜	12	24	6½	13
20	8	6	⅜	12	19½	5	10
20	12	6	⅜	12	29½	8	16
20	15	6	½	12	38	10	20
25	10	6	½	12	27½	7½	15
25	15	6	½	12	45	12	24
25	20	6	½	12	62	16½	33
30	10	7	½	12	37	10	20
30	15	7	½	12	58	15½	31
30	20	7	⅝	12	80	22½	45
40	15	8	½	12	80	22½	45
40	20	8	⅝	12	114	30½	61
40	25	8	¾	12	147	38½	77

Place vertical rods same size as horizontal, 2½ feet apart.
A cubic yard is about 1½ single load or ¾ of a double load.

The method of laying out the curves in order to make a section of the form for a silo shown above is given in Fig. 33.

The complete circles can be laid off in this manner on any level piece of ground or on a barn floor.

After laying out the circles, divide them into a number of equal parts in order that the sections shall be alike, eight divisions generally being the most convenient, for then the sections are not too large to handle easily, nor too small, making too many in number. Make all the joints between the sections on lines with the center of the silo except one inside joint, which is cut on an angle, as shown in the drawing, in order to permit removing the inner forms. This section which is cut at an angle is placed last and removed first.

The curved boards for the frames of the form sections can be cut either from one wide plank, as shown in Fig. 33, or from two narrow planks which are tacked together. The frames may be covered either with sheet iron or with thin boards 3 or 4 inches wide nailed endwise to the frame.

The forms can be made also by riveting angle irons to the sheet iron to stiffen it instead of the wood shapes. While the metal form is more expensive than wood, if a number of silos are to be built, the first cost of the forms can be larger, because it is divided among several. One man making a form of this type can rent it to his neighbors, and in this way more than pay for the extra money spent in making the forms.

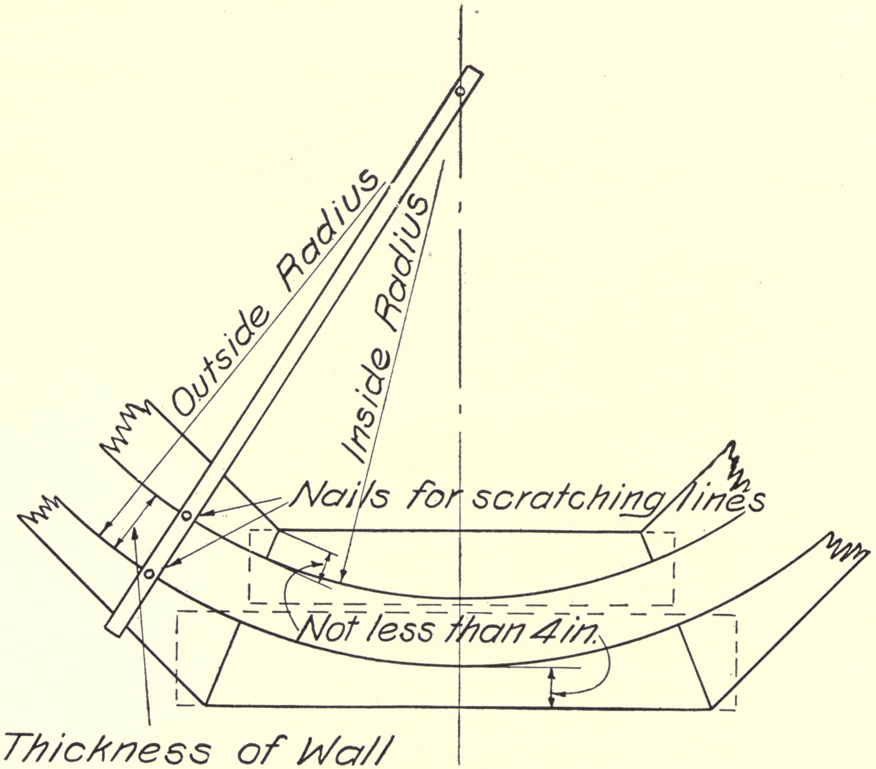
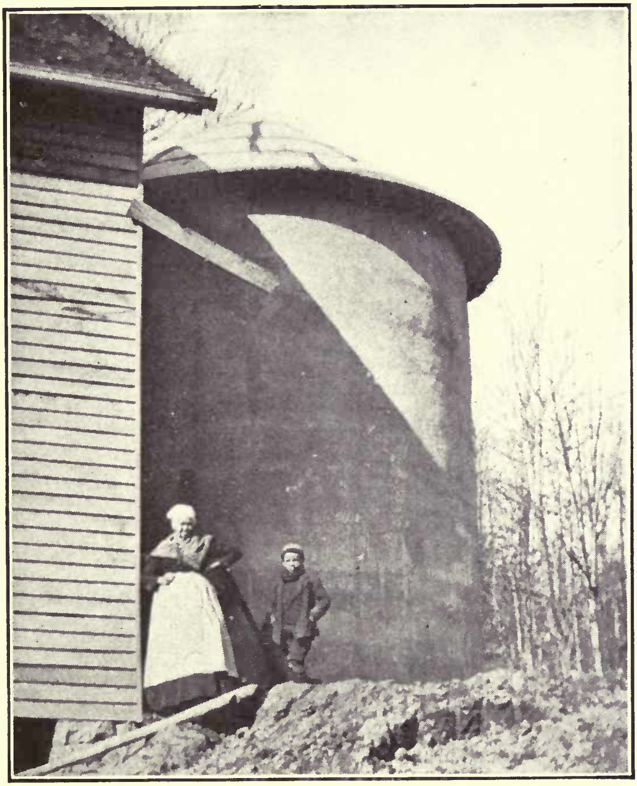


Fig. 33.—Method of Laying Out Silo Forms.

Excavate the earth to a depth below frost, which in the Northern and Middle States is about 4 feet, while in the Southern States 3 feet, or even 2 feet, may be sufficient and of the required diameter. If the earth is hard and will stand alone sometimes it is only necessary to excavate to the outside diameter of the silo. In other cases the diameter of the circle for excavating must be 4 or 5 feet larger than the outside diameter of the silo, so as to allow for a 2 or 2½-foot trench to make room for placing and removing the outer form. Grease the forms thoroughly. A mixture of fat or lard with kerosene makes a good grease for oiling the forms.

Care must be taken in placing the reinforcement. Locate the horizontal reinforcement by marking on one or two of the 4 by 4-inch upright studs of the scaffolding the location of all the rods; then there will be no question whether or not the reinforcement is in the correct position.

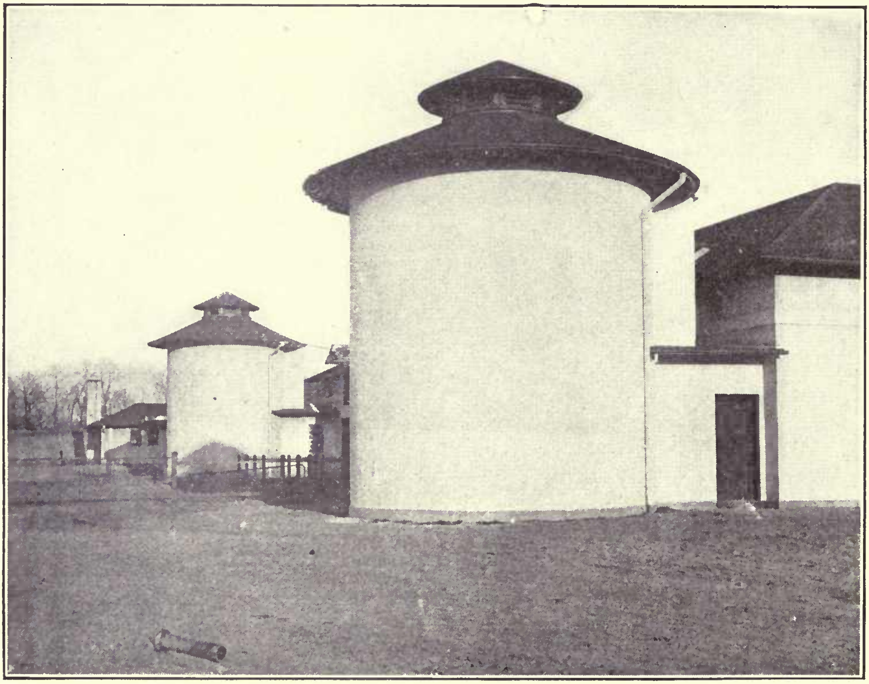
Before mixing the concrete, bend the horizontal rods into rings so that they will go in the middle of the wall. Lap the ends 2 feet. To find the length of rod to go around a silo, add to the inside diameter the thickness of one wall and multiply this sum by 3 1/7. This gives the circumference of the center line of the wall. If the length of this circumference is not too long for one rod, add 2 feet for the lap. If two rods are necessary, add 2 feet for each lap; that is, make every rod 2 feet longer than is required for the actual circum-



CONCRETE SILO AT CHARLOTTESVILLE. VA.

ference. By placing the inside form of the silo first, the reinforcement may be set in advance of the concreting, the horizontal rods being tied to the verticals by soft wire about 1/16 inch diameter. This is a better way than to place the horizontal rods as the concrete is being laid. The table gives the distance apart of the horizontal rods at the bottom of the silo. Increase the spacing slightly toward the top so that at the top the rods are double the distance apart they are at the bottom.

Mix the concrete, using one part "ATLAS" Portland Cement, two parts clean sand and four parts broken stone or screened gravel. For mixing of the concrete, see page 24. Make the mixture of sloppy consistency about like heavy cream, place it in the forms and ram lightly to distribute the mortar and drive out air bubbles. Before removing the forms, clean off the top of the wall with a stiff wire brush or an old horse curry comb, and raise the forms for the next filling. Before placing the new concrete, wet thoroughly the surface and spread a ½-inch layer of mortar mixed about one part "ATLAS" Portland Cement to one part sand and then place the concrete. Care must be



CONCRETE SILOS AT EAST NORWICH, L. I.

(The dimensions of these silos are as follows: Footing, 4 feet below ground; 20 feet inside diameter; 24 feet above ground; 12-inch walls reinforced vertically with 1-inch rods 4 feet c. to c. and horizontally with ½-inch rods 3 feet c. to c. There were 443 bags of "ATLAS" Portland Cement used.)

used in tamping the concrete, not to push the rods to one or the other side of the form, but to keep them in the center of the wall.

As soon as the forms are removed roughen the inside surface by scraping off the skin of cement with a wire brush or a brick; as soon as the walls of the silo are completed wet the inside surface thoroughly with clean water, and plaster it with not over a 1/16-inch coat of one part "ATLAS" Portland Cement to one part clean, coarse sand, screened through a fine screen. Protect the surface from the sun and wet twice a day for seven days. It is very important to have this inside surface perfectly smooth, for when the ensilage settles after being packed, any roughness of the walls is liable to cause the cornstalks to catch and prevent them settling evenly. The ensilage around the air space thus formed becomes moldy and must be thrown away. This same thing occurs where the concrete is laid with too little water. The concrete then is porous and sucks out the moisture from the ensilage, forming a dry skin of material next to the wall.

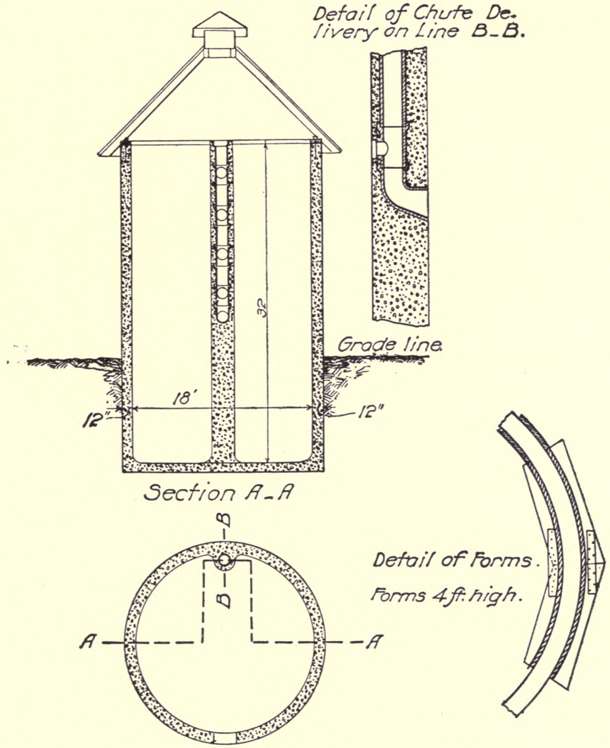


Fig. 34. Details of Silo Built at U. S. Soldiers' Home, Washington, D. C.

The outside surface of the silo is generally good enough if it is rubbed down with a board or a brick, using water with it, immediately after taking off the forms while the concrete is fairly soft so as to take off the joint ridges and leave a uniform surface. By removing the forms the next day after laying the concrete, it is possible then to entirely remove the skin of cement, leaving the sand and stone exposed enough to give a very pleasing finish.

For convenience in handling the ensilage, it is well to leave openings or doors about 20 inches square at least every three feet on one side of the silo.

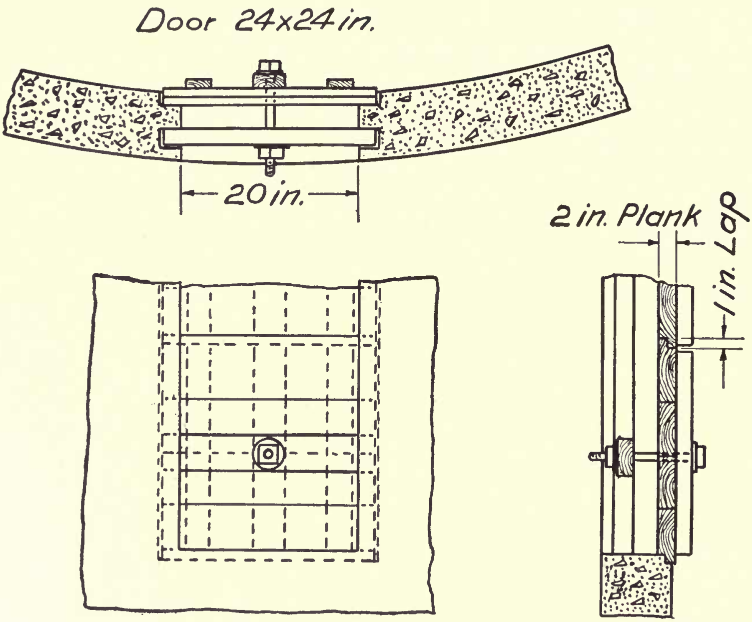
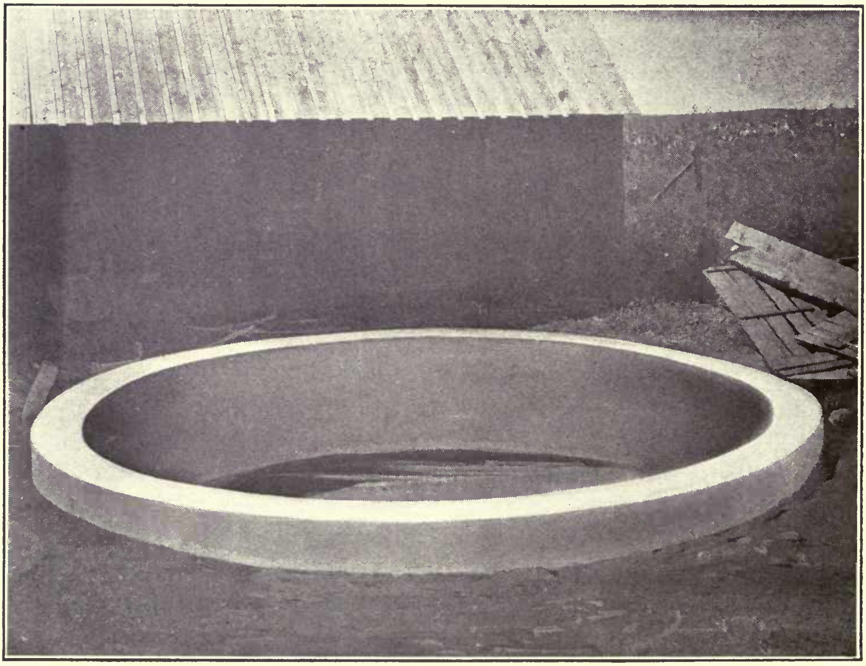


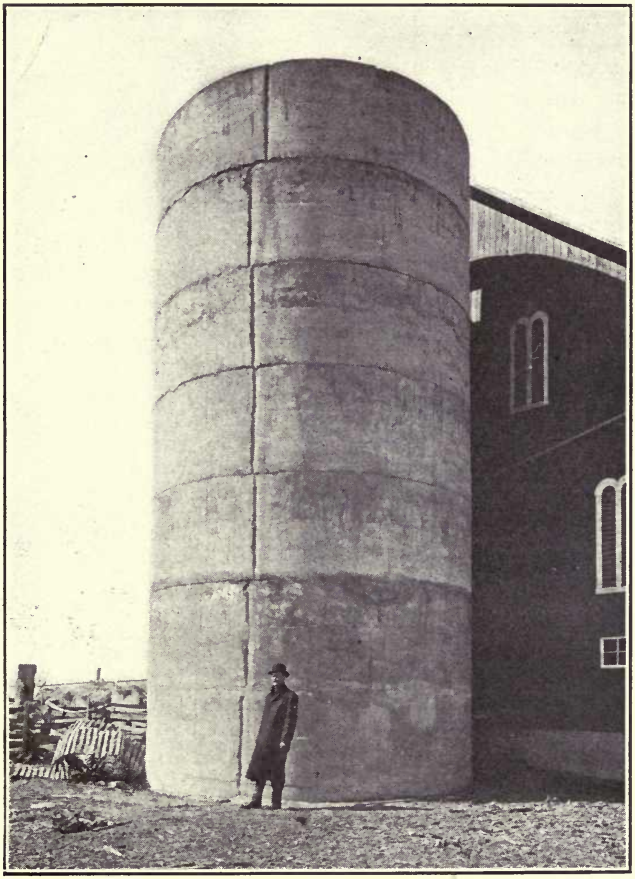
Fig. 35. Door for Silo at East Norwich, L. I., N. Y.



CONCRETE SILO FOUNDATION AT BRICELYN, MINN.

When desired, an opening 20 inches wide may be left the entire height of the silo if a part of the horizontal reinforcement is run across the opening to strengthen it; this opening is to be closed by a series of wooden doors. A good design for a door or a series of doors is shown in Fig. 35.

A chute running to the full height of the silo has sometimes been built around these doors or openings being constructed simultaneously with the



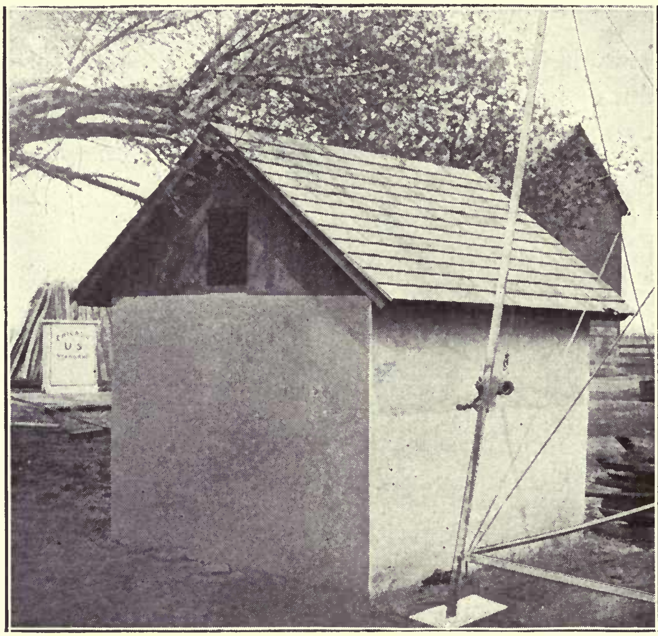
SILO AT SOUTH CHARLESTOWN, OHIO

walls. Make the walls of the chute 4 inches thick and reinforce them. A convenient size for such a chute is about 4 feet along the face and 2½ feet at the sides.

One method of building a chute is illustrated in Fig. 34. The chute is made of 12-inch tiles and pipe, each length being 24 inches. Alternate lengths of plain pipe and tiles were used so as to bring the openings 4 feet apart.

HOLLOW WALL SILOS.

If it is desired to make the silo with a hollow wall, the construction can be made similar to the ice-box walls described on page 102. The inside section of the wall of the silo is made the thickness required in the silo table, page 105, and the other walls 3 inches thick with lighter reinforcement. Formerly it was thought necessary to make all silos of hollow wall construction, but this is now practically superseded by the solid wall built with dense wet mixed concrete.



STORAGE WATER TANK AT BOODY, ILL.

TANKS.

