ELEMENTARY CONCRETE CONSTRUCTION

Leon · H · Baxter

144 cu ft per day
8
18 cu. ft. per hour
80 days

1440 cu. ft total

ELEMENTARY
CONCRETE CONSTRUCTION

Elementary Concrete Construction

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Introductory Note

It affords me great pleasure to commend "Elementary Concrete Construction" to teachers, parents and all others interested in the education of boys. My confidence is based upon personal knowledge of Mr. Baxter's aims and methods. During the six years that I was Superintendent of Schools in St. Johnsbury I had ample opportunity to see the interest which these projects aroused in the boys, and their reaction upon the home and community.

Pedagogically, Mr. Baxter's work is the best exemplification of the project method that has come to my notice. The reasons for this soon become obvious. The boy chooses the project, or problem, which appeals to him, does his work with a minimum of supervision, puts forth his best effort, and takes pride in the quality of his workmanship. He thus experiences the joy of real achievement.

The practical application of elementary work in concrete has been repeatedly demonstrated by Mr. Baxter. Under his direction the boys of the manual training department were engaged by the school board to do repair work during vacations, such as laying basement floors, walks, steps, setting posts and flag poles in concrete in and about the school buildings. They also did work for individuals and societies, as well as around their own homes. We are pleased to add that their work stood the test of time.

Any book containing projects which arouses the enthusiasm of the boy, holds his interest, and inspires him to think and to do, is bound to have a wide sphere of usefulness.

WALTER H. YOUNG, A. M.,
Superintendent of Schools,
Somersworth, N. H.

Author's Preface

Knowing the scarcity of material, of an elementary nature, on the subject of concrete construction, the author has gathered together a series of problems in concrete work, which, with but a very few exceptions, have all been successfully worked out by pupils in the seventh and eighth grades.

This book is to all intents and purposes a condensed textbook on those things which are necessary to follow, in order to make constructive work in concrete a success.

The excessive cost of lumber, together with its scarcity, has brought home very convincingly the necessity of finding some material which should be as good or better, as a substitute.

Concrete fulfills all the requirements of such a material. He who uses this medium builds for permanence and the many uses to which it may be put make it the ideal constructive material.

It is correlated with woodworking in an excellent manner in the making of forms, and its possibilities are such that the user has a wide field for original design.

The author owes his sincere thanks to the Association of American Portland Cement Manufacturers, the Atlas Portland Cement Company and the Alpha Portland Cement Company, for data and photographs loaned and information given by them.

All photographs of the boys at work and those showing the completed projects were taken by the author.

Thousands of feet of concrete have been laid, under the supervision of the writer, by boys whose ages ranged from ten to fourteen.

Hundreds of dollars have been saved by the school department by the work done by these boys. The boys received pay for their work, learned to know and handle concrete and were taught, through this, the dignity of labor.

St. Johnsbury, Vt. LEON H. BAXTER.

Jan. 12, 1921.

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PART I

History of Cement

There is an old saying, "There is nothing new under the sun." This holds true regarding the history of cement. To many the use of cement is of recent origin, the result of modern methods of construction. Nothing is further from the truth. With the dawn of civilization came the use of cement. Ancient Egypt and Assyria contributed wonderful examples of its use, one notable instance being the Queen's Chamber in the Great Pyramid. The Appian Way and the Pantheon at Rome, together with her aqueducts, are other examples of concrete art, some of which are in actual use at the present day.

From the time of the Romans until about 1756, little was done in the manufacture of cement. In 1824, Joseph Aspdin, of Leeds, England, discovered the method of making cement and named it "Portland Cement" from the fancied, though really slight, resemblance to the noted oölitic limestone, which by the way is used in the London Westminster Cathedral, found on the Isle of Portland, on the south coast of England.

Although European countries began manufacturing cement at once it was not until about 1850 that its commercial success was assured. In 1818 natural cement was discovered in New York State by a man named White, an engineer on the Erie Canal.

The first American mill was built at Rosendale, N. Y., and from this fact obtained the name of "Rosendale Cement." The first artificial or true cement was not manufactured until 1875, and it was not until 1896 that the annual production reached the million barrel mark. Previous to this time the English and German cements were regarded as having the greatest strength.

The growth of this important industry has increased wonderfully and today individual firms are turning out over 9,000,000 barrels yearly, and preliminary figures for 1919 show that the annual production for the United States will be in excess of 80,000,000 barrels. Pennsylvania is the banner state in production of cement, producing over 28,000,000 barrels yearly, or nearly three times as much as her nearest competitor, Indiana.

Composition of Cement

Cement is substantially an artificial stone made by uniting in very exact proportions, two materials, one of them a rock-like limestone, or a softer material like chalk, which is nearly pure lime, with a material like shale, which is hardened clay.

Classes of Cement

The method of manufacture determines the three classes into which cement is generally divided. These processes are: 1, the dry process; 2, the semi-wet process, and 3, the wet process.

In the dry process the raw materials are ground, mixed and burned in their original dry state. The wet process consists of mixing the raw materials, of grinding them with water and of feeding them into large rotary kilns in the shape of a "slurry" containing enough water to make the whole mass of a fluid consistency. The semi-wet process resembles the wet process except that the slurry contains comparatively little moisture.

The Manufacture of Portland Cement

The manufacture of Portland cement itself is divided into five heads as follows:

1. Mining and quarrying of raw material.
2. Drying and grinding.
3. Proportioning and mixing.
4. Burning the two materials to incipient fusion.
5. Grinding the clinker thus burned to an extremely fine powder, meanwhile adding the proper proportion of gypsum, the resulting powder being known as Portland cement.

Quarrying

The excavation of the raw materials is the first step, and this is done by one of three general methods. First, quarrying and digging from open pits. Second, mining from underground workings. Third, dredging from deposits covered by water.

The usual method of quarrying the rocks is similar to that followed in all quarry operations. The rock is dislodged from the quarry face by means of an explosive and then dumped into side dump cars or aerial trams by either steam shovel or manual labor, preferably the former. The stone is then conveyed to the stone house, where it is crushed to comparatively small sizes and then transported to storage bins before being mixed with other ingredients. While in storage the stone may be sampled and analyzed.

Drying and Grinding

One method of grinding, before being placed in the storage bins, is to pass the limestone, shale, or cement rock through crushers and ball mills, or other preliminary grinders, from which it is conveyed to storage bins. The ball mills are cylindrical steel drums containing a quantity of steel balls. The material to be ground after drying, is continuously added.

As the cylinder rotates the balls roll, thus grinding the rocks to coarse grit. The coarse grits are then run into storage bins. Tube mills which are used further on in the process are similar in general to the ball mills.

Proportioning and Mixing

After the raw materials have been drawn from their respective bins and accurately proportioned by weighing they are delivered to a screw conveyor which completes the mixing and delivers the combined material to the tube mills.

The tube mills are revolving cylinders half full of flint pebbles or steel slugs which reduce the material continually being fed, into practically the fineness of finished cement. At this point we are, however, a long way from the finished product.

All the tube mills deliver to the same conveyor, which results in a uniform product of the raw material mill as a whole.