Concrete tanks, if properly built, are superior in all respects to any other kind of a tank for storing water or grain. They are easy to clean, and do not rot or rust. The concrete mixture should be in proportions one part "ATLAS" Portland Cement to one and one-half parts clean but rather fine sand to three parts screened gravel or broken stone.

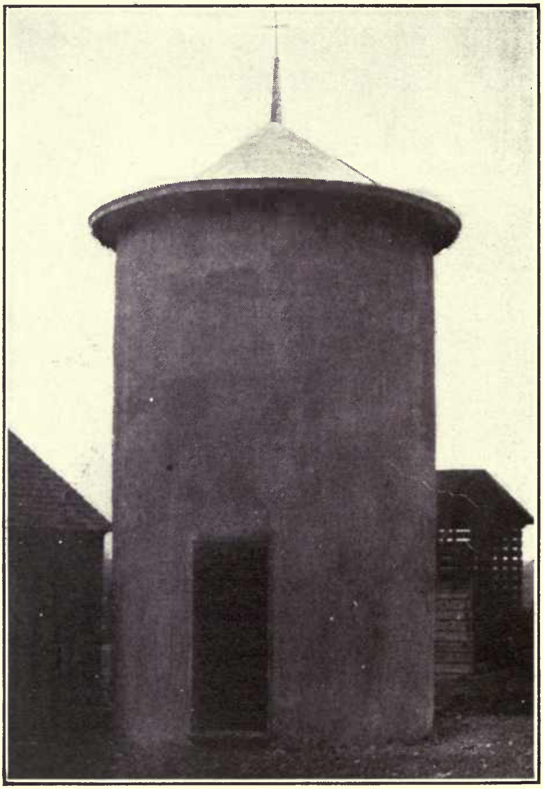
A tank in order to withstand water pressure and not leak is best built by laying the concrete without stopping. Even then there are other essential things which, if disregarded, will produce a leaky tank. The concrete must be mixed so wet that it will flow over and around the metal reinforcement and against the forms. The materials for the concrete must be very carefully proportioned and the stones small enough to pass a ¾-inch mesh screen. A concrete made by using very clean screened gravel makes a denser concrete than broken stone; it flows into place better and is not so apt to have voids and stone pockets which let through the water.

SQUARE TANKS (Small). Square tanks do not stand water pressure so well as round because the sides tend to bulge, but they are all right if not more than 4 feet deep and 8 feet square. Build outside forms 12 inches wider,

WATER TANK, NEAR MORTON, ILL.

12 inches longer and 6 inches deeper than the inside of the finished tank. Set mesh reinforcement, or else ¼-inch rods running both ways and 6 inches apart, in bottom of tank and the reinforcement given for a 5-foot round tank in the sides. Allow the vertical rods to project down into the bottom and the bottom rods to project up into the sides. Tie horizontal rods to vertical by 1/16-inch soft wire. Place inner form 4 inches from the outside form. This form can rest on iron pins driven into the ground. Grease forms thoroughly. Put concrete into forms at one continuous operation so that there will be no joints between courses, making it of the consistency of heavy cream. As the concrete is placed in the bottom, lift the reinforcement a little to allow the

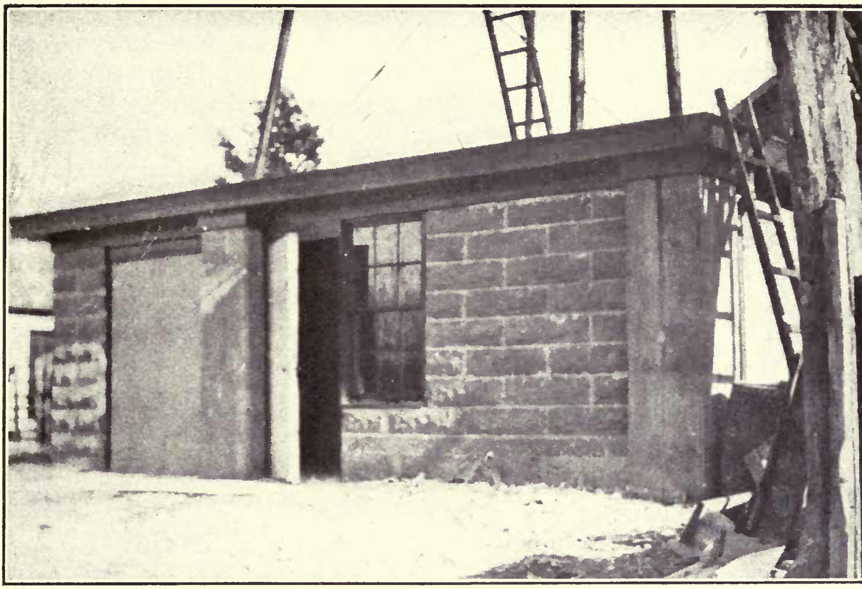
concrete to get in under it. When filling the wall take care to keep the reinforcement in place. By working carefully, the inside form may be removed as soon as the concrete has become dry on top, say, in two or three hours, although a better way is to leave it for two or three days and knock the form to pieces. Leave outside form in place for three or four days. After the concrete has set and the forms are removed, paint inside of the tank with pure cement mixed with water to the consistency of cream and brush in



WATER TANK AT MORTON, ILL.

well. This should prevent any leakage. Protect the tank from the sun till ready to use and wet two or three times a day for a week after removing the forms. Do not fill with water until tank is two weeks old.

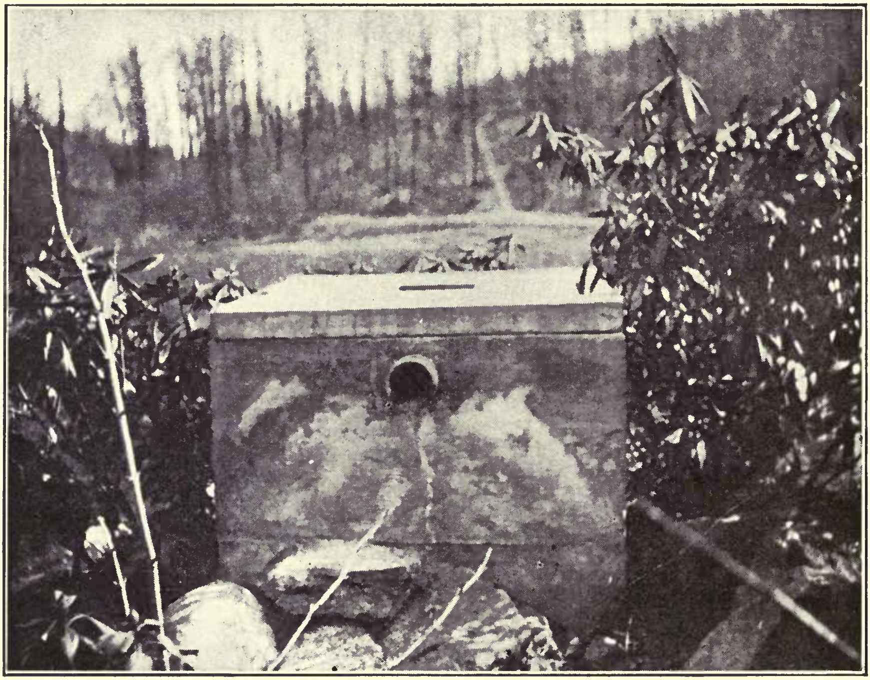
ROUND TANKS. Follow exactly the same methods given for square tanks, except using thicknesses and reinforcement given in the table. Lay out circular forms as described on page 20 or page 106. Set the reinforcement in place and pour the concrete in the same way as for square tanks.



WELL HOUSE WITH HEAVY CONCRETE COLUMNS FOR SUPPORTING STEEL FRAME OF HIGH WATER TANK AT COLUMBIA, MO.

WATER TANK, SO. CHARLESTON, O.

Tanks sometimes have to be constructed by filling one or two sections of forms each day, letting it set over night and continuing the next day. This is bad practice because it is readily seen that a joint is formed on the surface of each layer of concrete which is placed on top of another layer that has set up and hardened; to make the joint as tight as possible the top surface of the old concrete must be specially treated. The operation for treating this surface is as follows: Scrape off all dirt and scum from the old surface, pick it with a pick or scrub it thoroughly with a wire brush or horse curry comb in order to remove all surface mortar and scum and leave a very rough



WATER TANK AT BERRY HILL, L. I., N. Y.

surface. To make the bond between this cleaned surface and the new concrete, wet it thoroughly, soaking it well, place a ¼-inch to ½-inch layer of one part "ATLAS" Portland Cement to one part sand, or, better still, a layer of pure "ATLAS" Portland Cement on the cleaned surface, and before this has set or has begun to stiffen place the new concrete upon it. In some cases a positive bond between the old and new concrete work is used in addition to the above by imbedding in the top of the last mass of concrete laid each day a 4 by 4-inch piece or a V-shaped stick of timber. This timber, which is removed the next morning, will form a groove to bond the new and old concrete together.

If the tank is built above ground, remove sod and earth until good firm material is reached. Excavate in any case at least 6 inches below the bottom of the tank and build foundation 6 inches thick of screened gravel or cinders or crushed stone, spreading in 4-inch layers and ramming hard. Be sure that this foundation is drained so that the water cannot collect and freeze in it.

For inlets and outlets to tanks place pieces of pipe in the concrete while it is being deposited.

Tanks may be roofed with either a wooden or concrete roof. For concrete lay the concrete on a very flat slope and reinforce it as described in the table for concrete beams and slabs on pages 30 and 31. A wooden roof is apt to be cheaper and will answer most purposes.

REINFORCEMENT FOR TANKS.

The table which follows gives a list of sizes of steel required for tanks of several different dimensions, allowing ample factor of safety. It is extremely important that the horizontal steel be placed exactly as given. The entire pressure of the water is assumed, according to the very best practice, to be taken by the steel, as concrete is not reliable in tension unless reinforced. The thickness of concrete is only required to imbed the steel and to make the tank water-tight, and should vary with the height of the tank, but not necessarily with the diameter. A minimum thickness of 4 inches for a 5-foot tank, running up to 10 inches for a tank 15 feet deep, is suggested.

DATA FOR REINFORCED CONCRETE TANKS.

(1) Depth Ft.		(2) Diameter Ft.	(3) Thickness of Concrete Inches	(4) Diameter Circumferential Rods Inches	(5) Spacing Circumferential Rods at Bottom Inches	(6) Spacing Circumferential Rods at Top Inches	(7) Diameter Vertical Rods Inches	(8) Spacing Vertical Rods Ft.
5	by	5	6	1/4	6	9	3/8	1 1/2
5	"	10	6	5/16	6	9	3/8	2 1/2
10	"	10	8	3/8	6	12	3/8	2 1/2
10	"	15	8	1/2	6	12	1/2	3
15	"	10	12	1/2	6	15	1/2	2 1/2
15	"	15	12	5/8	6	15	5/8	3

NOTE.—Bend circumferential rods in rings, place in center of wall and lap ends 2 feet. Increase, gradually, spacing of circumferential rods from bottom to top.

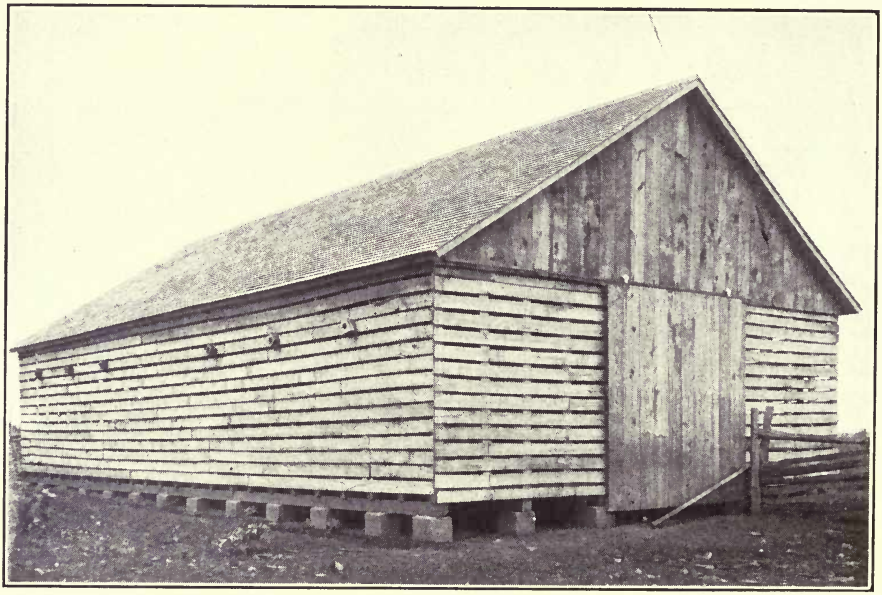
GRAIN ELEVATORS.

Concrete grain elevators of immense size are being built all over the country by the railroads. For the storage of grain on the farm or in a village, grain elevators can be built like silos, and the descriptive matter and amount of reinforcement under silos, pages 103 to 113, will apply. An elevator built in this way is proof against rats and other vermin, and is water-tight.

CORN CRIBS.

The waste caused each year by rats and mice in corn cribs is enormous. This loss can be prevented by constructing the entire corn crib of concrete, as well as the floor, which makes it also fireproof.

The corn crib may be constructed with 5 x 5-inch concrete posts, spaced 4 feet on centers, and extending from the concrete foundation to the roof plate, which may also be a beam of concrete tying the posts together and supporting the wooden roof. On two of the opposite sides of the posts mold a slot 1 inch deep by 2 inches wide its entire length. The sides of the crib may consist of



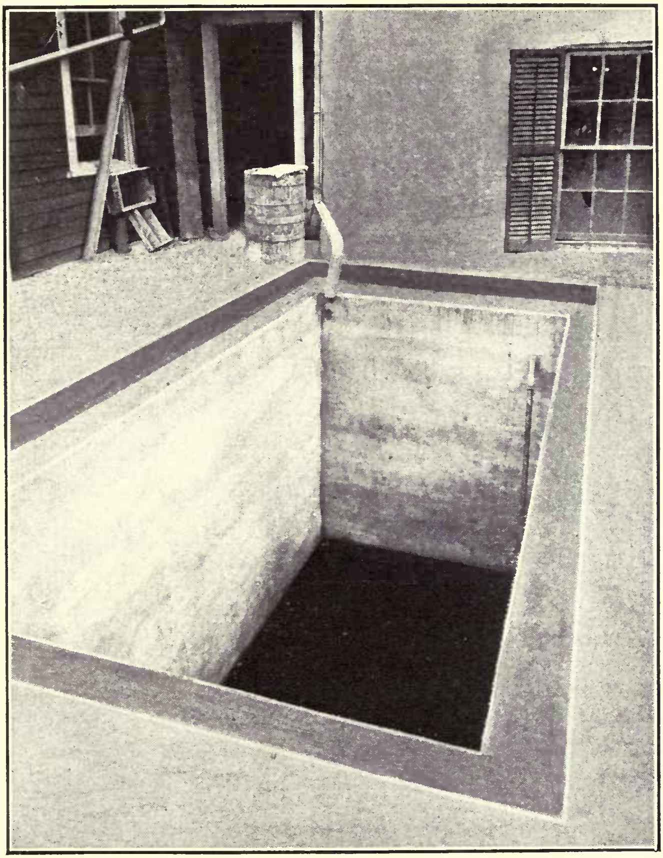
40 BY 60-FOOT STOREHOUSE AT LOWVILLE N. Y., WITH CONCRETE PIERS

a series of slats or slabs. Cast or mold these separately 2 inches thick by 5 inches high by 3 feet 8 inches long, and reinforce with two ¼-inch rods in the same way that fence posts are molded. After thoroughly seasoning, place the slats in the slots in the posts so that there is a ½-inch opening between them. To accomplish this place one slat, then throw some mortar in the groove in the post on top of it. Place the next slat, and push it into the mortar at the joint so that a ½-inch space remains between the two slats. Continue in this way up to the plate.

The mix of concrete should be one part "ATLAS" Portland Cement to two parts clean, coarse sand to three parts fine screened gravel, or one part "ATLAS" Portland Cement to four parts unscreened gravel or sand.

CISTERN.

Make a circular excavation 16 inches wider than the desired diameter of the cistern, or allow for a wall two-thirds the thickness of a brick wall that would be used for the same purpose, and from 14 feet to 16 feet deep. Make a cylindrical inner form (see Circular Form) the outside diameter of which shall be the diameter of the cistern. The form should be about 9 feet long



CONCRETE CISTERN AT ST. CHARLES, ILL.

for a 14-foot hole, and 11 feet long for one 16 feet deep. Saw the form lengthwise into equal parts for convenience in handling. Lower the sections into the cistern and there unite them to form a circle (Fig. No. 36), blocking up at intervals six inches above the bottom of excavation. (Withdraw blocking after filling in spaces between with concrete and then fill holes left by blocking with rich mortar.)

Make concrete of one part "ATLAS" Portland Cement, two parts clean, coarse sand and four parts broken stone or gravel. Mix just soft enough to pour. Fill in space between the form and the earth with concrete, and puddle it to prevent the formation of stone pockets, using a long scantling for the purpose and also a long-handled paddle for working between the concrete and the form. To construct the dome without using an expensive form, proceed as follows: Across top of the form build a floor, leaving a hole in the center two feet square. Brace this floor well with wooden posts resting on the bottom of the cistern. Around the edges of hole, and resting on the floor

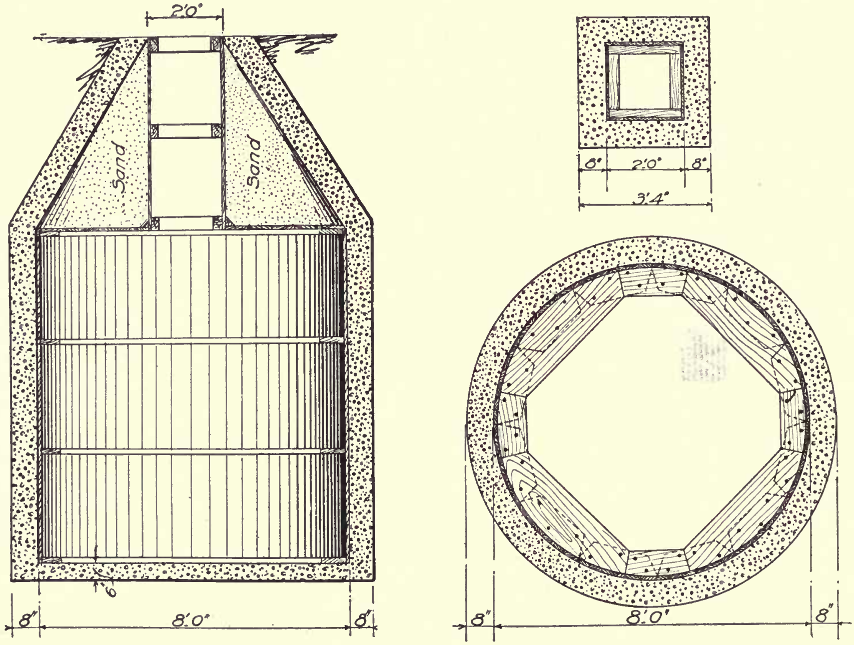


Fig. 36. Concrete Cistern.

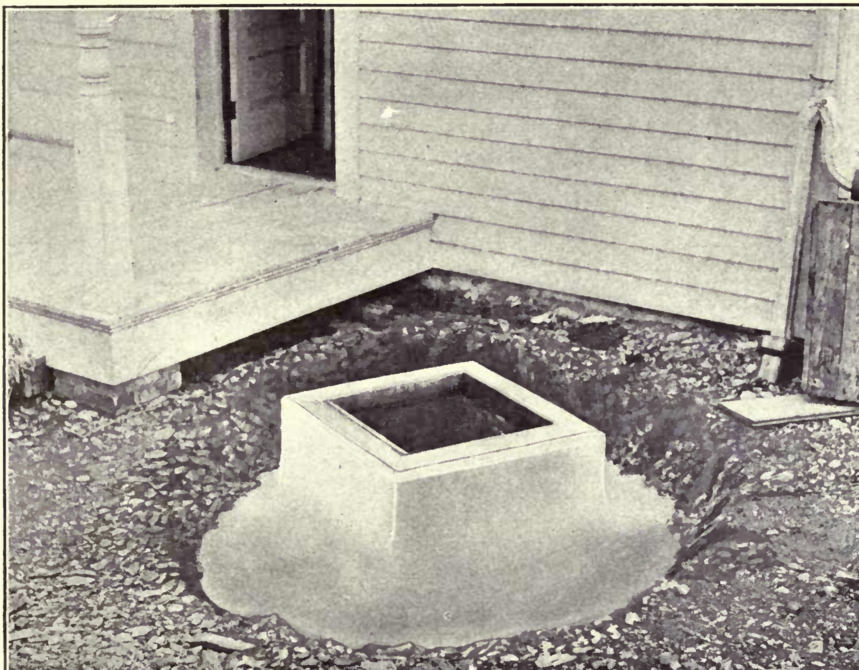
described, construct a vertical form extending up to the level of the ground.

Build a cone-shaped mold of very fine wet sand from the outer edge of the flooring to the top of the form around the square hole and smooth with wooden float. Place a layer of concrete four inches thick over the sand so that the edge will rest on the side wall.

Let concrete set for a week, then remove one of the floor boards and let the sand fall gradually to the bottom of the cistern. When all boards and forms are removed they can be easily passed through the two-foot aperture and the sand taken out of the cistern by means of a pail lowered with a rope. This does away with all expensive forms and is perfectly feasible. The bottom of the cistern should be built at the same time as the side walls and should be of the same mixture, six inches thick.

SQUARE CISTERNS.

Excavate to desired depth and put in 6 inches concrete floor, one part "ATLAS" Portland Cement, two parts sand and four parts broken stone. As soon as practicable, put up forms for 8-inch walls (see Walls) and build the four walls simultaneously. If more than 8 feet square, walls should be reinforced with a woven wire fabric or steel rods.



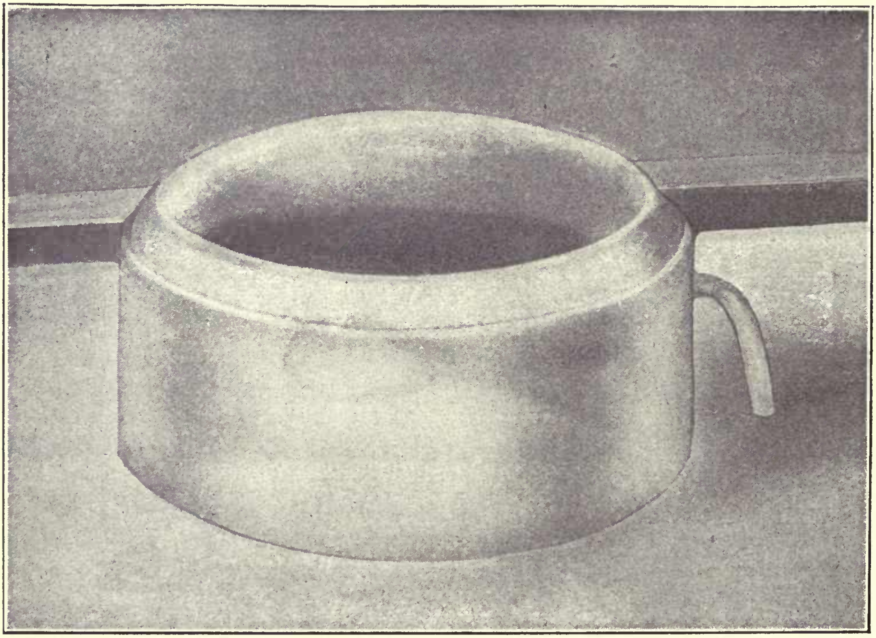
CONCRETE CISTERN AT MONROE, N. J.

WELL CURBS.

Concrete makes the best well curb, as it keeps out the surface water and is easily kept clean.

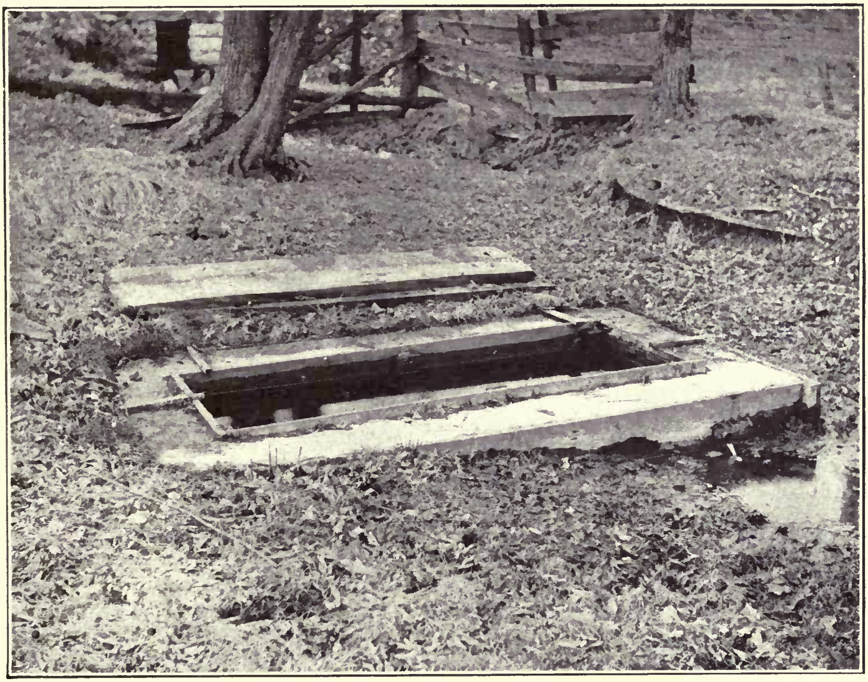
After the well has been dug to the desired depth, and the sides properly braced in short sections so that the earth cannot cave in, build a circular form 8 inches smaller than the diameter of the hole, and 4 feet long. (See Circular Forms.) Lower to the bottom in sections and adjust so that there are 4 inches between the form and the side of the hole. Place concrete mixture, one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand

SPRING CURB AT MONROE, N. J.



CURB IN INTERIOR OF SPRING HOUSE AT LAKE MASCOMA, N. H.

and five parts broken stone or gravel, in this space. To allow the water to get into the well, place a couple of pints of loose, broken stones in "pockets" every few feet until the water level is reached. After filling the form to the top and allowing it to set over night, or until the concrete will bear pressure of the thumb, raise it 3 feet, brace securely and repeat until ground level is reached. A slab 4 inches thick and 8 feet square should be built around the top of the well, first replacing surface soil with a layer of cinders or clean gravel, well rammed, about 12 inches thick.

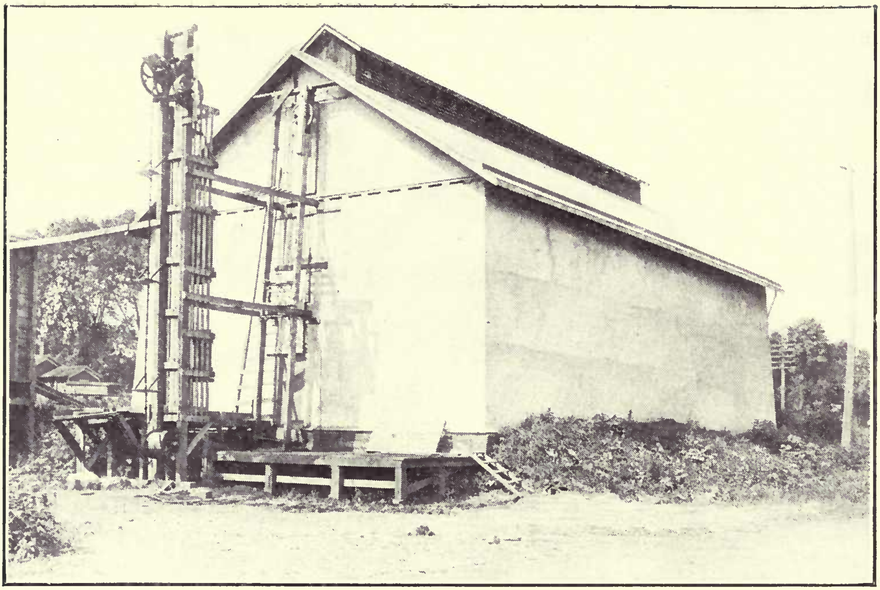


SPRING CURB AT MONROE, N. J.

ICE HOUSES.

There has been considerable discussion as to whether or not concrete ice houses are a success. After thorough investigation the conclusion has been reached that there are none better, if properly built—i. e., with a double wall.

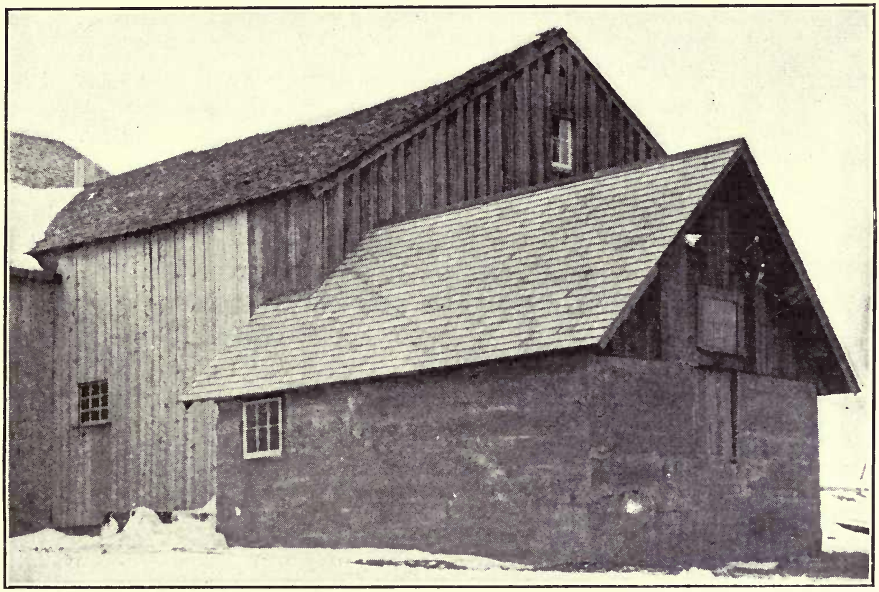
Excavate a foot below the desired depth and put in a layer of coarse gravel or broken stone, ramming hard. This makes a good floor and leaves plenty of drainage. Set up forms in shape finished structure is desired, allowing 16 inches for a wall, and build foundation one part



ICE HOUSE AT MONMOUTH, ILL.

ICE HOUSE AT BABYLON, L. I.

"ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone, 16 inches wide by 4 feet deep, or below frost. The wall should be built as shown in Hollow Walls, making two 3-inch walls with a 6-inch space, each reinforced with one-quarter-inch rods placed 12 inches apart in both directions. Mixture: One part "ATLAS" Portland Cement, two parts clean, coarse sand and four parts broken stone. The wall should be built in sections about 2 feet high at a time, and the outer and inner walls should be bound together by placing galvanized iron strips, one inch broad by one-sixth

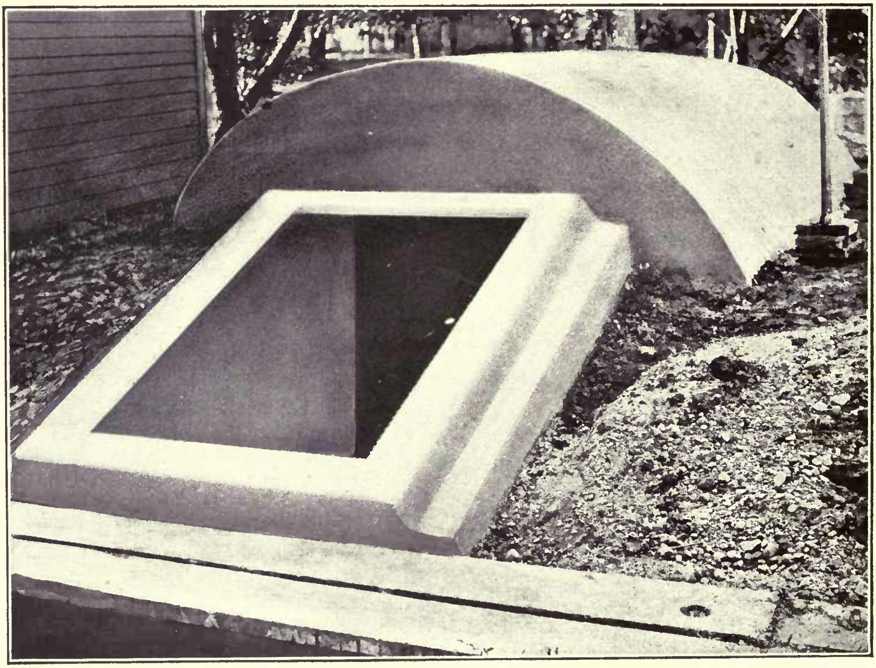


15 BY 20-FOOT CONCRETE ICE HOUSE ATTACHED TO COW BARN AT LOWVILLE, N. Y.

inch, and turned up about an inch at each end between the first and second section, after the first section of the inner form has been removed. These strips will not only strengthen the wall, but will serve as a convenient footing for the second tier of inner forms, etc. The ends and top should be filled in solid to the depth of 6 inches, leaving no openings for the air to circulate.

The roof should be made slanting, and after the lower or inner side is completed 5 inches of sand may be placed on top and leveled off. The upper or outer surface of the roof can then be laid, with suitable reinforcement, directly upon the sand, and carefully trowelled as soon as it is partly set. The sand is let out at an opening left for the purpose at the sides when the concrete has dried for a couple of weeks. There should be several square blocks of concrete placed so as to connect the two, and a strong concrete beam should form the ridgepole. All openings between the walls and roof and the two layers of roof should be sealed up solid, so as to give a dead air space between them. Shrinkage cracks are liable to form on large concrete roof surfaces so that if a surface is over 20 feet square it should be covered with tar and gravel or some other kind of roofing.

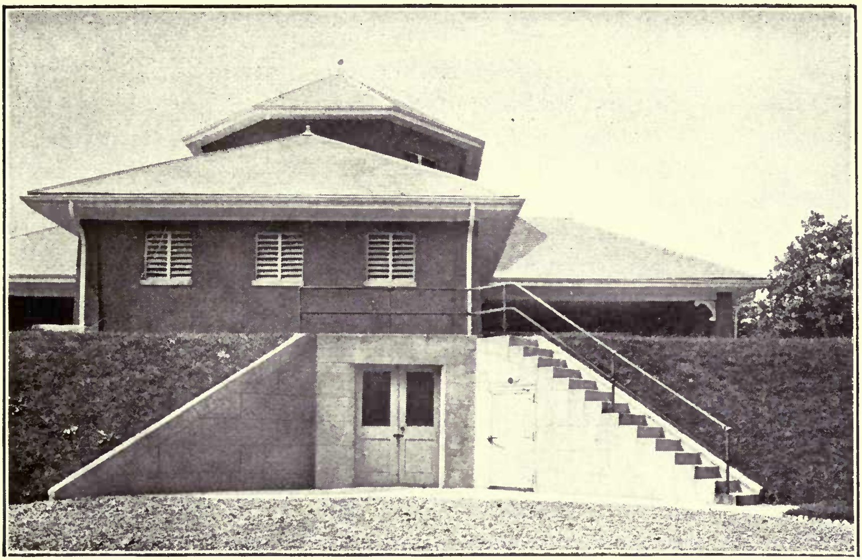
For a small house the dimensions of beams and slabs for roof may be obtained from table of Reinforced Beams and Slabs, but for a large house money will be saved and safety assured by consulting an engineer or architect experienced in concrete design.



ROOT CELLAR AT KNOXVILLE, IOWA

ROOT CELLARS.

Root cellars are usually built half below and half above the level of the ground. Excavate 16 inches below the desired level of the floor, and around the sides build a foundation 12 inches broad, one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone or gravel. Remove the form and fill between the foundations to a depth of 12 inches with porous material, tamping well. On this build a floor as described under Cellar Floors, p. 86. On the foundation and at equal distance from either edge



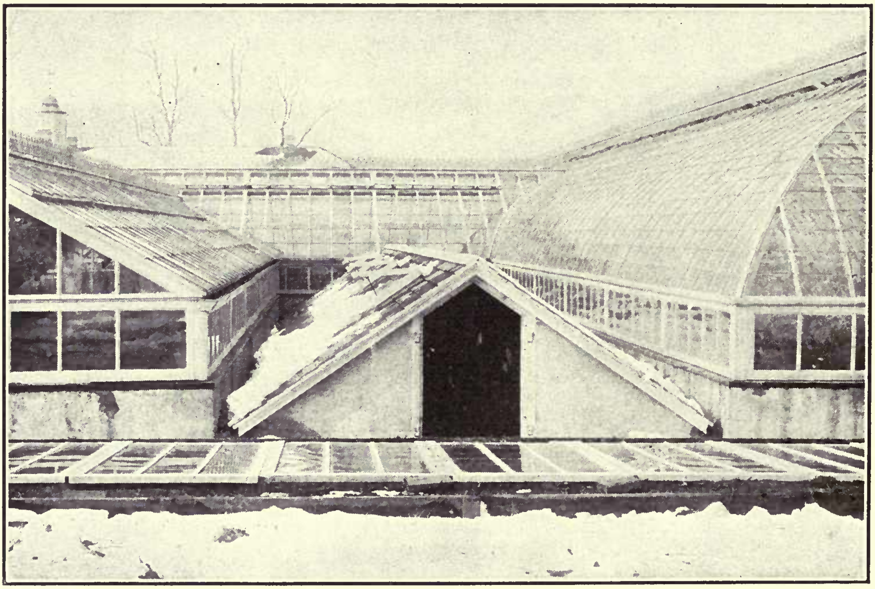
ENTRANCE TO ROOT CELLAR, UNDER WAGON HOUSE, AT U. S. SOLDIERS' HOME, WASHINGTON, D. C.

ROOT CELLAR, BABYLON, L. I.

erect a solid wall 8 inches thick (see Walls), one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand and five parts cinders, broken stone or gravel, leaving an opening at one end for the steps (see Steps). Build up the end walls so as to form a point in the middle and high enough to give the roof a sufficient pitch to shed the rain.

Near the top at each end, openings for windows should be left and sash fitted and plastered in after the concrete has set and forms have been removed.

Bins should be built of size and height to suit convenience, with walls 4 inches thick and reinforced with one-quarter-inch rods placed 12 inches apart horizontally and vertically.



ROOT CELLAR AT GLEN COVE, L. I.

If a concrete roof is desired, forms should be erected and a roof 3 inches thick laid on. On the top of this, and before the concrete is dry, a layer one-quarter inch thick of one part "ATLAS" Portland Cement and one part sand should be placed, trowelled when partially set, and smoothed with a wooden float. This surface must be wet three times a day for a week or two. Forms should not be removed from roof for at least three weeks.

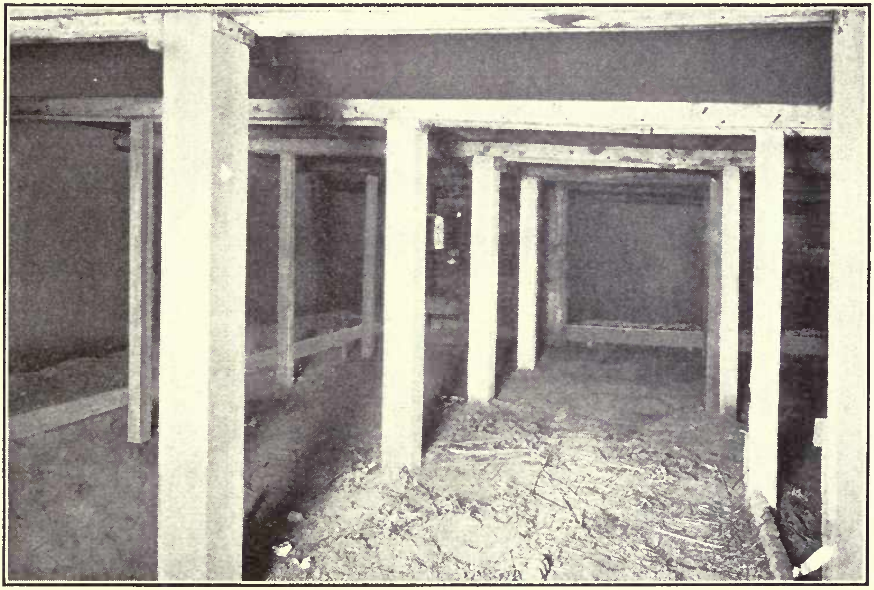
Should the roof be sufficiently long to require support other than the concrete beam that forms the ridge pole (see section on Reinforced Concrete), posts can be built in place 8 inches square.

Roof and steps should be reinforced with a woven wire fabric or with steel rods.

MUSHROOM CELLARS.

Mushroom cellars should be built at least two-thirds below the level of the ground to obtain the best results.

Excavate to the desired depth, and around the edge dig a trench 12 inches deep and 16 inches broad. In this lay a foundation one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone or gravel. On the foundations and at equal distance from either edge build a solid wall (See Walls) 8 inches thick; mixture, one part "ATLAS" Portland Cement, two parts clean, coarse sand and four parts broken stone, gravel or cinders.