Burning to Incipient Fusion

From the tube mills the material is fed into kilns by a system of conveyors. The kilns are from 6 to 8 ft. in diameter and average about 125 ft. in length. They are lined with fire brick, and revolve at the rate of one revolution a minute and it is estimated that it takes about one hour for one lot of material to pass through. Powdered soft coal, crude oil, or gas is used as fuel, powdered coal being most commonly used. It is blown into the kiln at the end opposite that at which the raw material enters.

The raw material entering as a powder is gradually brought to the point of incipient fusion at a temperature of 2500° to 3200° fahrenheit, producing clinkers varying in size from ¼ in. up to 1½ in. in diameter.

The clinker is red hot when discharged, but is quickly cooled by sprays of water or cold air blasts which are played over the elevator and also upon the clinker when delivered to the storage pile.

Grinding the Clinker and Adding Gypsum

From the kiln the clinker may go either to the clinker storage pile or directly to the grinding department. Before sending to the tube mills for the final grinding gypsum is added either by hand or automatically. This material is added to prevent the cement from setting too quickly. Otherwise the cement would harden quickly and develop but little strength. The tube mills grind the clinker so fine that the particles are less than 1/200 in. in size. It is now placed in storage to season.

Commercial Cement and Its Storage

Cement is placed on the market in bags weighing 94 lbs. net and barrels of 376 lbs. net, four bags to the barrel. Cement must be stored in a dry place, for dampness is the one element fatal to its keeping quality. Dampness causes the cement to become lumpy and even to solidify throughout and as a result absolutely unfits it for use. Lumps which do not crumble at the slightest touch should be thrown out. Place the cement on a wooden platform raised several inches from the ground. Never store directly on a concrete floor. Plate 1 shows the proper method of storing.

Aggregates

As a chain is no stronger than its weakest link, so concrete is no stronger than the weakest element of which it is composed.

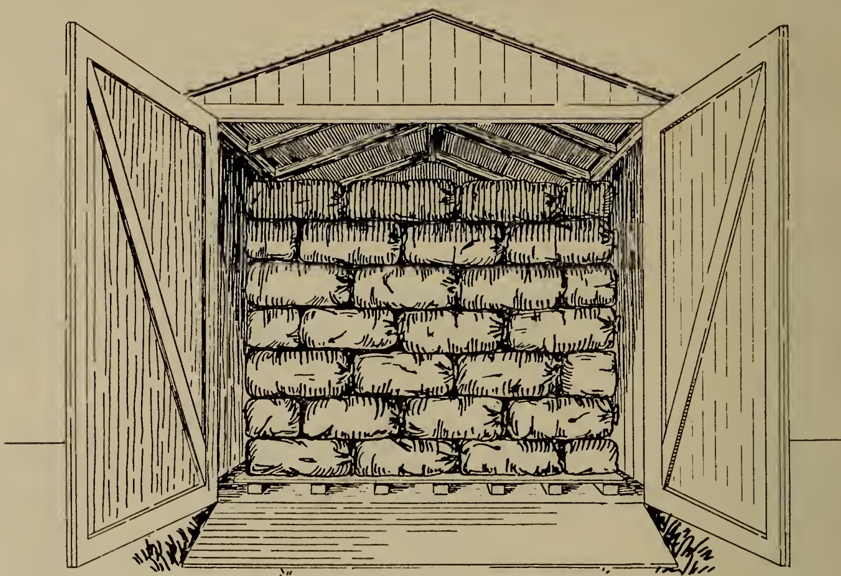


FIG. 1
THE PROPER WAY TO
STORE CEMENT
PLATE I

The material entering into the composition of concrete, such as sand and gravel, are called aggregates, sand being the fine and gravel the coarse aggregate. If good results are to be obtained extreme care should be taken in selecting these. They should be clean, hard, coarse, and well graded; clean, so that the coating of cement may adhere directly to the particles; coarse, because coarse aggregate is more easily covered with cement than a fine one; hard, so that it may retain its form under pressure.

Value of Different Rocks

Comparative tests have proven that in the order of their value for concrete, the different materials stand approximately as follows:

1. Granite.
2. Trap Rock.
3. Gravel.
4. Marble.
5. Limestone.
6. Slag.
7. Sandstone.

Fine Aggregate—Sand

Aggregate passing through a sieve of ¼ in. mesh is called sand. It should be sharp and free of all vegetable matter. The size of the grains should be graded from coarse to fine, the coarser particles predominating.

Tests for Loam

Sand should be free from loam or vegetable matter. A fair test for quality of sand is as follows: Take two handfuls of moist sand, and holding the palms about ½ in. apart let the sand run through. Repeat this several times and then rub palms lightly together to remove fine grains. Examine to see if a fine, sticky film adheres to the palms; if so, do not use it as it contains loam. Fine roots also indicate vegetable matter.

Another test is to fill a fruit jar to the depth of 4 in. with sand. Fill with water to within 1 in. of the top. Shake well and allow to stand for two hours. Sand will sink to the bottom while any mud or clay will settle on the top of the sand. If more than ¼ in. of such deposit remains, it is not suitable for use without washing.

Method of Washing Sand

Washing sand by wetting the pile with a hose is wrong—it only transfers the dirt to the lower part of the pile.

The proper way is for one man to shovel it on the upper end of a trough, like the one shown in Plate 2, while another man washes it down the incline by pouring water on it. There is a fine screen (size of mosquito netting) cleated to the incline. When the sand and water come to this screen, the dirty water drains through and leaves the clean sand ready for use.

Coarse Aggregate—Gravel

This should be clean and hard. The best results are obtained by a mixture graded from small to large, as it forms a more compact mass freer of voids.

The crushed rock should be screened on a ¼ in. screen to remove the fine particles, or sand.

As a general rule the ordinary run of bank gravel is not suitable for use without sifting and remixing, as described later. This is because there is generally too much sand for the gravel.

PLATE 2.

A screen with 30 meshes to the linear inch is a suitable size to use in this sand-washer. 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.

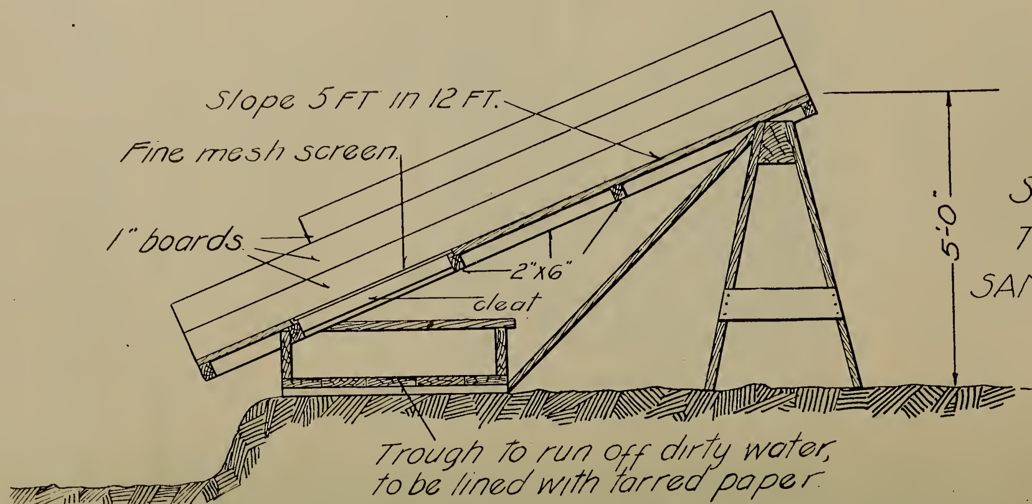


FIG 2.