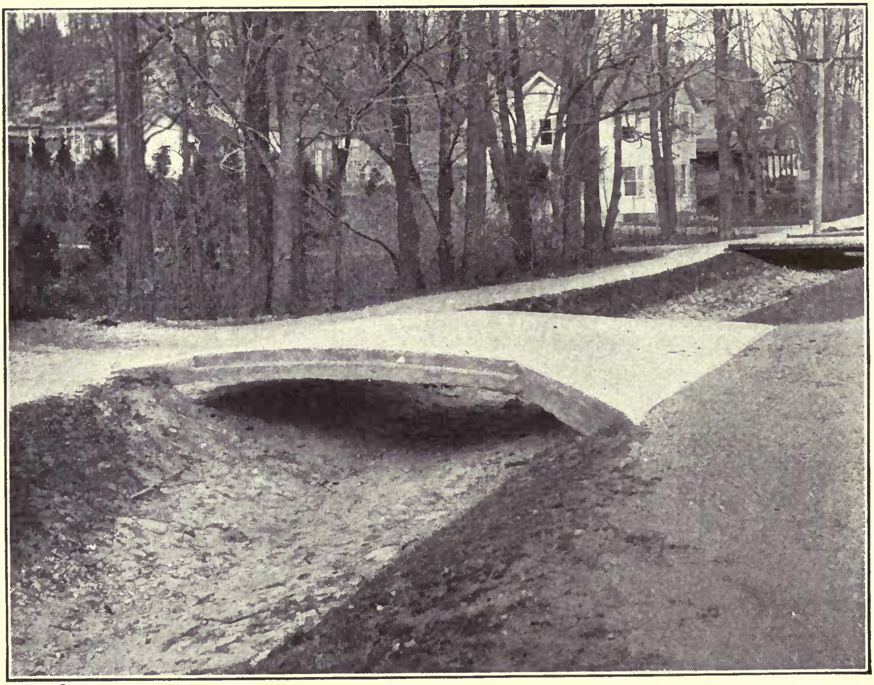


INTERIOR OF MUSHROOM CELLAR AT WESTWOOD, N. J.

Build a concrete roof 3 inches thick, supported by concrete beams and posts (see Table, Reinforced Concrete Beams and Slabs). An opening should be left at one side for steps (see Steps). All walls, posts, beams and roof should be reinforced. A coat of grout, one part "ATLAS" Portland Cement to one part fine, clean sand mixed to the consistency of cream, may be applied to the whole exterior with a brush if a very smooth surface is required.

Every farm or house along a country road must have one or more bridges or culverts where the driveways span the trench or ditch alongside the road. These arches or small bridges should be constructed of concrete, for then they will not continually rot out and need repairing and renewal.

An arch driveway consists of a slab supported on each side by a beam which spans the ditch. The size of the beams, the thickness of the slab, and the amount and spacing of the reinforcement in the beams and slab can be taken directly from the table on page 30. For example, take an arch



ARCH DRIVEWAY NEAR COLD SPRINGS HARBOR, L. I.

driveway of 12-foot span, having an 8-foot roadway. The heaviest loading, namely, 125 pounds per square foot, will be taken as given in the table. Beams 9 inches wide and 16 inches deep, reinforced in the bottom with four 9-16-inch rods, are required. The slab must be 3 inches thick, and be reinforced with 5-16-inch rods placed every 6 inches.

The arch or slab should be constructed during a dry spell, in order that little or no water need be taken care of in the ditch. The forms for the slab may be made of wood if desired, or it can be constructed as follows: If the ditch is not entirely dry, place a closed wood trough or a pipe in the bottom of the ditch, to take care of the small amount of water. Throw the earth which is excavated for the side walls into the ditch, and, if necessary, borrow sand from the bank beyond to bring the pile of sand to a height level with the bottom of the new arch or slab to be built and wet it thoroughly. Tamp this fill and level off the top of the pile. Place some boards for the side walls, and brace them. Place the necessary reinforcement, upon which lay the concrete, composed of one part "ATLAS" Portland Cement, with two parts clean, coarse sand and four parts screened gravel or stone. After the concrete has set for a week or two, shovel out the earth from under the arch, and the driveway is ready for use.

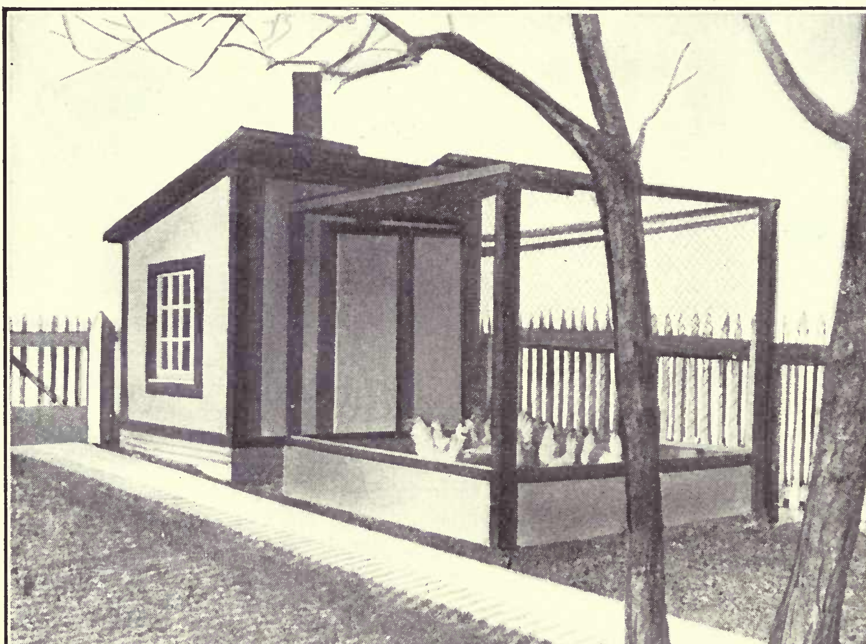
SPILLWAY AT DUMONT, N. J.

CULVERT DRIVEWAYS.

Culvert driveways are used to span small, shallow runways of water.

The bore or opening through which the water passes is generally built circular, although a square or rectangular opening may be used as well. Line the bottom or invert of the opening with small cobble stones or gravel, from which the sand has been screened. To make a circular bore or opening, get two or three flour barrels or cement barrels, with the heads in, place them end to end on the cobble or gravel base just laid, and brace them in position so that they will not be moved when placing the concrete. If desired, a layer of concrete can first be laid in the bottom of the ditch, on which the barrels can be placed and braced. After placing the barrels and side forms in position, lay the rest of the concrete, which should be composed of one part "ATLAS" Portland Cement to two and one-half parts clean, coarse sand to five parts gravel or broken stone. The walls should be about 10 inches thick and the top of the arch 6 inches thick. To remove the forms, knock in the heads of the barrels and pry out the staves.

WATER PIPES UNDER DRIVEWAYS. Concrete water pipes, which are covered over with earth, furnish a very good means for taking care of water underneath driveways. The pipes are constructed in the same manner as the



STUCCO CHICKEN HOUSE AT ALLENTOWN, PA.

concrete tile, described on page 91, and may be made up to 12 or 16 inches in diameter.

HEN NESTING HOUSES.

Hen nesting houses constructed of concrete are better and if a number are to be built are cheaper than if constructed of any other material. It is impossible to keep vermin from any nesting house, and consequently the nests must be cleaned artificially. The only sure way to clean a nest is by the burning out process. This is impossible, of course, where the nests are constructed of wood, and the only way therefore is to burn them every so often and build new ones.

It is hardly necessary to state the advantages of a concrete nest, but a few of them are: (1) that it is cool in summer and warm in winter; (2) no

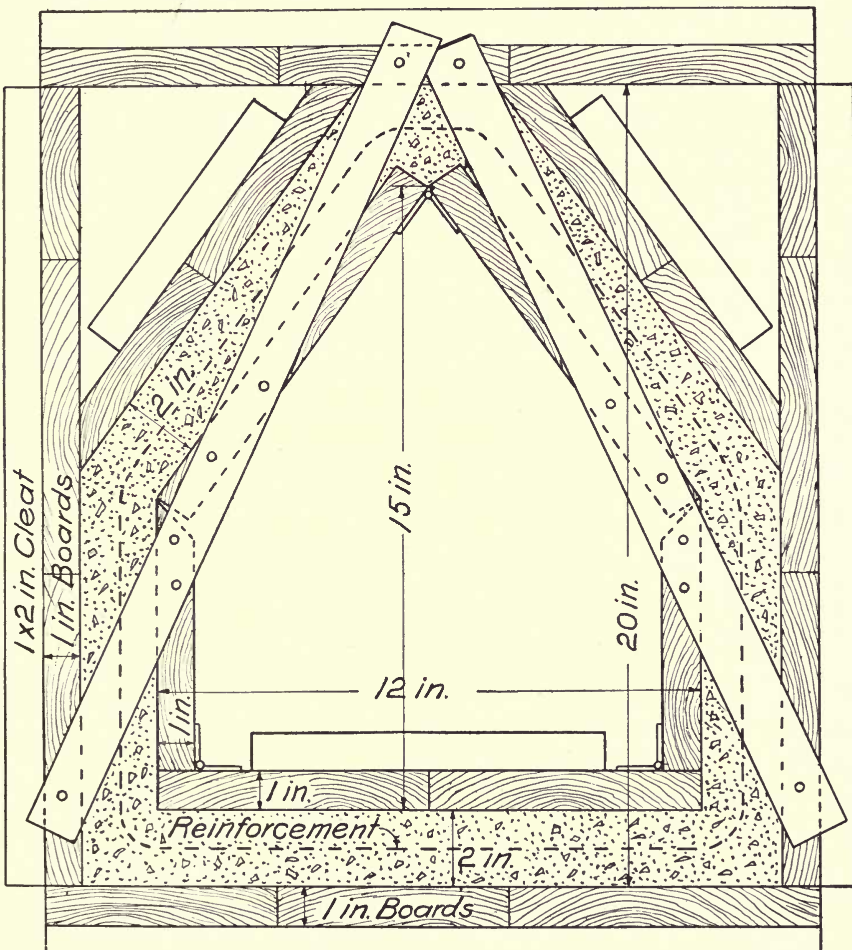


Fig. 37.—Design for Hen Nesting House.

draughts are possible, hence the hen will not acquire roup; (3) they can be burnt out after each nesting so as to destroy all germs, leaving the nest clean and wholesome; (4) if discolored by the fire the nest can be whitewashed after each firing.

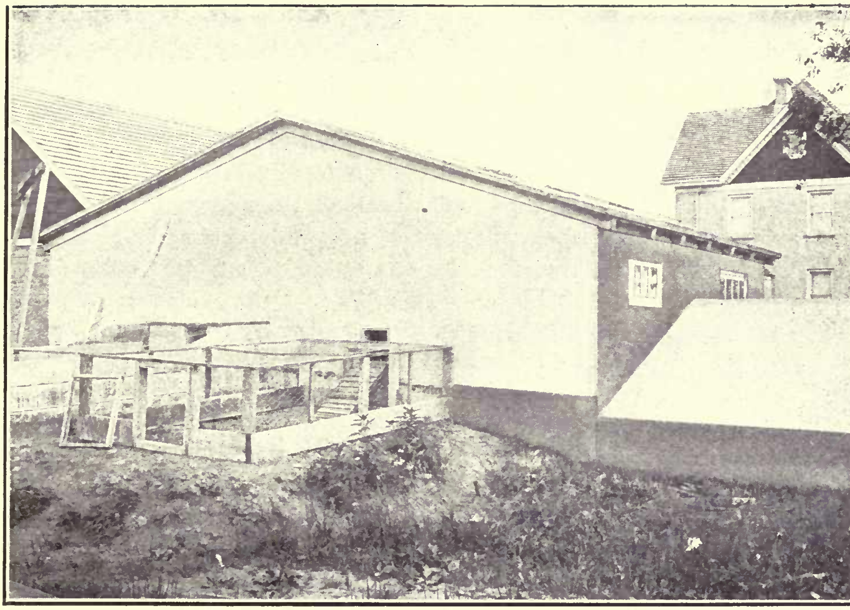
A good size for a hen nesting house is 12 inches wide, 15 inches high and 18 inches deep inside dimensions. The walls and back should be 2 inches thick, while the front is left entirely open, although if desired a lip or ledge can be cast on the front side. The ledge can be made out of wood and cut so that it fits snugly in the concrete and this can be removed very easily when cleaning the nests. The forms, as shown in Fig. 37, are very simple, and are made so that a number of nests can be built with one set of forms. The outside forms consist of a rectangular box without any ends and each side made as a separate member so that they can be easily taken apart after the concrete has hardened. When nailing the sides together do not drive the nails home, but leave the heads so that they can be easily drawn with a claw hammer, or, better still, drive the nail first into a short piece of lath which can be easily split when the sides of the form are to be removed, and thus the heads of the nails will stick out from the form ¼ inch and can be easily pulled out. Nail the outside form together with the two bevel pieces for the top of the nest tacked in and place on either hard level ground or a plank floor or platform. Oil the forms well so that they can be easily removed. The inside form is made as shown in the figure, having a hinge at the peak of the roof and two hinges at the bottom in order to facilitate removing the form. It is made in two separate sections which are held together by nailing on two cleats to serve also to hold them in the outer form and at the right distance, namely, 2 inches from the ground or platform. After placing the forms, which should be well greased, mix one part "ATLAS" Portland Cement with two and one-half parts of clean, coarse sand with five parts of screened gravel or broken stone. Place the layer of concrete in the bottom of the form for the solid back of the nest and then fill in the concrete for the walls. To remove the inside form take off the two top cleats, which allow the two slant boards to swing together on the hinge at the top, and the two side boards swing in on to the base boards, making it possible to remove them very readily.

Thirteen nests can be made from one barrel (4 bags) of cement, one-half of a single load (20 cubic feet per single load) of sand and one load of screened gravel or broken stone. Figuring cement at $2.00 a barrel, sand at 75 cents a cubic yard and gravel at $1.25 per cubic yard, the cost of the material for the concrete for each nest will be about 25 cents.

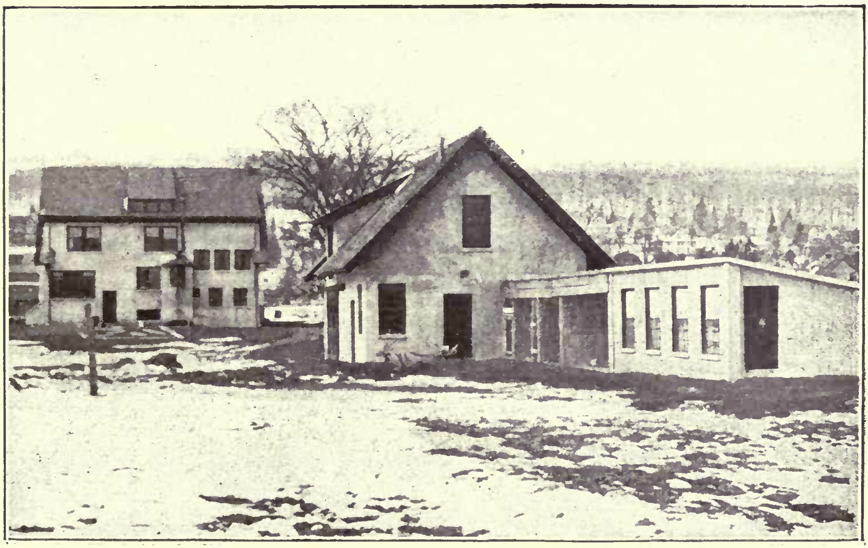
CHICKEN HOUSE.

The protection afforded by a concrete chicken house against rats, weasels, and other vermin, and the ease with which such a structure is kept clean, should be sufficient reason to give it preference over every other kind.

Excavate a trench 10 inches wide, to a depth below frost, and fill with concrete one part "ATLAS" Portland Cement, three parts clean, coarse sand

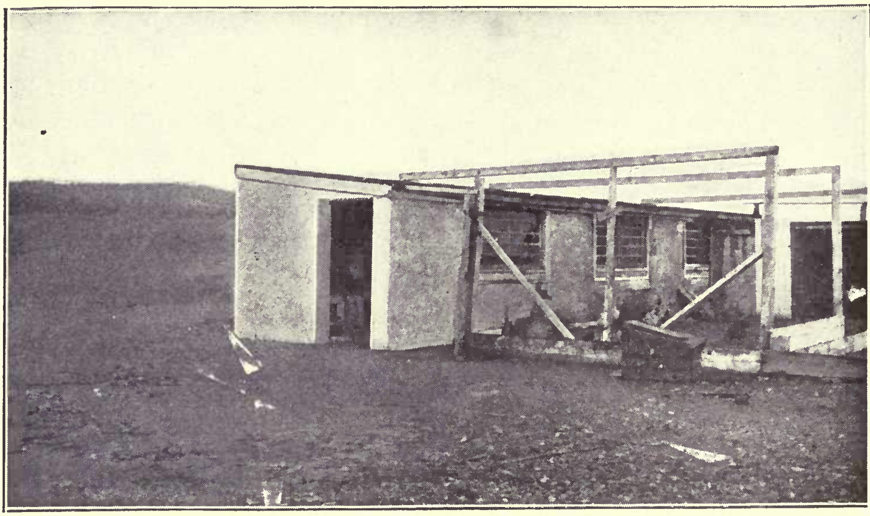


CHICKEN HOUSE AT WESTWOOD, N. J.



CHICKEN HOUSE AT MONTCLAIR, N. J.

and six parts cinders. On this foundation, and at equal distance from either edge, build a solid wall 5 inches thick (see Walls), one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand and five parts clean cinders or screened gravel. The roof may be made of wood or of concrete. If the house is not more than 8 feet wide, a roof with slope in one direction may be made of a 4-inch concrete slab reinforced with steel rods or heavy wire mesh of size suggested in the table of Reinforced Beams and Slabs. For a shorter span a less thickness may be adopted. A slope of six inches in eight feet will give sufficient pitch for the water to run off if the surface is well trowelled, as described under Sidewalks. If the width is more than 8 feet, concrete rafters may be placed and slabs upon them of dimensions to be selected from the table of Reinforced Beams and Slabs.



CONCRETE CHICKEN HOUSE AT LAUREL GROVE, N. J.

Concrete shelves and water basins can be put in to suit convenience.

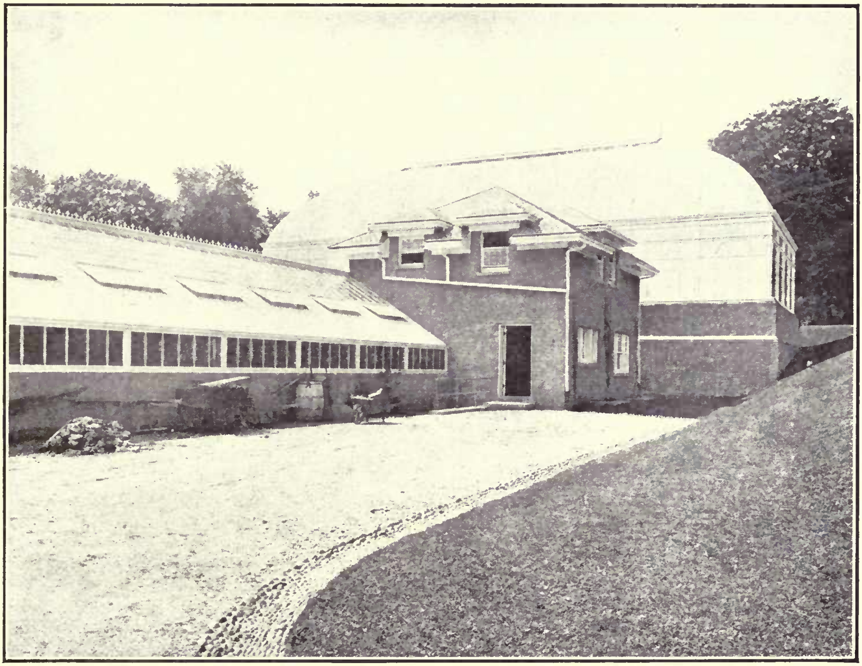
A coat of mortar one part "ATLAS" Portland Cement and one part fine clean sand, mixed as thick as cream, may be applied with a brush to the outside walls as soon as forms are removed, although with careful placing of the concrete, the surface may be wet and rubbed down as soon as the wall forms are removed and before the concrete has hardened, with a board or a brick, to remove the board marks of the forms and leave a pleasing rough surface.

The use of cinders is recommended in this construction, as the voids in the cinders take up the moisture, which is otherwise liable to collect on the inside of the wall in cold weather. The walls may be made with a hollow space, as shown in Fig. 31 (p. 102).

GREENHOUSES.

A greenhouse built of concrete not only does not require constant repairs, but saves fuel, as it retains heat and keeps out cold air.

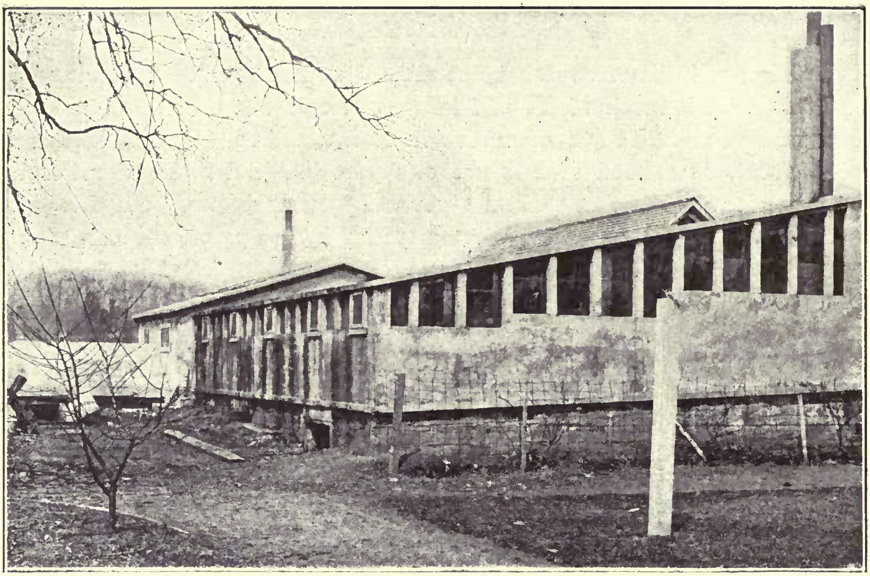
Greenhouses should have a foundation 10 inches broad and 16 inches deep, or below frost, composed of mixture one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone. On this, and at equal distance from either edge, erect a wall 7 inches thick, mixture one part "ATLAS" Portland Cement, two parts clean, coarse sand and five parts



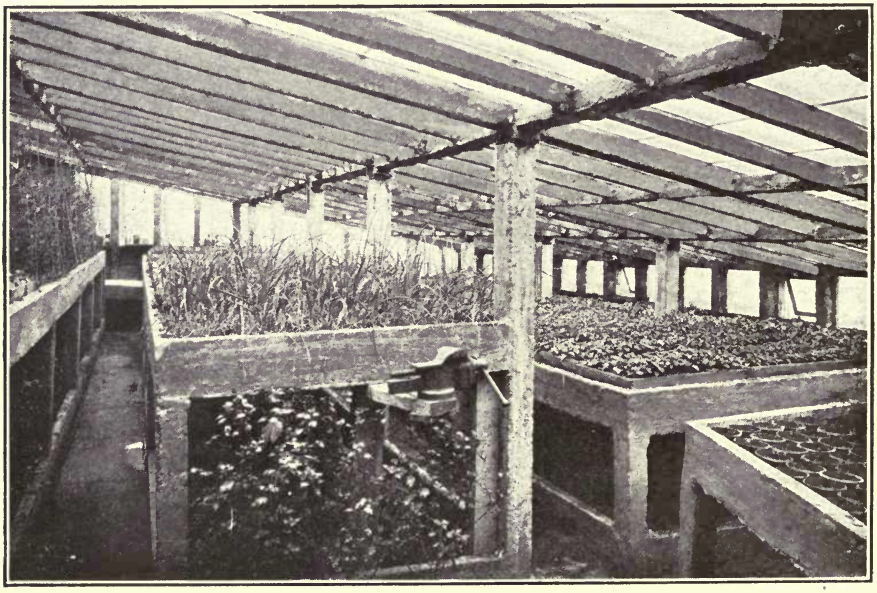
GREENHOUSE AT U. S. SOLDIERS' HOME, WASHINGTON, D. C.

cinders, to the height required for the walls. A ridgepole can be erected, 6 inches wide by 8 inches deep, of concrete, one part "ATLAS" Portland Cement, two and one-half parts clean, coarse sand and five parts broken stone or gravel not over three-quarters inch in size, reinforced with two steel bars each one-half inch in diameter. If total width of house is not over 16 feet, beams 2½ inches by 5 inches, extending from ridgepole to side wall, reinforced with a ½-inch bar, will be sufficiently strong to support the sashes.

Reinforced concrete posts 8 inches square should be placed at intervals of 10 feet to support the ridgepole.



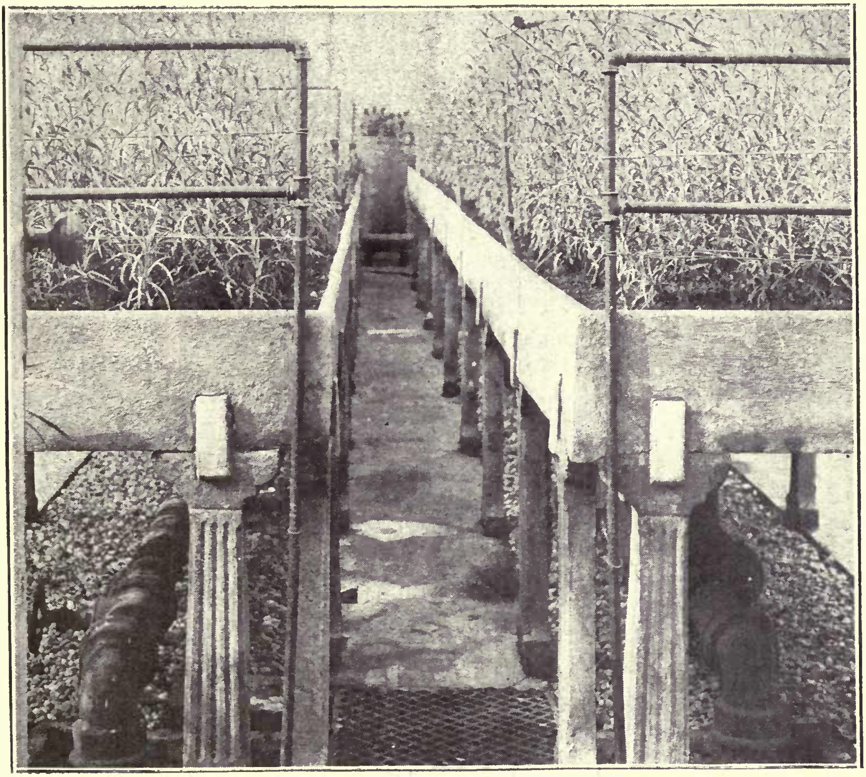
CONCRETE GREENHOUSE WITH CONCRETE SASH AT WESTWOOD, N. J.



INTERIOR VIEW OF GREENHOUSE AT WESTWOOD, N. J.

CONCRETE GREENHOUSE TABLES.

The tables or benches in greenhouses should be constructed of concrete in order to save the grower the large expense and annoyance of renewing and replacing every few years the old decayed wooden benches. The tables can be made either as one member, in which case the posts, bottom and sides are cast in one continuous piece of concrete, or they can be made by constructing them in parts. In order to facilitate the drainage of the water from the table, holes



INTERIOR VIEW OF GREENHOUSE AT GLEN COVE, L. I.

must be left at the bottom of the benches except when the bottom is cast in a series of slabs, where the cracks between them will be sufficient.

Make the concrete tables which are cast in one piece 2½ inches thick and of a mixture composed of one part "ATLAS" Portland Cement to two parts of clean, coarse sand to four parts of cinders, reinforced with a woven wire fabric or ¼-inch round rods spaced 7 inches apart. A design for a table and forms for molding the separate members is shown in Fig. 38. The posts should be 5 inches square, spaced on 6-foot centers, and the table may be made 4 feet wide. If the slab is molded in sections, as shown in the drawing (Fig. 38), the section should be made about 12 inches in width for convenience in handling.

The forms if well planned and greased with oil should leave the concrete surface smooth enough without plastering them, but if desired a coating 1/8

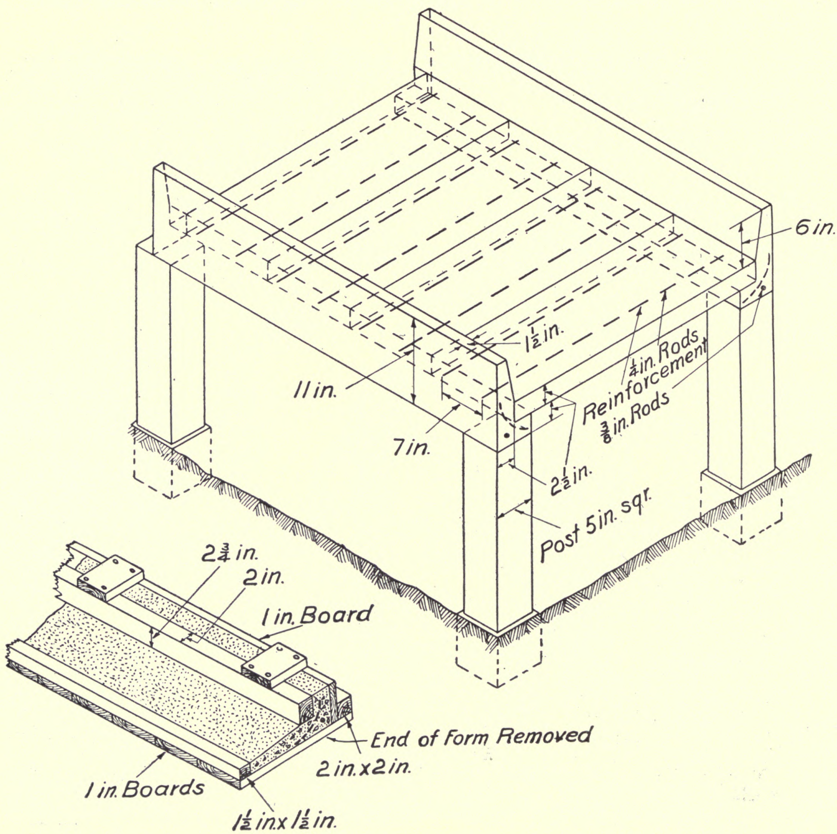
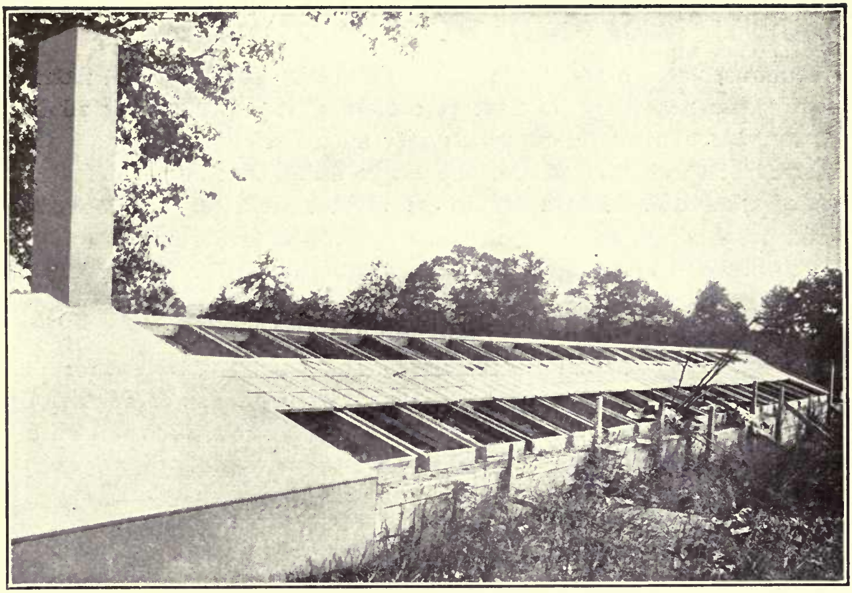
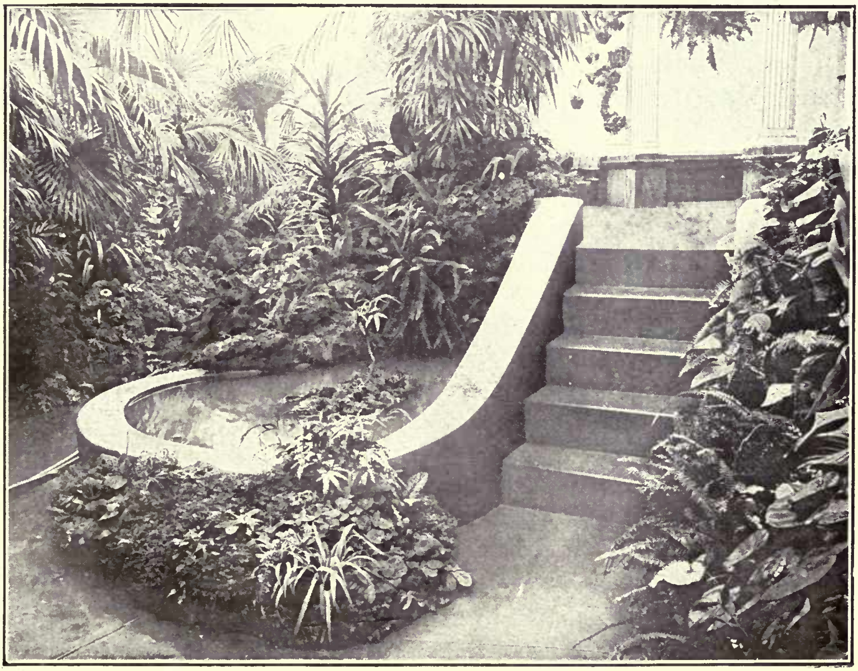


Fig. 38. Design of a Separately Molded Greenhouse Table.

of an inch thick, of one part "ATLAS" Portland Cement to one part of clean, fine sand, may be applied to them. This should be put on after the surface to be covered has been picked with a stone axe or old hatchet and thoroughly wet.



GREENHOUSE AT WESTWOOD, N. J.



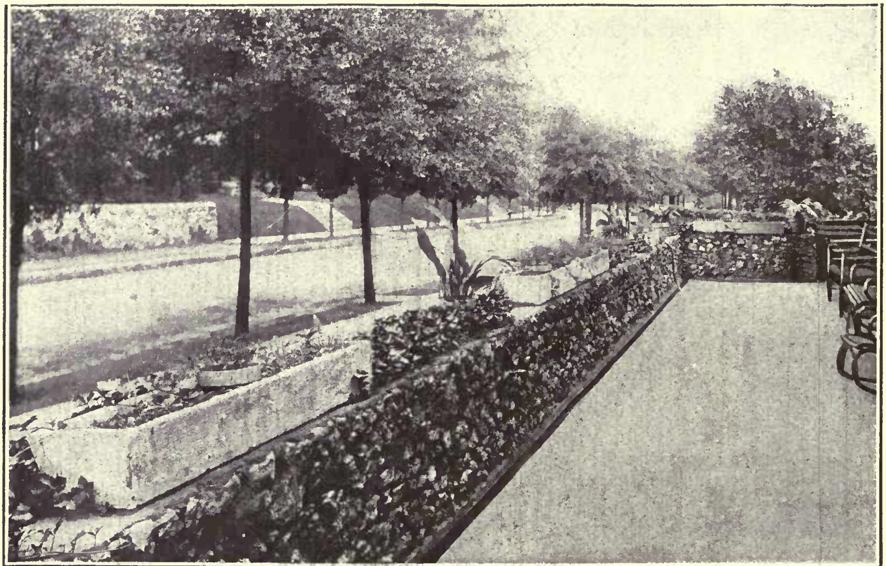
INTERIOR OF GREENHOUSE AT U S. SOLDIERS' HOME. WASHINGTON, D. C.

CONCRETE GREENHOUSE TRAYS.

Greenhouses are so warm that the moisture is soon dried out from the air. To supply the necessary amount of moisture, it is frequently advisable to keep a number of trays filled with water about the greenhouse. The larger the surface of these, the greater the evaporation, and hence the better producers of moisture. These trays are most satisfactory if constructed of concrete, because the concrete, unlike the wood ones, do not rot, and do not shrink if allowed to become dry and consequently need little attention to see that they are always filled. The concrete trays can be made very attractive, and are more serviceable than if made of any other material.

Make the trays like the slabs for tables (see page 140), except form a lip all around them to the required height. Brush a layer of pure "ATLAS" Cement, mixed to the consistency of thin cream, over the inner surface two or three hours after the concrete is poured to make them water-tight. Protect from sun and keep wet until they are to be used.

Frequently larger tanks are preferred, which may be made 18 inches wide by 18 inches deep, with 6-inch reinforced walls.



CONCRETE FLOWER BOXES.

CONCRETE FLOWER BOXES.

Concrete veranda boxes for flowers do not rot and therefore do not have to be renewed every two or three years. They are attractive, too, not only on the porch of any stone, stucco or cement house, but are ornamental to a frame house.

The length of the concrete veranda box is generally determined by the size of the space in which it is to be placed on the veranda. A good size is 5 feet long, 8 inches deep, and 10 or 12 inches wide. The outside forms consist of a long rectangular box, which may have the two long sides tapered if desired, so that the box will be 10 inches at the bottom and 12 inches at the top. This will make the finished concrete box look more attractive than if made with perfectly vertical sides. Use planed lumber in the forms and oil them thoroughly on all the surfaces coming in contact with the concrete. Line the outside form with poultry netting, folding it at the end or corners so as to make a reasonably close fit to the walls of the mold. Place the inside form, which consists of a bottomless frame having dimensions 3 inches smaller each way than the outside one, so as to make the walls 1½ inches thick. Set

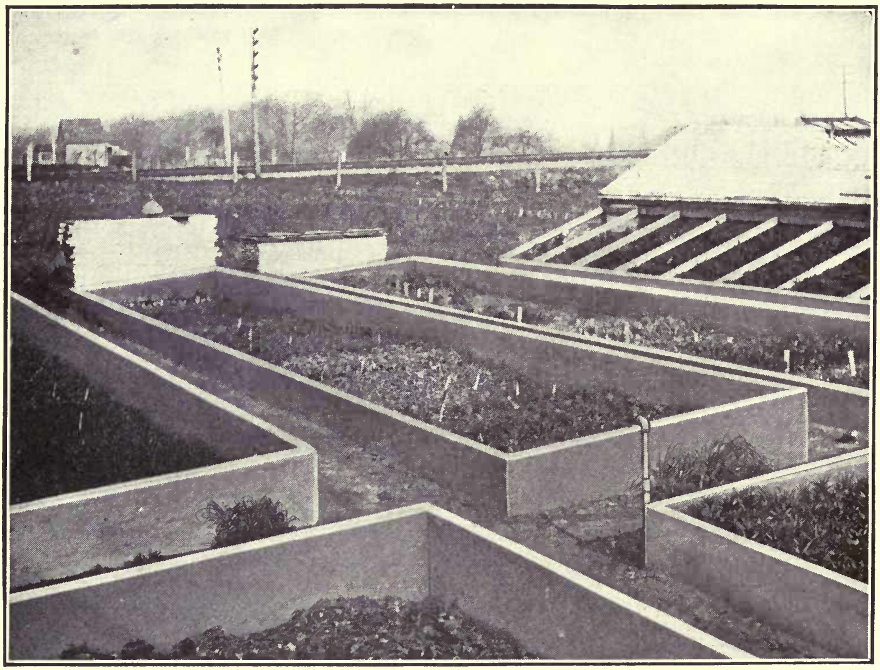
CONCRETE FLOWER BOX AT PATERSON, N. J.

this inside form on little blocks of wood to keep the form raised 1½ inches from the bottom of the outside form. These wood pieces can be removed when the concrete is hard, and will leave holes in the bottom of the box for draining off the excess water.

Mix a batch of concrete composed of one part "ATLAS" Portland Cement to three parts clean, gravelly sand which has been screened through a ½-inch mesh screen, that is, a screen having openings ½ inch square. Lay the concrete, which should be of the consistency of mortar for laying brick. Remove the inner form very carefully in an hour or two, but leave the outside form at least until the next day. The outside surface generally need not be finished off further than wetting it down thoroughly and rubbing it with a wood float or brick, but if desired it may be finished off as described on page 27. The box must not be moved for at least a week, for fear of cracking it. Wet it occasionally during this time.

HOT-BED FRAMES.

Excavate a trench to a depth below frost and erect forms for a 4-inch wall. Fill with concrete mixture one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone or gravel, to level of the ground. On top of these build forms for a 3-inch wall to height desired, and fill with concrete of the same proportions. Remove the forms in two or three days and keep the walls damp for a couple of weeks.



CONCRETE COLD FRAMES AT WESTCHESTER, N. Y.

WINDMILL FOUNDATIONS.

The great danger caused by the rotting of wooden windmill foundations is obviated by the use of concrete.