It is not well to use pebbles or pieces of broken stone if their greatest dimension is more than one-half the thickness of the concrete you are placing.

Cinders as Aggregate

Cinders are used to some extent as a substitute for crushed stone or gravel. They are lighter and more porous than stone but less strong, but where lightness is more important than strength or where a poor conductor of heat or sound is required, they may be used.

Successive floors of tall buildings are often laid with cinder concrete. Roofs are also constructed with it. It cuts more easily than that made of stone and nails may be driven into it. Cinders used in concrete work should be practically free of ashes. Wood ashes should never be used.

Power plant cinders are better than those from household furnaces as the intense heat of the former fuses most of the ash into hard material. It should be drenched with water to wash out the finer material. Concrete made of cinders should not be rammed, as the material will break up easily. As cinders have been subjected to a great heat they are good from a fireproof point of view.

Water

Use nothing but clean water. Scummy, dirty, muddy or alkaline water must not be used. A good drinking water is always right to use for mixing concrete. The amount of water to be used varies with the material used and results desired.

Cold water (below 40° fahrenheit) retards the set of concrete. The amount of water used varies with conditions, as before stated, and divides green concrete into three groups according to its consistency, "wet," "medium" and "dry."

Wet concrete requires but little puddling, flowing readily into corners and crevices. It is preferred for reinforced concrete as the metal can be easily imbedded. "Wet" concrete requires a bucket or similar vessel for handling.

For general work "medium" concrete gives the densest, hence the strongest mixture. It quakes like jelly and can be carried on a shovel.

"Dry" concrete should contain enough water so that tamping brings it easily to the surface.

Proportioning the Materials

By "proportioning" we mean determining the necessary quantities of cement, sand and gravel, for a piece of work.

Cement is always the smallest quantity in a mixture and is always mentioned first. A bag of cement contains approximately 1 cu. ft., so that amount of cement is taken as the unit of measure.

The second figure is always the number of parts of sand. The

PLATE 3.

VOLUMES OF THE THREE MATERIALS
WITH THE
RESULTING VOLUME OF CONCRETE

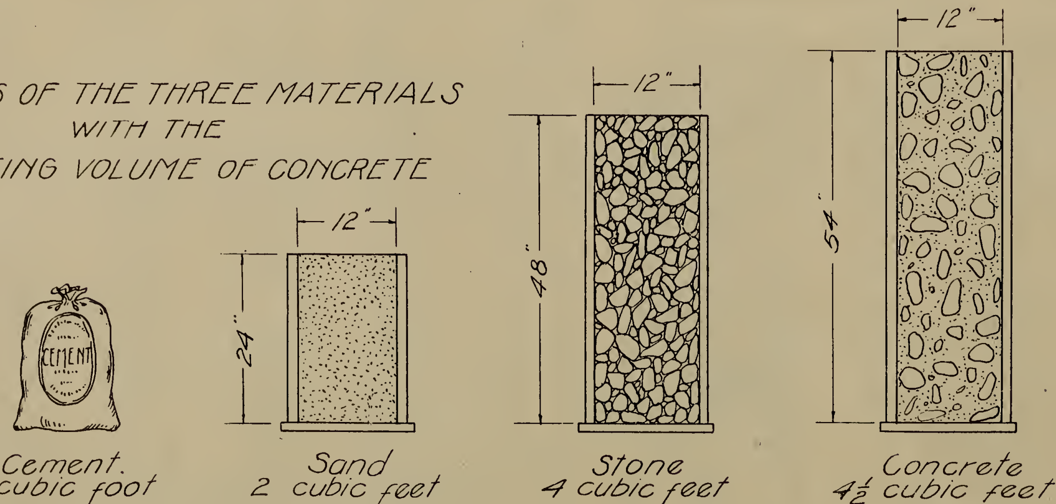


FIG 3

The sand fills in the voids, or spaces, between the stones while the cement fills the voids between the grains of sand and therefore the total quantity of concrete will be but slightly in excess of the original quantity of stone third figure is the number of parts of stone or gravel. Thus when we speak of a 1-2-4 mixture, we mean that to every cubic foot (bag) of cement there are 2 cu. ft. of sand and 4 cu. ft. of gravel or stone. Satisfactory results can only be obtained by proper proportioning.

The object of proportioning is to make a sufficiently dense concrete mixture. Sand or gravel or crushed stone, alone, have between their particles empty spaces called "voids." To make dense concrete the cement, sand and stone must be proportioned so that the voids in the coarse aggregate are filled with the finer particles of sand and cement, and so that the voids in the sand are filled and bound together with particles of cement. If this subject of voids is borne in mind, you will not make the common mistake of estimating that 1 cu. ft. of cement, 2 cu. ft. of sand and 4 cu. ft. of stone will make 7 cu. ft. of concrete. On account of so much of the material being used in filling up voids, the actual total quantity of concrete obtained by mixing these quantities of aggregates is only a little more than the quantity of stone—4 cu. ft.—see Plate 3.

For almost all work twice as much coarse aggregate (gravel or stone) must be used as fine aggregate (sand).

Various Mixtures for Various Purposes

A mixture of 1 part cement, 1½ parts sand and 3 parts coarse aggregate is suitable for roads, columns, waterproof buildings and other constructions coming under high stresses. Such a mixture is termed a rich mixture.

A mixture of 1 part cement, 2 parts sand and 4 parts coarse aggregate is suitable for roofs, arches, reinforced floors, columns, reinforced engine bases subject to considerable vibration, beams, tanks, extra strong walls, sewers and various other work requiring watertightness. This mixture is termed a standard mixture.

A mixture of 1 part of cement, 2½ parts sand and 5 parts coarse aggregate is suitable for retaining walls, ordinary floors, ordinary machine foundations, abutments, sidewalks, piers, and sewers requiring extra heavy walls. Such a mixture is known as a medium mixture.

A mixture of 1 part of cement, 3 parts sand, and 6 parts coarse aggregate is suitable for foundations supporting stationary loads, unimportant work in masses, backing for stone masonry and heavy walls. It is known as a lean mixture.