Excavate four holes at the proper distance apart, 2½ feet square and 5 feet deep; build forms for the sides and grease properly. Fill forms 2 feet deep with concrete, one part "ATLAS" Portland Cement, three parts clean, coarse sand, six parts broken stone or gravel, of a jelly-like consistency, tamping well every six inches. To insure proper location of holding-down

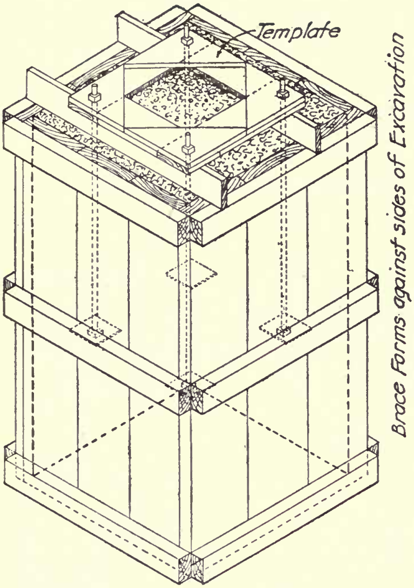
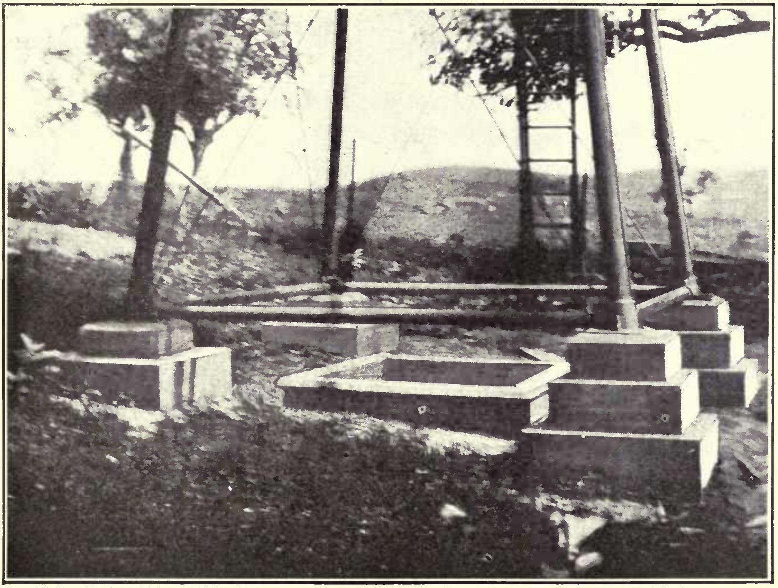


Fig. 39. Form for Windmill Foundation.

bolts, construct template and hang the bolts from it, as shown in Fig. 39, and fill in concrete around them until flush with top of form, and allow to set several days before using. This gives a substantial anchorage for a steel tower.

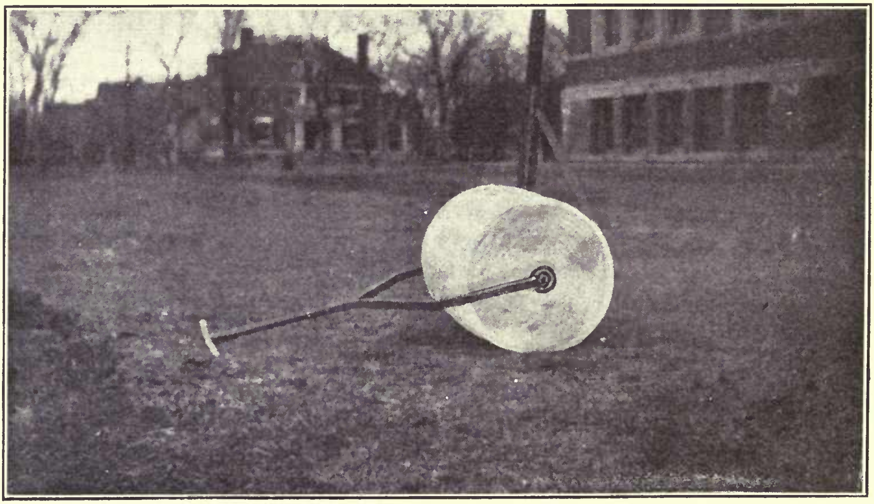
In case a wooden tower is to be used, run projecting bolts up through the timber sills and use large cast-iron washers under the nuts. The anchorage in this case should project at least 6 inches above the ground.



WINDMILL FOUNDATION AT MONROE, N. J.

CONCRETE ROLLER.

A concrete roller may be made as a hand roller to be operated by one or two men or as a horse roller, when it is, of course, larger and heavier. A hand roller for two men suitable for rolling lawns should be made about 18 inches in diameter and 24 inches long. This size of roller weighs about 530 pounds or 265 pounds per foot of length. The roller shown below is of the dimensions first given and has been used very satisfactorily for several years.



CONCRETE ROLLER AT NEWTON, MASS.

A form for making a concrete roller is very easily and cheaply made, as shown in Fig. 40. For a roller 18 inches in diameter and 24 inches long cut a piece of sheet iron 24 inches by 25¼ inches. The edges must be cut even and must be square. Make two sets of wood clamps like the circular forms shown on page 21. The piece of sheet iron cut to the dimensions as given can now be bent in a circle and nailed, if necessary, to the two wood clamps. Wire the iron form or jacket with No. 16 wire to hold the form from opening at the joint when the concrete is placed. Grease or oil the inside of the form thoroughly so that it will not stick to the concrete. To make an opening through the center of the roller for an axle or shaft, place a ¾ or ⅞-inch iron pipe in the center of the form. The axle can be cast in the roller itself if desired instead of casting a ¾ or ⅞-inch pipe in the roller in which to place the axle. The concrete should be made of one part "ATLAS" Portland Cement to two parts of sand to four parts of stone or gravel. It will take a little less than one bag of cement for a roller of the above dimensions.

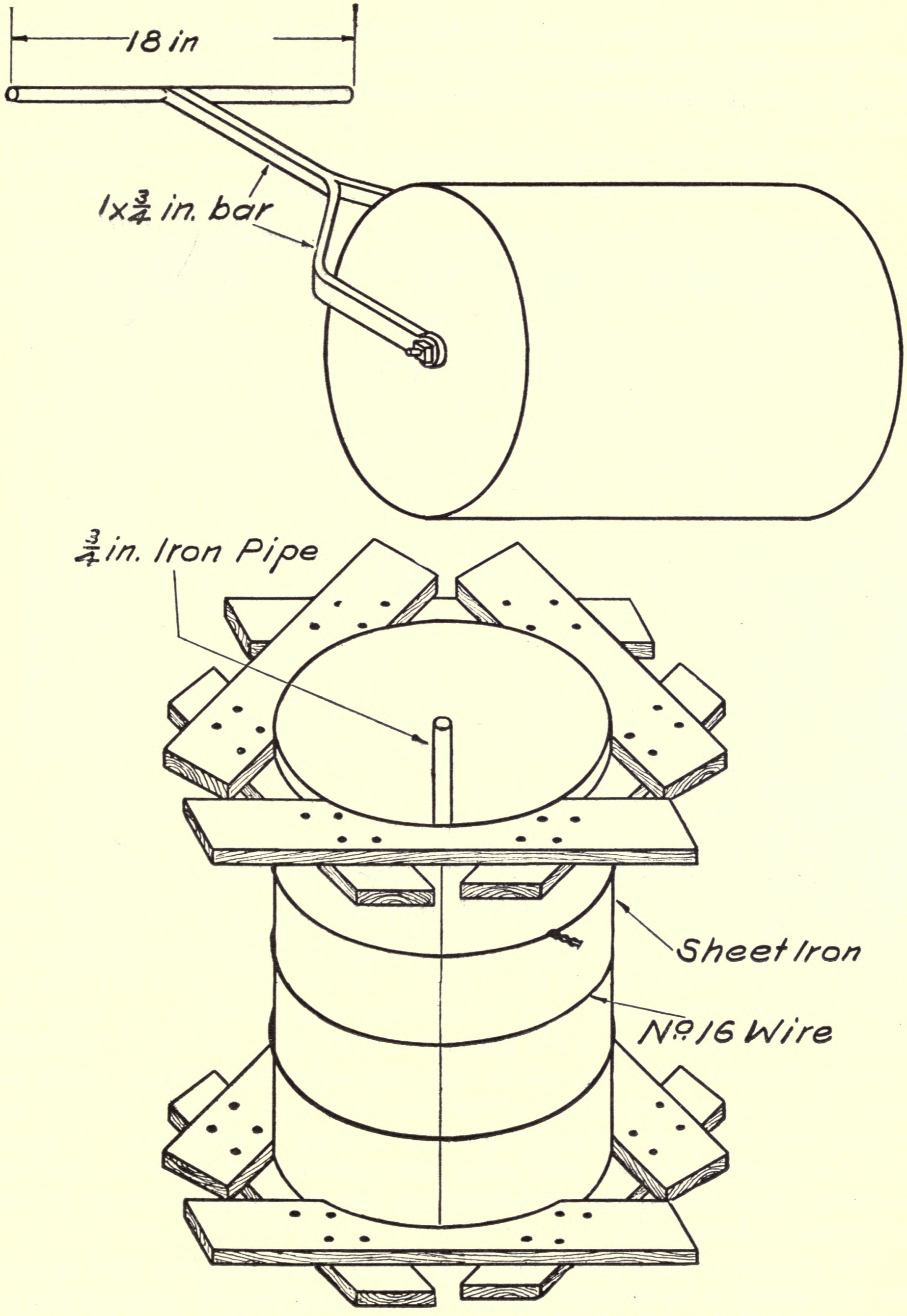


Fig. 40. Form for Concrete Roller.

The handle for a hand roller may be made of ¾-inch by 1-inch iron, bent and welded together as shown in the figure. Where the roller is heavier, or is to be operated by a horse, a heavier handle and different design of handle can be easily made.

A small roller for rolling seeded ground or golf greens may be made by pouring concrete into a piece of pipe which forms the outside surface.

DANCE PAVILION AT TWIN LAKE, HARRISTOWN, ILL.

DANCE PAVILION.

The photograph of the pavilion at Twin Lake, Harristown, Ill., shows what can be accomplished by a farmer and one farm hand who had never before had any experience with concrete. There are 16 posts in the 30 by 40-foot pavilion, each 8 inches by 11 inches, and the walls are 3 feet high and 4 inches thick. The lumber used for the forms was not cut up any more than necessary and was all used for the roof. Thirty-five barrels of "ATLAS" Portland Cement were required in the construction of the posts, walls and floor. Sand and gravel found on the farm was used and the concrete was proportioned one part "ATLAS" Portland Cement to seven parts of aggregate. A 3-inch floor was laid, using the same mix of concrete, and was surfaced with a ¾-inch coat of mortar, one part "ATLAS" Portland Cement to one part of sand.

The time required to make, place and remove forms was two days each for the two men. It took them 10 days to mix and lay the concrete for the entire structure.

PIAZZA.

In building a concrete piazza the first care should be the supports. Unless these are strong and have a foundation that will not be affected by frost, the piazza is liable to prove a failure.

Erect two lines of 4-inch posts, 8-inch bases, 8 feet apart, extending below frost. The outer line of posts should be slightly lower than the inner line, which is next to the house to allow water to flow off the piazza. On top of and connecting these in both directions, build concrete cross beams and stringers 4 inches by 8 inches. Posts should be reinforced with a 3/8-inch

CONCRETE PORCH STEPS AND LATTICE AT WESTWOOD, N. J.

steel bar and beams with two 3/8-inch bars placed one inch above the bottom. For a large piazza, refer to dimension of beams and reinforcement in Table for "Designing Reinforced Concrete Beams and Slabs," pages 30 and 31.

After the concrete has set hard, erect forms and build a solid slab of concrete over the entire framework, allowing it to project slightly over the outer edge. This slab should be reinforced with a woven wire fabric or expanded metal or with steel rods, using the size and spacing given for slabs in the Beam and Slab Table just mentioned.

If preferred the forms for the beams and floor may be built at the same time, and the concrete poured in one operation.

A finished surface can be obtained by plastering the surface one-half inch thick with mortar, one part "ATLAS" Portland Cement and one part clean, coarse sand, before the concrete has set and trowelling it hard as the mortar begins to stiffen.

LATTICE.

In building a lattice, the fact that there are two thicknesses of concrete, i. e., the thickness of the panel or border and the thickness of the lattice itself, should be borne in mind.

Build a form 8 inches higher and 8 inches longer than the size the finished lattice is to be, using 2-inch stuff. Along the top, bottom and at either end, nail a 4-inch by 4-inch scantling, and on these nail a 2-inch by 8-inch plank

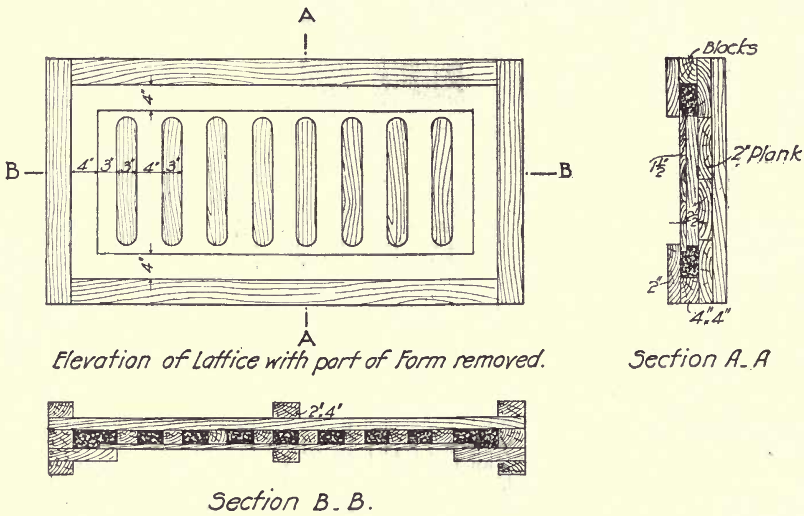


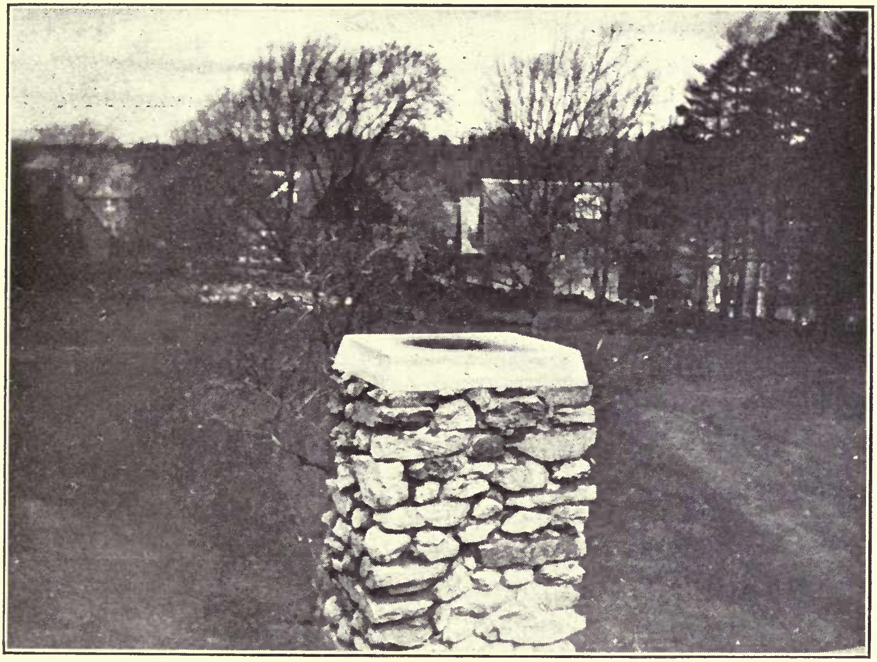
Fig. 41. Forms for Concrete Lattice.

(see Fig. 41). On the back of the form, at equal distances apart and equal distances from the edge of the 2-inch by 8-inch plank, nail securely blocks of wood of the shape of the holes desired. (See holes in lattice in accompanying cut.) Lay the form thus made on the ground, face up, and block securely. Fill with concrete one part "ATLAS" Portland Cement, two parts sand and four parts fine broken stone or gravel to the level of small blocks for holes, and pack concrete all around under the 2-inch by 8-inch plank to form panel; tamp hard, making sure there are no voids. Smooth off face of concrete and let stand for a week, or until the concrete is thoroughly dry. If the surface is not smooth enough a coating of grout, one part "ATLAS" Portland Cement and one part fine, clean sand, mixed as thick as cream, may be applied with a brush after first roughening surface and wetting it thoroughly. A moderately dry concrete should be used in this form.

The lattice may be built in place by leaving off the 4-inch by 4-inch block at the top of form and boarding up the open space in front of "hole-blocks" with a 1½-inch plank and pouring the concrete in from the top (Fig. 41). A very wet concrete should be used if this plan is followed.

CHIMNEY CAPS.

Chimney caps of concrete are rapidly supplanting stone, brick or iron, as they are not only cheaper and more durable, but protect the top of chimney better.



CHIMNEY CAP AT CHESTNUT HILL, MASS.

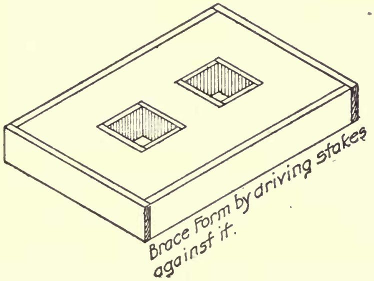
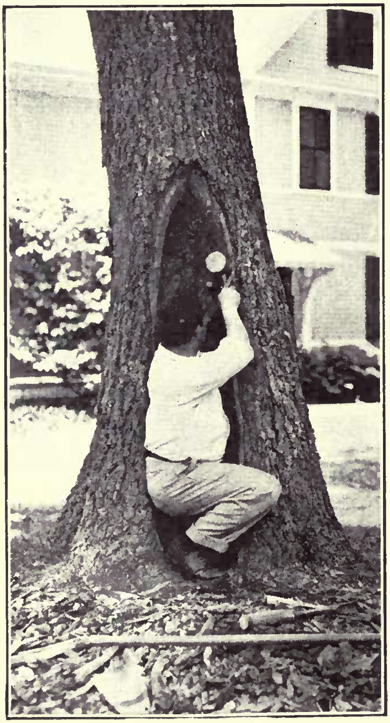


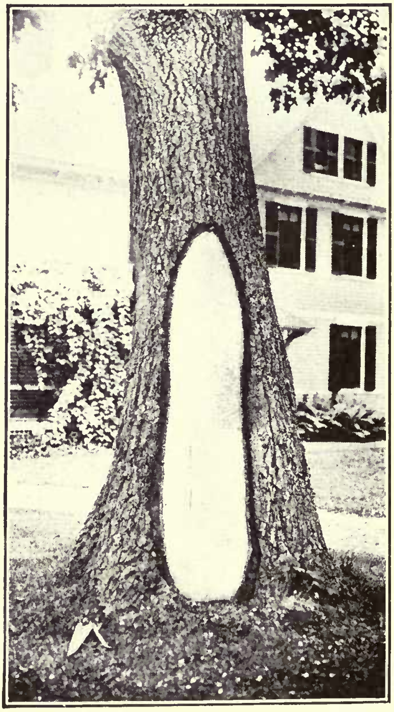
Fig. 42. Forms for Chimney Cap.

Make a bottomless box the size of the required cap, and one or more small bottomless boxes to correspond to the flue or flues of the chimney, and ½ inch higher, so that the surface of the concrete can be sloped to allow water to flow off, and set in place (Fig. 42). The thickness is usually about 4 inches, but this can be varied to suit convenience. Plaster the inside surface of the large mold with ½ inch of stiff mortar and then immediately fill form one-half full with one part "ATLAS" Portland Cement, three parts clean, coarse sand and six parts broken stone, and put in reinforcing, either woven wire, expanded metal or 1/4-inch rods, complete, and tamp until water puddles on top. When partly set, trowel smooth.

If it is desired to build the cap in place, the following plan should be adhered to: Place small rods across the chimney between the flues. On these build platform of tongue and grooved board planed on upper side and driven snug together, but not nailed. On this platform place the forms previously described and fill with reinforced concrete. After the concrete has set (at least a week is needed) remove platform and rods by raising each side of chimney cap alternately and knocking platform apart. Remove outer and inner forms. Raise one end of slab, cover all accessible surface of top of chimney with mortar, lower cap on bed thus formed and remove rods under end. Repeat process at opposite end.



REMOVING DECAYED MATTER FROM TREE BEFORE FILLING



TREE WITH CAVITY FILLED WITH CONCRETE

TREE SURGERY.

Tree surgery not only consists in cutting away all the decaying and dead matter of the tree, but embraces also the pruning and chaining of limbs, scraping, and filling of cavities. Through the skillful methods used by the tree surgeon it is possible to give a new lease of life to trees which apparently have reached their limit of existence. The cavities are caused by poor pruning of limbs, the breaking off of branches and other injuries. While the treatment of the cavities varies more or less in different cases, if the specifications given below are followed closely a good job should result.

The tree grows in girth by the deposit of a thin layer of new wood between the wood and the bark. It is this new layer and others recently formed which are known as the sapwood and form the active section of the trunk and branches. The inner rings are gradually covered by the yearly deposit of this new growth, and in turn the living sapwood becomes heartwood, which is dead, and serves merely as a strong framework for the living parts of the tree. This is the reason why hollow trees may often be found in a flourishing condition when the heartwood has entirely disappeared.