Equipment Used in Elementary Concrete Work

Plate 4 shows all necessary concrete equipment for hand mixing, much of which can be of home made construction: 2 good quality No. 2 square nosed "paddy" shovels; 1 or more tampers of about 20 lbs. weight, as shown; a home made wooden float or trowel of di-

PLATE 4

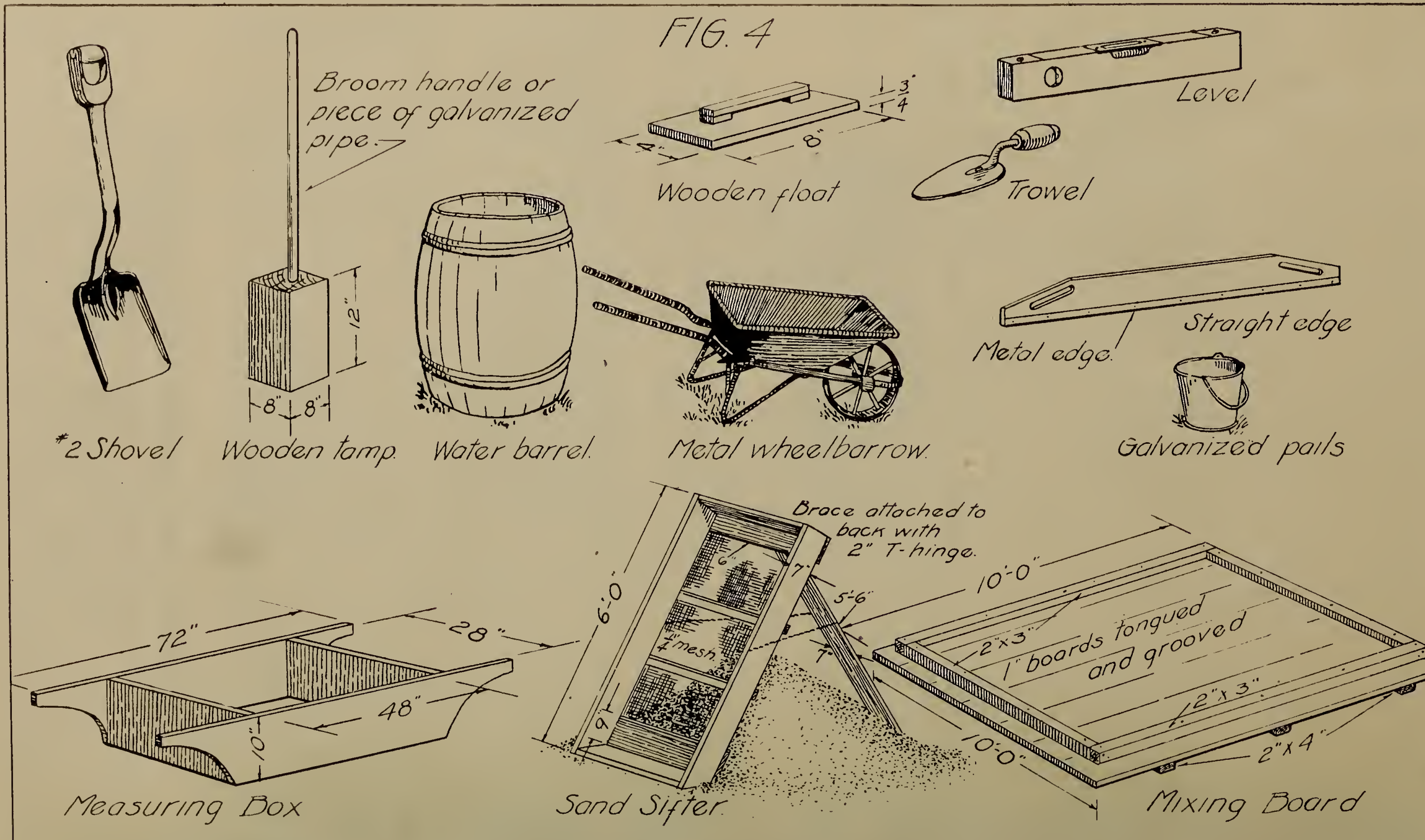


FIG. 4
Broom handle or piece of galvanized pipe.
12"
8"
8"
*2 Shovel
Wooden tamp.
Water barrel.
4"
8"
3/4"
Wooden float
Level
Trowel
Metal wheelbarrow.
Straight edge
Metal edge.
Galvanized pails
72"
28"
48"
10"
Measuring Box
Brace attached to back with 2" T-hinge.
6"
7"
5'-6"
7"
6'-0"
1/4" mesh
9"
Sand Sifter.
10'-0"
2"x3"
1" boards tongued and grooved
2"x3"
2"x4"
10'-0"
Mixing Board

Illus. 1. A Typical School Outfit.

mensions shown on drawing; a clean water barrel, one which has not previously contained oil; 2 galvanized iron water pails; a heavy garden rake; 1 galvanized sprinkling can of fairly good size; some garden hose; 1 sand screen made of ¼ in. wire mesh; 1 measuring box or frame (see drawing); 1 mixing platform; 1 strong metal wheelbarrow; trowels; a carpenter's level; 1 tool for edging and 1 for jointing.

Illus. 1 is a photograph showing the typical school outfit.

Mixing

After proper sand and gravel have been secured, the success or failure of the finished job is in the proper mixing.

Have all gravel and other material placed convenient to the work. A good amount of sand should be sifted previous to the mixing and the method is clearly shown in Illus. 2. The use of the measuring box is of great assistance and a table showing the depths, widths and lengths for various mixes is given below.

Illus. 3 shows the measuring box in use.

Quantity of Materials and Sizes of Measuring Box

Mix	Cement (bags)	Sand	Gravel	Concrete made. (cu. ft.)	Size of Measuring Box Length Depth Width
1-1½-3	2	2.8 cu. ft. or ¾ bbl.	5.7 cu. ft. or 1½ bbl.	7.0	3′ 0″ x 2′ 0″ x 10″
1-2-4	2	3.8 cu. ft. or 1 bbl.	7.6 cu. ft. or 2 bbl.	9.0	4′ 0″ x 2′ 4″ x 10″
1-2½-5	2	4.8 cu. ft. or 1¼ bbl.	9.5 cu. ft. or 2½ bbl.	10.9	4′ 6″ x 2′ 2″ x 12″
1-3-6	2	5.7 cu. ft. or 1½ bbl.	11.4 cu. ft. or 3 bbl.	12.8	4′ 6″ x 2′ 7″ x 12″

INSIDE DIMENSIONS
(Note.—A cement barrel holds 3.8 cu. ft.).

Illus. 2. Sifting Sand Before Mixing.

For a 1-2-4 mix, which is an average mix, the box shown in Plate 4 is the proper size. This is filled half full of sand and emptied on the mixing board and two bags of cement are opened and spread upon it. Turn the dry sand over and over with a shovel until it is thoroughly mixed and of a uniform color. See that there are no hard lumps or cement "pockets" remaining. Spread out the mixture and empty on it the mixing box filled even full of gravel. Mix this thoroughly.

Add three-quarters of the required amount of water—say, about ¾ gallon to each cubic foot of concrete. Apply the water with a sprinkling can or hose with a spray nozzle, slowly and evenly, mixing the whole mass at the same time.

Illus. 4 and 5 show the method of applying the water and Illus. 6 the method of mixing.

Illus. 3. Measuring Box in Use.

Illus. 4. Applying Water to Mixture.

Add more water when dry spots appear until the whole mass has been turned over at least three or four times. The mixture should now be shoveled into a compact mass to wheel away.

It is extremely bad practice to apply water with a hose which has not a spray attachment as the heavy stream will cause the cement to wash away and be deposited unevenly throughout the mixture.

Placing Concrete

After the concrete has been mixed, it is in plastic form and must be placed in forms or moulds to shape it in the required form. The subject of forms for concrete will be taken up later on.

Concrete must be placed as soon as it is thoroughly mixed as it begins to set very quickly.

Methods of placing vary with working conditions and the nature of the construction, but the following are useful rules for nearly every sort of work:

A. Place concrete in layers about 6 in. thick.

B. Pack it down lightly with a tamper or rammer (see Plate 4), until water shows on top. This makes the mixture dense.

C. If a smooth surface is desired, such as on an exposed wall, work a spade back and forth and up and down between the concrete and the form on the side which will be exposed to view.

This brings the coating of mortar next to the form. Where a spade cannot be used substitute a thin wooden paddle, made from a board 1 in. by 4 in., sharpened to a chisel edge on one side of the end. Keep the flat side of the paddle next to the form with the sharpened side turned in.

The dryer the mixture the more important the tamping and spading.

Reinforcing

Where any great strength is required reinforcing should be used.

A concrete column, for instance, will support a tremendous load, but a side or lateral pressure of half the magnitude might cause the same column to fall. Concrete when reinforced with steel rods, wire

Illus. 5. Applying Water with Sprinkling Can.
Illus. 6. Method of Mixing.

strands, or wire mesh, has added strength and will stand considerable tension. Steel is elastic and when properly used with concrete imparts sufficient of this elasticity to make an ideal building material.

Where a large amount of reinforcing on heavy work is required rods should be used. For flat work requiring less strength, wire mesh or in some cases any kind of wire is suitable.

An invariable rule in placing reinforcing is to insert where the pull will come. Thus in a beam or slab it is close to the bottom, while in a wall built to withstand earth pressure it is placed in the face nearest the earth.

The True Use of the Word Cement

It is well to say a word here regarding the use of the words "cement" and "concrete" as they should be spoken. We often read and hear of cement walks, cement houses, cement steps, etc. This is extremely incorrect; the proper word to use is "concrete." There never can be such a thing as a cement house, etc. It must be remembered that cement is but a powder and bears the same relation to concrete that flour does to bread, and is only a part of the finished product.

Protection of Concrete

If the forms are removed as soon as the green concrete will sustain itself, where the surface is exposed to the elements, it should be protected from the drying action of the sun and hot winds.

Concrete should set 5 or 6 days before being exposed and during this interval it should be sprinkled with water morning and night to keep the surface of the concrete from drying out faster than the interior.

Protect exposed vertical surfaces with old burlap, hung 1 in. or so from the surface, and keep this cover moist all the time.

Flat surfaces such as feeding floor and walks should be protected from rain, sun, wind and frost by sand, straw or building paper.

Forms for Concrete

Plastic concrete is very heavy and forms therefore should be strongly made. Green lumber should be used, as dry, seasoned material will swell and warp from the moisture in the concrete.

Planed lumber is more easily cleaned and the concrete does not stick to it so easily. Use lumber planed on one face and two edges to insure a tight job.

Tongued and grooved boards will be a little more expensive but insure an exceptionally nice job.

Grease the forms with soap, linseed oil or crude oil to keep the lumber free of the concrete. Although some do not do this it is much the better way.

Be positive all forms are absolutely vertical, especially forms for walls or piers. Use a spirit level or a plumb bob. Do as little pounding as possible near fresh concrete.

Length of Time Forms Should Be Left in Place

This depends on the nature of the construction.

For small construction work, where the concrete bears no weight, the forms may be removed as soon as the concrete will bear its own weight, that is, some time between 12 and 48 hours after the concrete has been placed.

Where the concrete must resist earth or water pressure—as in retaining walls or dams—the forms should be left in place until the concrete has developed nearly its final strength (this may be 3 or 4 weeks, if the weather is damp or cold, or anything else prevents quick curing).

Various Surface Finishes for Concrete

Mortar Finish

Facing concrete with a coat of mortar plaster is often a troublesome undertaking because it is difficult to obtain a strong enough bond—that is, a strong enough cohesion—between the concrete mass and the surfacing mortar. The mortar should be applied in as thin a layer as possible. The proportions are 1 part Portland cement and 2 parts sand. Opinions vary as to the exact proportion of cement and sand in cement mortar, varying from 1 part cement and 1 part sand to 1 part cement and 2½ parts sand. The character of the job should be considered and a proportion of sufficient strength to fit the proposition at hand decided upon. However, a mixture of 1 part cement to 2 parts sand may be considered a good all around proportion.

Before applying the surfacing mortar see that the whitish scum on the old work is removed, as it has no strength in itself. This may be done if the work has just had the forms removed, by using a wire brush vigorously. If the concrete is hard the surface scum cannot be removed unless the surface is roughened with a cold chisel. Whichever method of removal is used the aggregate of the concrete must be exposed, or the newly deposited concrete or mortar will not bond to the old.

In placing a mortar facing on a concrete surface, drench the wall thoroughly with water not more than 30 minutes before the application of the mortar, and brush the surface with a thin cream made of cement and water.

This cream should be mixed in small batches as the work progresses and should be used within 30 minutes after it has been mixed, as it loses its strength after that length of time.

Trowel the mortar facing on the surface after this preparation, and press the mortar firmly to a smooth uniform surface.

Sprinkle the mortar surface with water twice a day for about 10 days. This is a positively necessary precaution, because facing cannot develop its full strength unless it has moisture applied continuously throughout the time it is hardening. If drying is too rapid, there will be excessive shrinkage and the surface will check and show hair cracks.

Whenever it is possible, apply the mortar surfacing or wearing surface as in sidewalks, floors, etc., at the same time as the base or main mass of concrete. This gives far more satisfactory results and makes a perfectly solid mass, like one huge stone, therefore causing no difficulties in bonding.

Brush Surfaces

One of the best methods of removing the plaster from the forms is as follows: After removing the forms concrete should be brushed while green with a steel brush or one made of stiff fiber bristles. If the concrete hardens so that the mortar cannot be brushed away from the coarse aggregate, the mortar may be softened by a solution of muriatic acid. After brushing, the work should be treated with an acid solution and for this purpose the solution should be 1 part of commercial muriatic acid to 3 parts of water. After the use of an acid solution the work should be washed immediately, and thoroughly, with clean water, as any acid remaining on the surface of the work will ultimately cause streaks and discolorations.

The following materials are recommended as suitable aggregates for the production of desirable brush surfaces, it being understood in using any of them for aggregates that the mixture is to be 1 sack of Portland cement to 2½ cu. ft. of aggregate.

Yellow marble screenings up to ¼ in.; red granite screenings up to ¼ in.; black marble graded from ⅛ to ½ in.; river or lake gravel graded from ¼ to ½ in. To secure economy, limestone may be substituted for white marble and either black granite or trap-rock may be substituted for black marble.

The above materials are merely suggestions of the possibilities of concrete surfaces. Infinite variations may be made by substitutions in combining materials, while if one takes trap-rock, red granite or limestone, for instance, by merely increasing or diminishing the size of one or two of the ingredients it readily will be seen that a great many combinations may be effected, all of which will produce desirable surfaces for brushing. In general fine aggregate will produce a comparatively smooth surface of uniform color while coarser aggregates will give greater irregularity in both surfaces and color, producing a somewhat rustic appearance.