FILLING THE CAVITY. Cut out all the deceased and decaying part of the tree without regard to the size of the wound which is made. This must be cleaned out with the same thoroughness which a dentist uses when cleaning the cavity of a tooth for a filling. If all of the decayed matter is not removed the decay will continue as if the filling had not been placed. Disinfect the freshly cut surfaces with a coat of creosote or crude petroleum oil. Heat some coal tar and apply a thick coat to the disinfected surfaces. This coat of tar applied thick serves as a plastic substance to prevent any cracks between the cement and the wood from shrinkage.*

The cavity, if it is a large one, may be reinforced to better hold the concrete in place with either some woven wire mesh reinforcement or with small steel rods placed across from side to side of the cavity. Cut back the bark for about 3/8 of an inch or so around the entire wound in order to prevent bruising it while the work is in progress, and in order to get the cement perfectly flush with the wood, which cannot be done when the bark is not cut away.

For a large cavity some kind of a form must be used to prevent the concrete from caving out when it is being placed. For this boards may be fitted to the opening, leaving a space at the top to pour in the concrete; or metal, like zinc or tin, may be thoroughly greased and tacked on. When it is ready mix up a batch of concrete composed of one part "ATLAS" Portland Cement, two parts of sand and four parts of screened gravel or stone made up to a rather stiff consistency, about like jelly.

If the opening to the cavity is small, so that no form is required, trowel the surface of the concrete lightly so as to leave it smooth. If the concrete is too soft to make a good vertical surface or if the upper part of the cavity is

*Methods similar to these have been used by Mr. G. E. Stone, of the Massachusetts Agricultural College, for a number of years.

not entirely filled, wait for two or three hours until the concrete has begun to stiffen, ram it in again to completely fill the hole and then trowel the surface, adding a little stiff concrete if necessary.

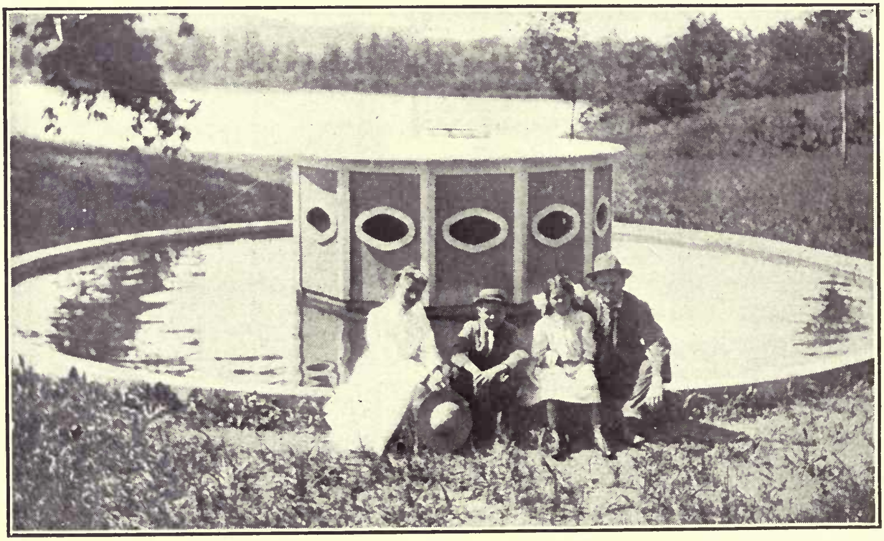
If forms are used, remove them as soon as possible, either in a few hours or else the next day, and go over the surface so as to slightly roughen it and remove the form marks.

The bark on a tree treated in this way will in time grow over the concrete and in some cases not even leave a scar.

CONCRETE AQUARIUM.

Aquariums constructed of concrete can be made attractive and have been found very serviceable. At the fisheries at Cold Springs Harbor, L. I., some of these concrete aquariums have been in service since 1904 and look as good to-day as when first made.

Make the base or bottom of each tank 18 by 31 inches and the vertical sides 13 by 15 inches, by 2 inches thick. Make the sides with vertical grooves

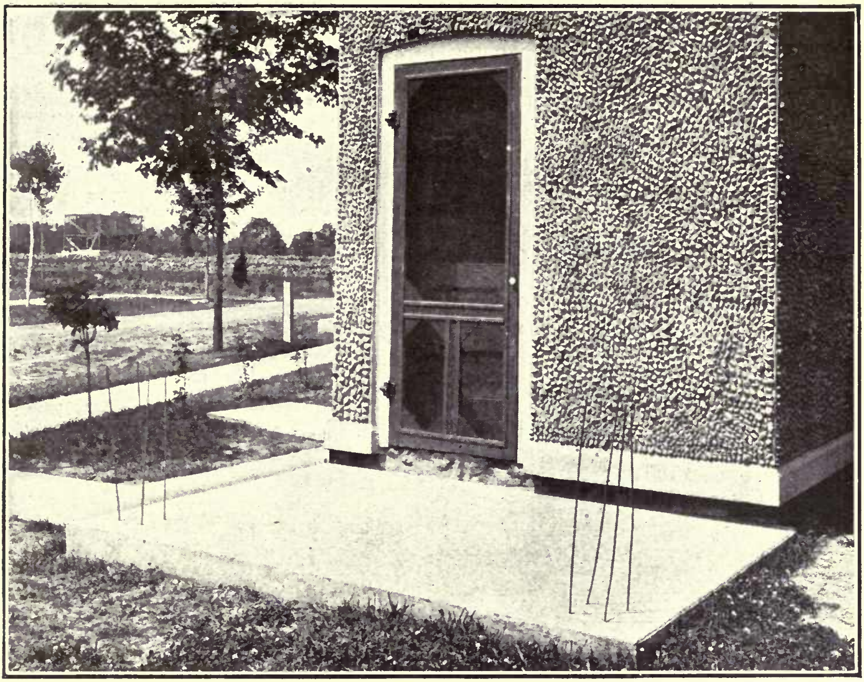


THIRTY-FOOT DIAMETER CONCRETE FOUNTAIN AT UNION, PA.
(1:4 Mix, 6-inch Thick Walls, 10 inches Deep)

1¼ inches from the edge in order to set in the glass sides. Leave grooves in the bottom also so that the glass sides can be puttied in and be made water-tight at the joints.

CONCRETE BLOCKS.

During the past few years concrete blocks have been used extensively and many patents have been granted the manufacturers of concrete block



DETAIL OF CONCRETE PEBBLE-FINISHED RESIDENCE AT WESTWOOD, N. J.

STUCCO COTTAGE AT CEDARHURST, L. I.

machines for the various devices and methods employed. Buildings constructed with concrete blocks have proved satisfactory when the blocks have been made with care and with proper materials.

STUCCO.

Stucco work is cement plastering, and, in one form or another, has been in use for ages. It is durable, artistic and impervious to weather. For veneering new buildings, or protecting old structures, and wherever the cost of solid concrete is prohibitive, Portland Cement Stucco cannot be equaled.

Stucco work may be used to cover wood, brick, stone or any other building material, provided special precautions are taken in preparing the surface properly so that it will adhere and not crack or scale off. The work should be done by an experienced plasterer.

As a rule two coats are used—the first, a scratch coat composed of five parts "ATLAS" Portland Cement, twelve parts clean, coarse sand and three parts slaked lime putty and a small quantity of hair; the second, a finishing coat composed of one part "ATLAS" Portland Cement, three or even five parts clean, coarse sand and one part slaked lime paste. Should only one coat be desired the finishing coat is used. Some masons prefer a mortar in which no lime is used, but this requires more time to apply it.

To apply Stucco to brick or stone or concrete, clean the surface of the wall thoroughly, using plenty of clean water so as to soak the wall. If the surface is concrete roughen it by picking with a stone axe. Plaster with a 1½-inch coat and finish the surface with a wood float, or to make a rough surface cover the float with burlap. Protect the stucco work from the sun and keep it thoroughly wet for three or four days; the longer it is kept wet the better.

In using Stucco on a frame structure, first cover surface with two thicknesses of roofing paper. Next put on furring strips about one foot apart, and on these fasten wire lathing. (There are several kinds, any of which are good.) Apply the scratch coat ½ inch thick and press it partly through the openings in the lath, roughing the surface with a stick or trowel. Allow this to set well and apply the finishing coat ½ inch to 1 inch thick. This coat can be put on and smoothed with a wooden float, or it can be thrown on with a trowel or large stiff-fibered brush, if a spatter-dash finish is desired. A pebble-dash finish may be obtained with a final coat of one part "ATLAS" Portland Cement, three parts coarse sand and pebbles not over ¼ inch in diameter, thrown on with a trowel.

COLORING FOR CONCRETE FINISH.

The use of colored concrete up to the present time has not been general, and the effect of coloring ingredients upon the strength of concrete is not definitely known.

METHOD OF APPLYING PEBBLE DASH FINISH

In his book on "Cement and Concrete,"* Mr. L. C. Sabin, an eminent authority, states that the dry mineral colors mixed with the water in proportions by weight of from two to ten per cent. of the cement give shades approaching the color used, with no apparent effect on the early hardening of the mortar.

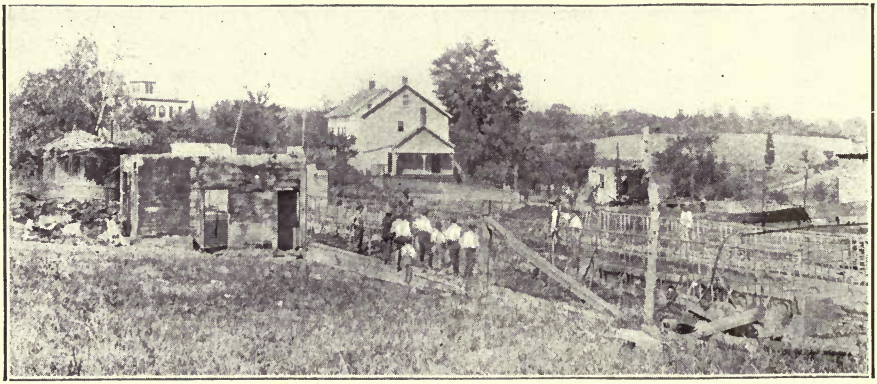
Mr. Sabin also gives the following table, showing the result obtained from a dry mortar (wet mortars give a darker shade):

COLORED MORTARS

Colors Given to Portland Cement Mortars Containing 2 Parts River Sand to 1 Cement.

Dry Material Used	Weight of Dry Coloring Matter to 100 Pounds of Cement				Cost of Coloring Matter per Pound, Ct.
	½ Pound	1 Pound	2 Pounds	4 Pounds	
Lamp Black	Light Slate	Light Gray	Blue Gray	Dark Blue Slate	15
Prussian Blue	Light Green Slate	Light Blue Slate	Blue Slate	Bright Blue Slate	50
Ultra Marine Blue	....	Light Blue Slate	Blue Slate	Bright Blue Slate	20
Yellow Ochre	Light Green	....	....	Light Buff	3
Burnt Umber	Light Pinkish Slate	Pinkish Slate	Dull Lavender Pink	Chocolate	10
Venetian Red	Slate, Pink Tinge	Bright Pinkish Slate	Light Dull Pink	Dull Pink	2½
Chattanooga Iron Ore	Light Pinkish Slate	Dull Pink	Light Terra Cotta	Dull Brick Red	2
Red Iron Ore	Pinkish Slate	Dull Pink	Terra Cotta	Light Brick Red	2½

*"Cement and Concrete," Louis Carlton Sabin; McGraw Publishing Company, N. Y.



BURNT BARN AT BROOKSIDE FARM SHOWING CONCRETE BUILDING IN REAR IN WHICH THE LEAD TRAPS ON THE SINKS WERE NOT EVEN MELTED OFF

CULVERTS.*

Concrete culverts of all sizes and shapes are being constructed not only where the roads have been fully developed, but also on a great many farm roads. They are cheaper than wooden culverts considering that the wooden ones rot out every few years. If desired, they can be made quite artistic.

Culverts vary greatly in size, from those which are nothing more than a large sewer pipe to those which span a wide stream.

CULVERT AT HARRISTOWN, ILL.

The bore or opening through which the water passes may be made either circular or rectangular. Culverts are generally built with a circular bore, although the forms for these are more difficult to make than for the rectangular, so that frequently the latter are much cheaper.

A culvert should be built, if possible, during the dry season or when the water is low. When of such size as to make it impracticable to build it by having the water flow through the center in a trough or flume, then build a dam above the culvert and convey the water around one side of the proposed new structure while the work is in progress by means of a wooden trough or a deep ditch.

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*For further detail information see "Concrete in Highway Construction," published by The "ATLAS" Portland Cement Co.

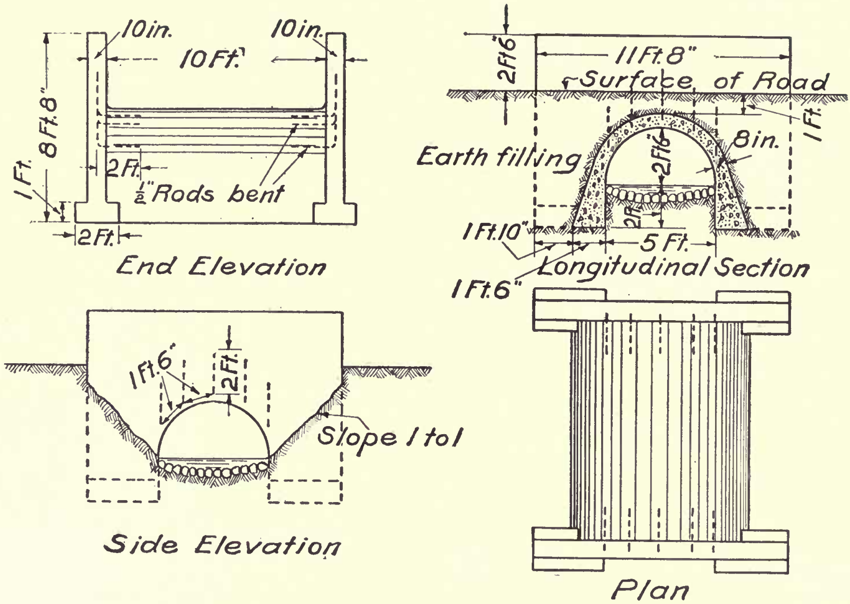


Fig. 43. Design for a 5-Foot Arch Culvert.

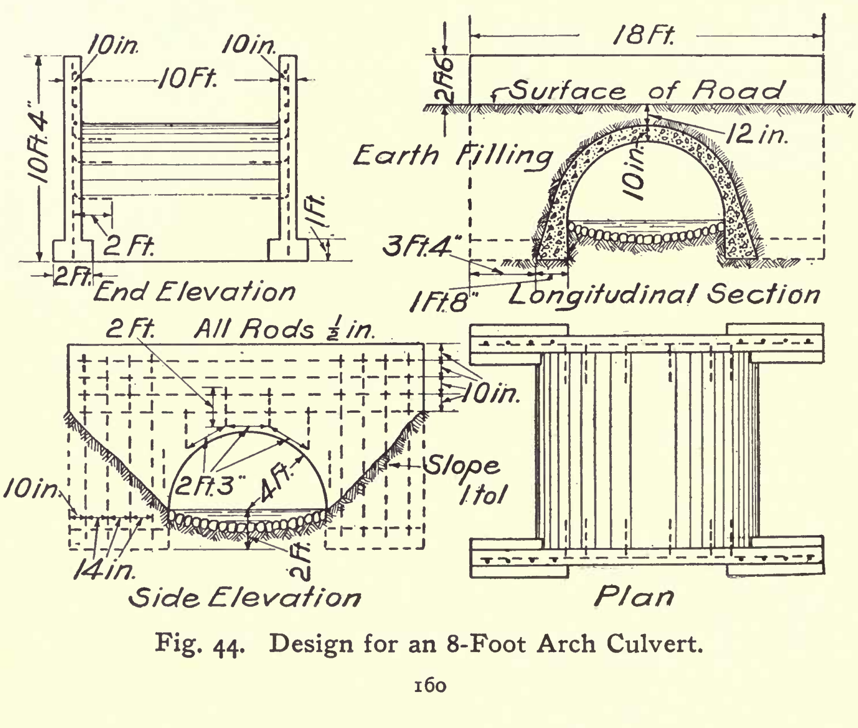
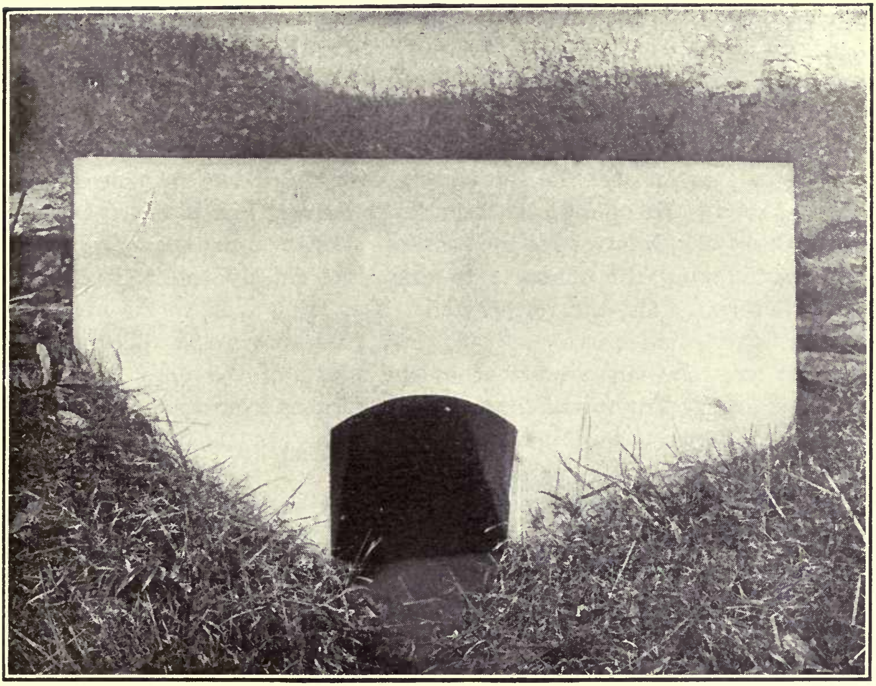


Fig. 44. Design for an 8-Foot Arch Culvert.



CULVERT AT DES MOINES, IOWA.

CULVERT AT MORTON, ILL.

The footings of the culvert can usually be laid directly on the earth in the bottom of the trench dug for them. Where the ground is soft, place wide footings under the culvert, and if deep marsh is encountered excavate to hard soil and fill with gravel well rammed or else drive piles to prevent any settlement.

In a small culvert set the forms complete and place the concrete for the whole culvert in one operation. In a large culvert this is not practicable, in which case set rough forms for the footings and up to the springing line of the arch. After laying the concrete to this level set up the arch centers and wing wall forms. Oil the forms well. The wing wall forms may be built of 1-inch boards laid horizontally against 2 x 4-inch studs. The inner wing wall form must be cut somewhat to the shape of the arch or stepped off around the arch. The top of the arch needs forms from the springing line up to about one-half to three-quarters of the way to the crown, as the wet concrete will not stand on so steep a slope.

The mix of concrete for culverts should be one part "ATLAS" Portland Cement to two and one-half parts of clean, coarse sand to five parts of screened gravel or broken stone. The amount of materials for the culverts given in Figs. 43, 44 and 45, is tabulated in the table below. If the excavation must be deeper than shown, of course more material will be needed.

AMOUNT OF MATERIALS FOR ARCH CULVERTS.

Materials for Culvert for 10-Ft. Roadway (See Figs. 43, 44 and 45)				Extra Material for Each Additional Ft. Width of Road		
Span of Culvert Feet	Cement Bags Bbls.	Sand* Double Load	Screened* Gravel or Stone Double Load	Cement Bags Bbls.	Sand Double Load*	Screened Gravel or Stone* Double Load
5	50 or 12½	3	6	2 or ½	⅛	¼
8	80 or 20	4¾	9½	3 or ¾	8/16	⅜
10	115 or 28¾	7	14	4 or 1	¼	½

*A double load of sand or gravel is taken as 40 cubic feet or about 1½ cubic yards.