One of the chief advantages of finishing surfaces by brushing is the adaptability of this process to every class of concrete construction. Park benches, lawn vases, lamp-posts and statuary of all kinds may be finished by this process as easily as buildings.

Rubbed Surfaces

Where it is desired to leave a smooth surface in the shape produced by the forms, but to obtain a more finished surface than possible by washing with a float under which sand is used for cutting, the concrete may be finished, when it is at an age of from 1 to 2 days, by removing the form and rubbing the surface with a brick and sand, natural stone, emery, or carborundum.

Where it is desired to finish concrete in this manner the large pieces of aggregate should be spaded back from the forms so that the face will contain little or no coarse aggregate. If a mottled surface is desired it may be produced by a mortar composed of 1 part of Portland cement and 2½ parts of white marble or limestone, either of which will rub to a very beautiful surface. While the rubbing is in process a thin grout, composed of 1 part of cement and 1 of sand should be applied and well rubbed in. The work should afterwards be washed down with clear water.

Dressed Surfaces

When concrete is thoroughly hardened, it may be dressed in the same manner as natural stone, although the stone cutter's tools require slight alterations to suit the need of concrete. While this work is sometimes done on concrete when it is 2 or 3 days old, the best results are obtained when it is about 1 month old. The great disadvantage of dressing concrete with a stone hammer at too early an age is that pieces of the aggregate will be knocked out from the cement mortar, leaving unsightly holes, while if left for a few weeks it will become so thoroughly hardened that they will break under the hammer and give a uniform surface much the same as natural stone. For this purpose the best tool is a special form of bush hammer, designed to dress concrete, the points on the face of which are farther apart and larger than the regular stone cutter's hammer. A three pound hammer with four points is a good size for concrete work, although larger ones are frequently used. Another hammer which has been especially designed for dressing concrete is similar to a pick having five teeth on each end. For finishing large surfaces a pneumatic hammer is used and produces a very uniform finish, doing the work much more rapidly than where the tools are operated by hand. Another finish is obtained by an expensive machine which gives a sand-blast finish.

Concrete should never be subjected to sand-blasting until it is at least one month old. A nozzle pressure of from 50 to 80 lbs. should be maintained.

Colored Surfaces

For artistic work, the suggestions already made with reference to the selection, gradation and mixing of aggregate will accomplish better results in any process of artificial coloring which may be adopted.

There are, however, possibilities of producing artificially colored concrete work of which some notice should be given.

The coloring-matter should not exceed 5 per cent of the weight of the cement and should be mixed with the dry cement before water is added. Nothing but mineral coloring should be used. The following table taken from "Cement and Concrete," by L. C. Fabin is generally accepted as authority for mounts of a different color and material.

COLORED MORTARS

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

Dry Material Used	Weight of Coloring-matter Per Bag of Cement			
	½ lb.	1 lb.	2 lbs.	4 lbs.
Lamp black	Light slate	Light gray	Blue gray	Dark blue slate
Prussian blue	Light green slate	Light blue slate	Blue slate	Bright blue slate
Ultramarine blue	....	Light blue slate	Blue slate	Bright blue slate
Yellow ocher	Light green	....	....	Light buff
Burnt umber	Light pinkish slate	Pinkish slate	Dull lavender pink	Chocolate
Venetian red	Slate, pink tinge	Bright pinkish slate	Light dull pink	Dull pink
Chattanooga iron ore	Light pinkish slate	Dull pink	Light terra-cotta	Light brick red
Red iron ore	Pinkish slate	Dull pink	Terra-cotta	Light brick red

There will be exceptional cases where it is necessary, or desirable, to color concrete surfaces after the surface has been completed. For this purpose cement paint should be used, several brands of which are now manufactured, in a limited number of colors, by reputable companies.

Design

There remains only one further feature of concrete surfaces to be discussed and that is the producing of mosaics or pattern work. The plasticity of concrete makes it lend itself particularly to the reproduction of beautiful designs which may be secured in a variety of ways. For the more elaborate designs the pieces of marble, if that be the material selected, should be glued face down upon tough paper, in the same manner in which floor tiles are prepared for laying. This paper, with the design upon it should be placed in the forms and the concrete rammed in place. After the forms are removed, and the concrete allowed to harden, the paper should be removed by wetting. Then clean the face of the finished design by the usual acid solution 3 parts of water to 1 part of commercial muriatic acid.

Waterproofing Concrete

Concrete made from carefully selected materials, properly mixed and properly placed, under ordinary conditions should be watertight.

All the waterproofing materials in the world will not insure a tight job unless the foregoing conditions are met.

The Use of Concrete in Winter

Indoor concrete work such as floors, the making of concrete posts, etc., is quite feasible during the winter providing the temperature where the work is being done does not go below 45°. Outside work requires considerable care during cold weather and the aggregates must be properly heated before being used. This is usually done on small work by having a hot fire under a metal arch on which the sand or gravel may be thrown.

Warm water should be used in mixing and the finished job properly protected with straw or other materials until it has obtained a sufficient set to prevent freezing.

Estimating

The first step in calculating quantities is to figure the total cubic space to be occupied by the concrete. This is done by reducing all dimensions to like units, such as multiplying length, width or height, and thickness together in feet or fractions thereof.

For illustration, if a walk was to be laid 75 ft. long, 6 ft. wide and 6 in. thick, we would have 75 x 6 x ½ or 225 cu. ft. Dividing this by 27, which is the number of cubic feet to a yard, we have 8⅓ cu yds. as the volume to be filled with concrete.

Figuring a foundation. We will assume that we have a house foundation 1 ft. thick, 10 ft. high, 28 ft. wide and 42 ft. long.

This would figure 1 x 10 x 26 or 260 cu. ft. for the short wall and 1 x 10 x 42 or 420 cu. ft. for the long wall. In the short wall 26 is used instead of 28 because we figure the long wall the full length or 42 ft. We must lessen the width, therefore, by 2 ft. (1 ft. on each end) to allow for the thickness of the wall itself, which is 1 ft.

Since there are two short walls and two long walls, it is necessary to double the totals 260 and 420, making them 520 and 840, totaling 1,360 cu. ft., from which must be deducted window and door spaces.

Assuming that there are two doors 7 ft. x 3 ft. and eight windows 3 ft. x 2 ft., there must be deducted the following amounts: Two doors would equal 7 x 3 x 1 x 2 or 42 cu. ft., eight windows, 3 x 2 x 1 x 8 or 48 cu. ft., totaling 90 cu. ft. This leaves the total cubical contents 1,360 less 90 or 1,270 cu. ft.

It is always necessary, in measuring the height of walls, to take into consideration the depth that the footings or foundations go into the ground and if the footing is thicker below the ground than above, as is quite common, it is better to figure their volume separately.

In figuring curved work, such as a road, which is crowned, the average thickness should be taken.

Table for Determining the Quantities of Materials Needed

The following table will enable you to figure the quantities of each material needed for any job, by adding together or multiplying the quantities in the table corresponding to the volumes in the first columns. The first column shows the quantity of concrete. The other five divisions show the different mixtures and quantities of material under each mixture needed to produce the quantity of concrete given in the first section.

	1 : 1½ : 3 Mixture			1 : 2 : 3 Mixture			1 : 2 : 4 Mixture			1 : 2½ : 5 Mixture			1 : 3 : 6 Mixture		
Cu. ft. of Concrete	Bags Cement	Cu. ft. Sand	Cu. ft. Stone	Bags Cement	Cu. ft. Sand	Cu. ft. Stone	Bags Cement	Cu. ft. Sand	Cu. ft. Stone	Bags Cement	Cu. ft. Sand	Cu. ft. Stone	Bags Cement	Cu. ft. Sand	Cu. ft. Stone
100	28	42	84	25 4/5	51 3/5	77 2/5	22	44	88	18	45	90	16	48	96
90	25 1/5	37 4/5	75 3/5	23 1/5	46 2/5	69 3/5	19 4/5	39 3/5	79 1/5	16 1/5	40 1/2	81	14 2/5	43 1/5	86 2/5
80	22 2/5	33 3/5	67 1/5	20 2/3	41 1/3	62	17 3/5	35 1/5	70 2/5	14 2/5	36	72	12 4/5	38 2/5	76 4/5
70	19 3/5	29 2/5	58 4/5	18	36	54	15 2/5	30 4/5	61 3/5	12 3/5	31 1/2	63	11 1/5	33 3/5	67 1/5
60	16 4/5	25 1/5	50 2/5	15 1/2	31	46 1/2	13 1/5	26 2/5	52 4/5	10 4/5	27	54	9 3/5	28 4/5	57 3/5
50	14	21	42	13	26	39	11	22	44	9	22 1/2	45	8	24	48
40	11 1/5	16 4/5	33 3/5	10 1/3	20 2/3	31	8 4/5	17 3/5	35 1/5	7 1/5	18	36	6 2/5	19 1/5	38 2/5
30	8 2/5	12 3/5	25 1/5	7 3/4	15 1/2	23 1/4	6 3/5	13 1/5	26 2/5	5 2/5	13 1/2	27	4 4/5	14 2/5	28 4/5
20	5 3/5	8 2/5	16 4/5	5 1/5	10 2/5	15 3/5	4 2/5	8 4/5	17 3/5	3 3/5	9	18	3 1/5	9 3/5	19 1/5
10	2 4/5	4 1/5	8 2/5	2 3/5	5 1/5	7 4/5	2 1/5	4 2/5	8 4/5	1 4/5	4 1/2	9	1 3/5	4 4/5	9 3/5
9	2 1/2	3 4/5	7 3/5	2 1/3	4 2/3	7	2	4	8	1 3/5	4	8	1 1/2	4 1/3	8 2/3
8	2 1/4	3 3/8	6 3/4	2	4 1/6	6 1/4	1 3/4	3 1/2	7	1 2/5	3 3/5	7 1/5	1 1/4	3 7/8	7 3/4
7	2	3	6	1 4/5	3 1/2	5 2/5	1 1/2	3	6	1 1/4	3 1/8	6 1/4	1 1/8	3 3/8	6 3/4
6	1 2/3	2 1/2	5	1 3/5	3 1/5	4 3/5	1 1/3	2 2/3	5 1/3	1 1/10	2 3/4	5 1/2	1	3	6
5	1 2/5	2 1/10	4 1/5	1 1/3	2 2/3	4	1 1/10	2 1/5	4 2/5	9/10	2 1/4	4 1/2	4/5	2 2/5	4 4/5
4	1 1/8	1 3/4	3 3/8	1	2	3 1/5	7/8	1 3/4	3 1/2	7/10	1 4/5	3 3/5	5/8	2	4
3	4/5	1 1/4	2 1/2	3/4	1 1/2	2 1/3	2/3	1 1/3	2 2/3	1/2	1 1/3	2 2/3	1/2	1 1/2	3
2	9/16	7/8	1 11/16	1/2	1	1 1/2	7/16	7/8	1 3/4	1/3	9/10	1 4/5	5/16	1	2
1	9/32	7/16	7/8	1/4	1/2	3/4	7/32	7/16	7/8	1/5	1/20	1	5/32	1/2	1

To figure out how many cubic feet there are in a job, write down the dimensions, all in feet or fractions of feet, so that the result will be in cubic feet. To find the number of cubic feet in a pavement 30 ft. long, 4 ft. wide and 4 in. thick, write the last dimension in feet, calling it 4/12 or 1/3 ft. Then multiply 30x4x1/3 and the answer will be 40 cu. ft. Look in the table under the mixture you are going to use—opposite 40. Take the quantities there for your job.

Example: If you want to know the materials for 291 cu. ft. of 1-2-4 mixture, copy out the figures for 100 cu. ft. and multiply them by 2, to make 200. You will have 44 bags of cement, 88 cu. ft. of sand and 176 cu. ft. of stone. Then look under the same head, opposite 90 cu. ft.: 19 4/5 bags of cement, 39 3/5 cu. ft. of sand and 79 1/5 cu. ft. of stone. Then look opposite 1 cu. ft. and you find 7/32 bags of cement, 7/16 cu. ft. of sand and 7/8 cu. ft. of stone. Adding these three results you will find 291 cu. ft. of concrete in a 1-2-4 mixture will require 64 bags of cement, 128 cu. ft. of sand and 256 cu. ft. of stone or gravel.

For a wall, slab or a roof, you will find it easy to calculate the total cubic feet of concrete if you will just remember that you must multiply together the three different dimensions, all expressed in feet or fractions of feet.

For more complicated jobs do not count corners twice, as there is a liability of doing, on walls, for instance.

If you are building a trough, 12 ft. long, 6 ft. wide with walls 6 in. thick and 48 in. high, the two long walls will be 12 ft. long, 4 ft. high and 6 in. thick, but the two other walls will be only 5 ft. long, 4 ft. high and 6 in. thick,—because the 6 in. thickness comes off the end of each of the short walls at each end.

If a square tank or a room or anything hollow is being built, in which the proportioning of materials is the same in all its parts, figure on the whole thing as if it were solid and then subtract the cubical contents of the hollow part in the center.

For instance, find the number of cubic feet of concrete for a tank 10 ft. long, 10 ft. wide and 8 ft. high with walls, floor and roof all 6 in. thick, by first calculating the contents of the whole thing as if it were solid. This would be 10x10x8 or 800 cu. ft. Then figure the contents of the hollow inside. Allowing for the 6 in. walls, the inside measurements would be 9 ft. long, 9 ft. wide and 7 ft. high, or 9x9x7 equalling 567 cu. ft. Subtracting this from the former figure (800—567), the answer will be 233 cu. ft.

To calculate circular work there is one rule to remember: The area of a circle is found by multiplying the diameter by the diameter, then multiplying the result by 3 1/7 and dividing by 4, so that a circular slab of concrete 7 ft. in diameter would have an area of 7x7x3 1/7 divided by 4, which equals 38½ sq. ft.