Fig. 46 shows a form for an arch culvert and also the flume box in place to take care of the water during construction. The inside wall form is constructed in the same manner as the wall forms previously explained, except that a 3 by 4-inch or a 4 by 4-inch ranger is set across the top of the cleats on which the wedges are placed to support the arch form. The wedges should separate the two forms at least 3 inches so that when the forms are

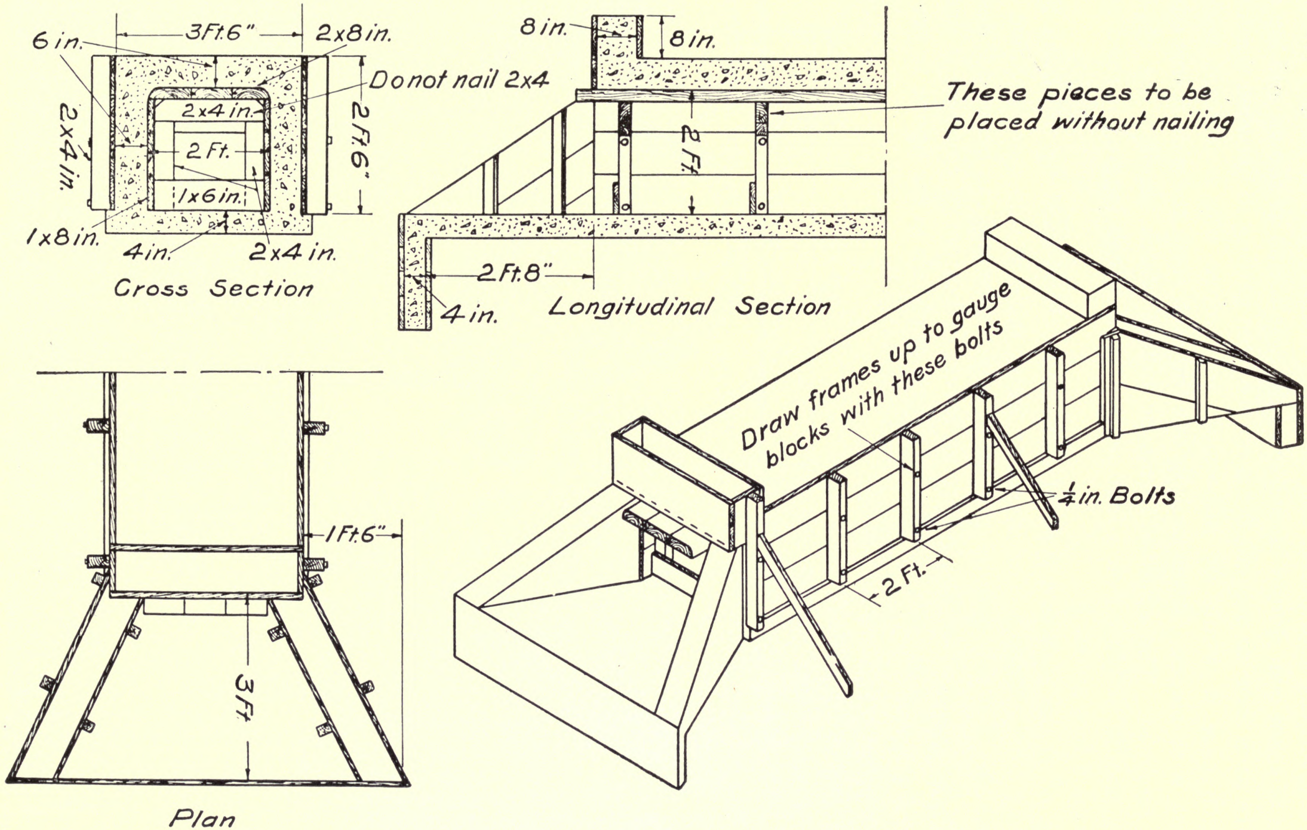


Fig. 47. Form Construction for Square Culvert.

to be removed the arch center can drop this distance and be readily removed. A strip of sheet iron should be nailed to the side forms as shown and lap over on to the arch form to prevent the concrete from getting in between the forms, in which case it would be impossible to remove the arch form without breaking it to pieces. After pulling out the arch form the side forms can be easily removed. The circular forms or braces which support the 1½-inch lagging should be placed on 4-foot centers, or if 1-inch lagging is used space the forms 2 feet apart.

Fig. 47 is the standard type of form and culvert used by the Iowa State Highway Commission. The invert or water table in this case is shown as a concrete slab, but this may be omitted in some cases and can be used if desired in an arch culvert as well. Where an invert or bottom of concrete is used it must be protected at both ends by an apron, as shown in the figure, to prevent the water from washing the earth from underneath it.

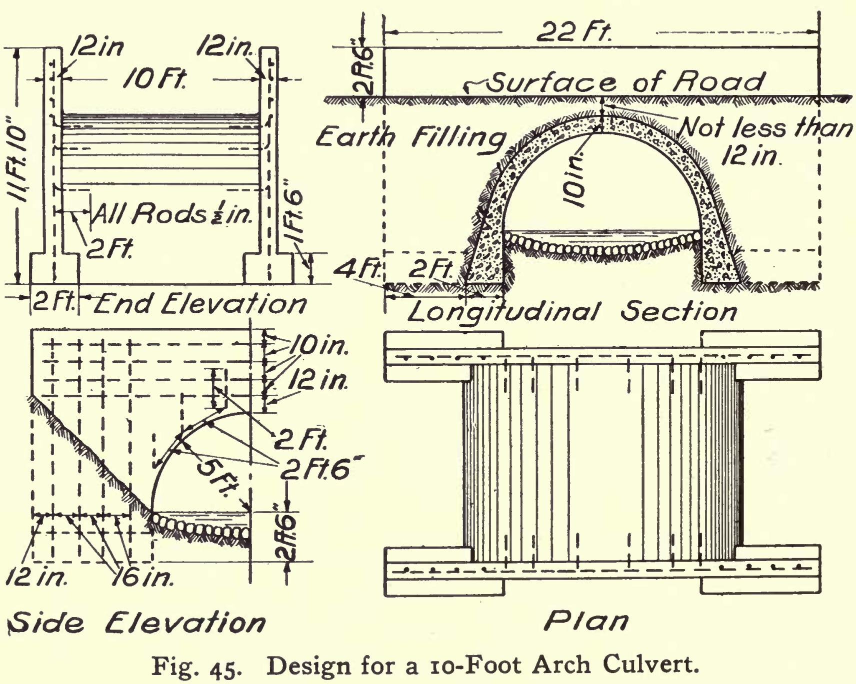


Fig. 45. Design for a 10-Foot Arch Culvert.

A good method of making the invert of a culvert is to lay cobble or field stones as shown in the figures. This can be done even when there is considerable water running through the culvert, and should a dry spell occur the cobbles can be plastered or grouted over, making a very satisfactory and efficient invert.

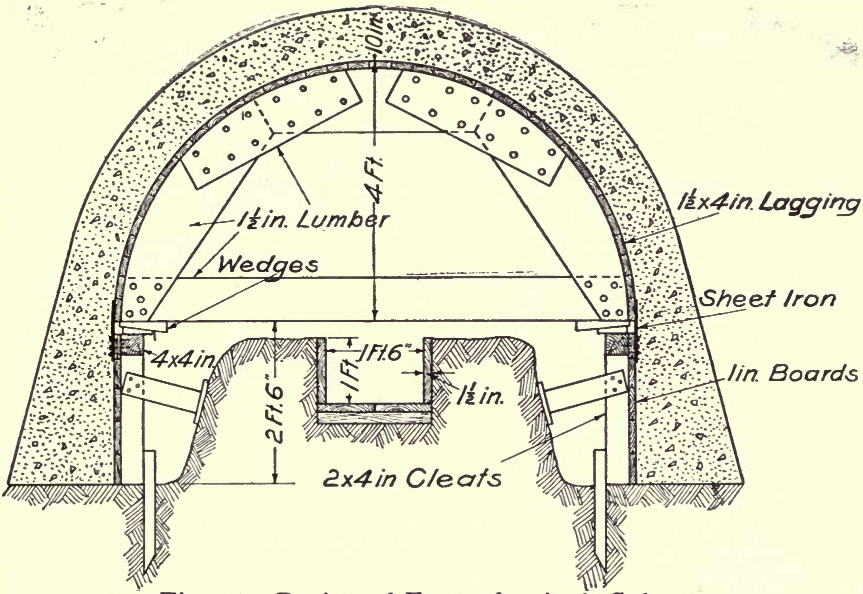
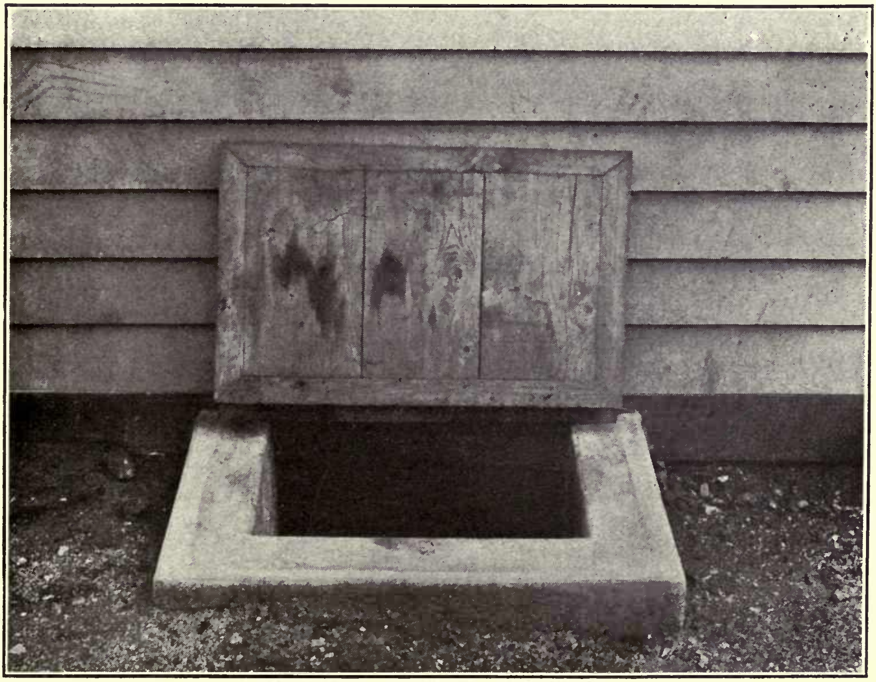
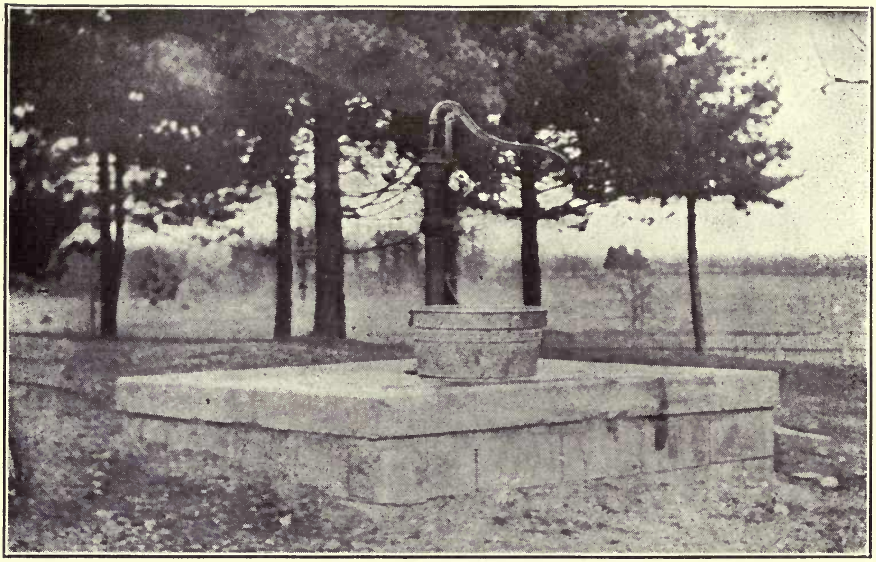


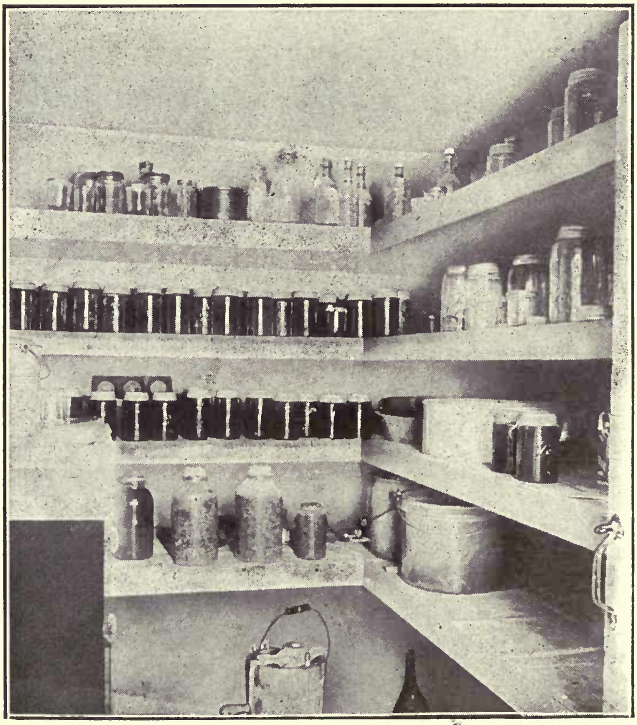
Fig. 46. Design of Forms for Arch Culvert.



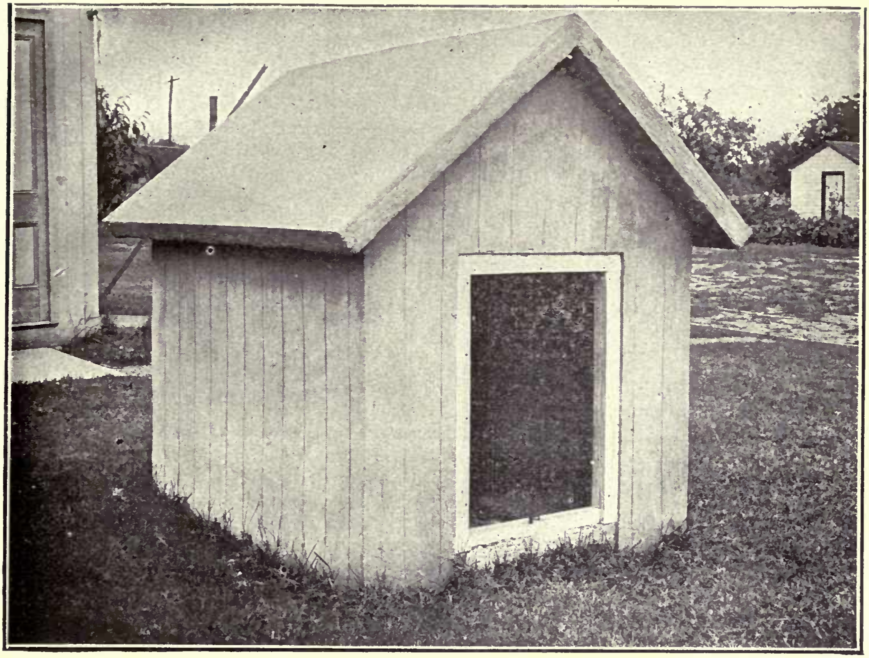
CONCRETE COAL CHUTE, DUMONT, N. J.



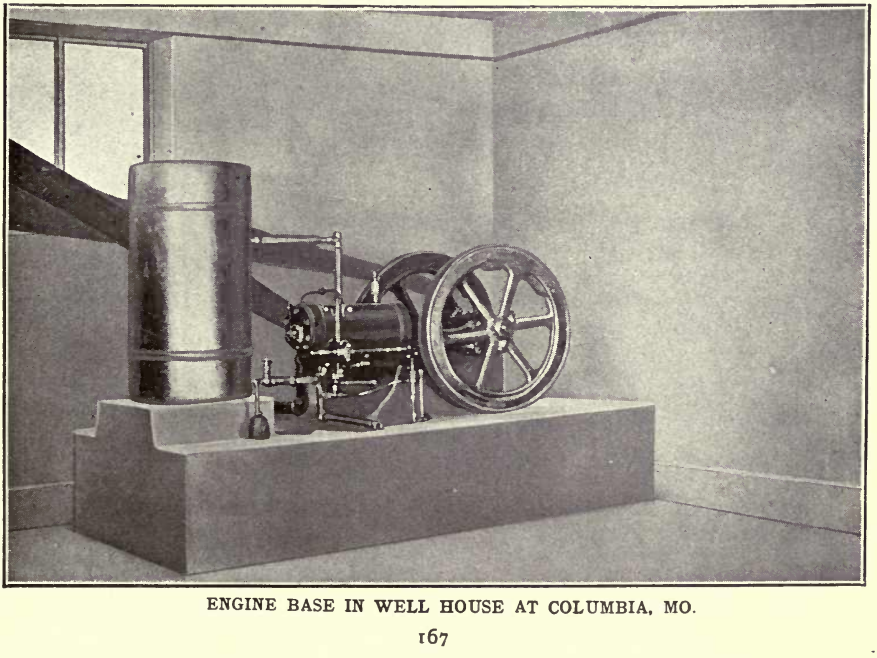
CONCRETE CISTERN COVER, HARRISTOWN, ILL.



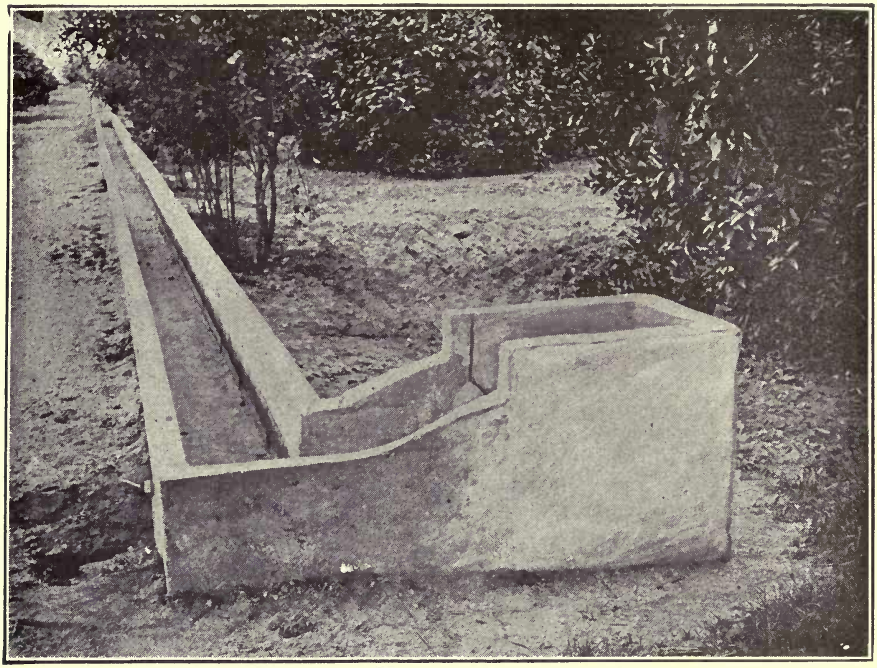
FRUIT CELLAR AT WESTWOOD, N. J.



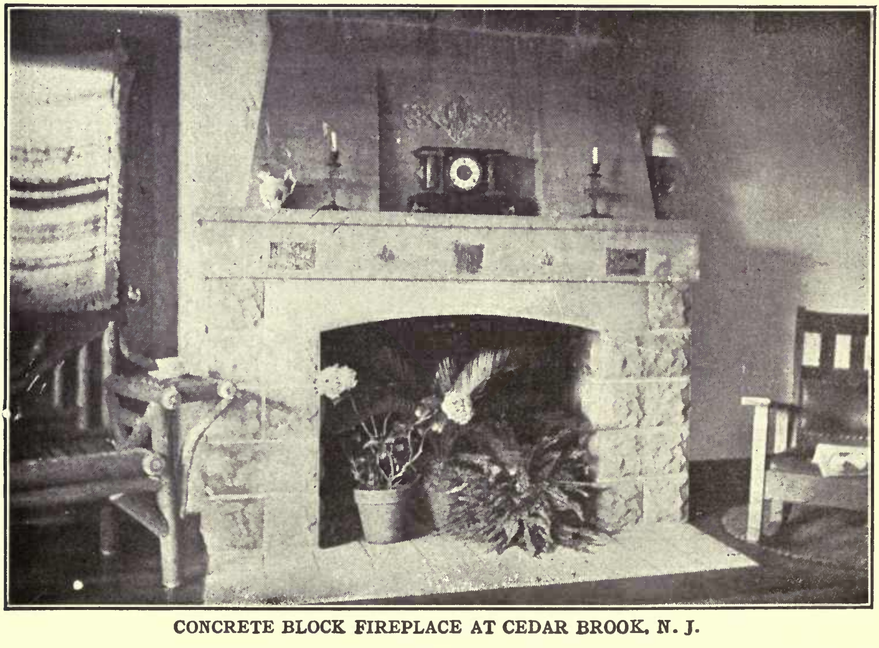
DOG HOUSE AT WESTWOOD, N. J.



ENGINE BASE IN WELL HOUSE AT COLUMBIA, MO.



CONCRETE FLUME, REDLANDS, CALIFORNIA



CONCRETE BLOCK FIREPLACE AT CEDAR BROOK, N. J.

The Federal Printing Co., 231 West 39th St., N. Y.