Multiply the area by the thickness in feet or fractions of feet thereof, and you have the number of cubic feet in the slab. If this slab is 6 in. thick, the number of cubic feet in it will be 38½x½ or 19¼.

If you are building a circular tank, figure the total contents as if it were solid right through; then calculate the contents of the hollow space that is not to be filled with concrete and subtract this from the first total.

Mortar

1 bag cement..................	2 cu. ft. sand......................	make 2 1/10 cu. ft. mortar.
1 bag cement..................	2½ cu. ft. sand......................	make 2½ cu. ft. mortar.
1 bag cement..................	3 cu. ft. sand......................	make 2⅘ cu. ft. martar.

Concrete

1 bag cement.....	1½ cu. ft. sand.....	3 cu. ft. gravel or stone.....	make 3½ cu. ft. concrete.
1 bag cement.....	2 cu. ft. sand.....	3 cu. ft. gravel or stone.....	make 3 9/10 cu. ft. concrete.
1 bag cement.....	2 cu. ft. sand.....	4 cu. ft. gravel or stone.....	make 4½ cu. ft. concrete.
1 bag cement.....	2½ cu. ft. sand.....	5 cu. ft. gravel or stone.....	make 5⅖ cu. ft. concrete.
1 bag cement.....	3 cu. ft. sand.....	5 cu. ft. gravel or stone.....	make 5⅘ cu. ft. concrete.

The mortar and concrete tables given above give the cubic foot quantities of mortar and concrete respectively resulting from each of the mixtures shown. See Plate 3.

The author will assume, in the problems following, that the student has familiarized himself with the previous text, especially that relating to the proportioning, mixing and placing of concrete in the forms.

Questions and Answers

1. Why should bank-run gravel be screened and the fine and coarse materials be reproportioned before using in a concrete mixture?

Most bank-run gravel contains a great deal more sand than is desirable in a concrete mixture. Sometimes this sand is twice as great in quantity as what would be best. If 75 per cent of bank-run gravel were fine material, the proper proportion of cement would vary widely from that required in case only 30 per cent of a bank-run gravel were fine material. Only by separating the fine material (sand) from the coarse material (pebbles) can definitely specified mixtures be secured.

2. How does a 1:6 mixture differ from a 1:2:4?

Part of the answer to this question is suggested in the preceding answer. A 1:6 mixture is 1 cu. ft. of Portland cement to 6 cu. ft. of fine and coarse aggregates, mixed. The resulting volume would be approximately 6 cu. ft., while a 1:2:4 mix would produce a volume of about 4 cu. ft. In one case there are 6 cu. ft. of concrete containing 1 sack of cement as against a little over 4 cu. ft. containing the amount of cement. Evidently the latter mixture will have greater strength.

3. How wet should concrete be mixed for average work to secure the greatest strength?

For most construction, concrete should be of a quaky consistency, which means that when placed in a pile it will gradually spread out or flatten of its own weight. If more water than is required to produce a quaky consistency is used, the cement-sand mortar and pebbles will most likely separate, resulting in porous pockets in the construction.

4. When should sand and gravel be washed before using in a concrete mixture and why?

If the sand or pebbles are coated with clay for instance, the cement cannot adhere to the surface of these particles. Therefore the cement cannot perform its binding function.

5. How may sand and gravel be easily and quickly washed?

A washing and screening apparatus may be readily constructed for a small outlay, by making a trough having a ⅜ in. mesh screen at one end, then raising and propping up the other end in which the materials are placed, attaching a pipe or hose at this end so that water may be supplied to tumble the material about, down the trough and over the screen at the lower end.

6. What is the largest size aggregate permissible in a concrete mixture?

There is a general rule in concrete construction, which specifies that no aggregate (pebbles or broken stone) shall exceed in size one-half the wall thickness in which it is used. As a rule, however, 1½ in. is fixed as the maximum for most work, while in thin walls, where reinforcing must be surrounded perfectly, it is often advisable to use a smaller maximum. Again, in the case of fence posts, there is a limit of size usually fixed at ¾ in. owing to the fact that the space to be filled with concrete is small. For much foundation work it is often permissible to exceed 1½ in. maximum but generally speaking the maximum should not be more than 2 in.

7. What method should be used to finish a concrete floor to prevent the surface from being slippery?

Floors such as feeding floors and barnyard pavements should be finished with a wood float instead of a steel trowel. The former will produce an even but sufficiently gritty surface to make a non-slippery floor.

8. How long a time should elapse after a floor has been constructed before it should be put into use?

The time which concrete floors must be allowed to harden before putting them into use depends largely upon prevailing weather conditions and whether proper protection has been given the floor to enable the concrete to acquire strength under favorable conditions. Generally speaking, the time may vary from 10 days to 3 weeks.

9. What protection should be given to concrete after it is placed to insure proper hardening?

All concrete construction which exposes a large surface to the air should be kept moist by some such protective covering as sand, burlap or canvas, to prevent rapid drying from the action of sun and wind. This covering should be kept moist by frequent sprinkling as often as necessary until the concrete has acquired the desired hardness.

10. What slope should a floor have to provide the necessary drainage?

One-eighth in. to the foot is sufficient.

11. What thickness should a concrete feeding floor have?

If the construction is one-course of a 1:2:3 mixture the floor should be not less than 5 in. thick. If of two-course construction then there should be a 1:2½:5 base with 1½ in. or 2 in. of 1:3 mortar surface, making the floor not less than 6 or 7 in. thick.

12. Is a cinder fill under such a floor necessary?

Not unless the conditions where the floor is to be laid are such that the underlying soil will collect and retain moisture. Even then, the cinder or gravel fill should be connected with a drain that will prevent water from being retained beneath the floor. In any case it is best to have the floor above the level of the surrounding soil.

13. How will concrete construction save the liquid content of manure?

The concrete feeding floor or barnyard pavement should slope toward a gutter that leads to a concrete manure pit. In this way all of the liquid content of manure is preserved. Likewise, the surroundings are made more nearly sanitary.

14. Why is concrete usually the most economical material to use for farm improvements?

Concrete is fireproof, rot-proof, rat-proof, sanitary, and reduces the labor of caring for stock.

15. Can concrete work be successfully carried on in cold weather?

If sand and pebbles and mixing water are heated and the concrete is properly protected against freezing for at least 48 hours after being placed, much successful work can be done in cold weather.

16. What feature of design should a concrete water tank or trough have to prevent cracking due to the freezing of the water?

There should be a slope or batter on the inside so that when ice forms the expansion will cause it to slide up the tank sides, thus relieving the tank of pressure outward from ice within.

17. Is barbed wire a suitable reinforcing material for concrete?

Barbed wire should not be used as reinforcing material for concrete construction. It is difficult to handle and keep in position while concrete is being placed. Furthermore, it lacks the qualities which reinforcing steel should have for best results in concrete work.

18. In what way may rust be objectionable on reinforcing steel? Is there danger of the steel rusting after encased in concrete?

Unless the rust on the steel is in the form of a loose scale, it will do no harm. Once the steel is thoroughly embedded in concrete of proper consistency and density, it is protected against further rust.

19. Is waterproofing necessary to produce watertight concrete?

No waterproofing is necessary if the concrete mixture is properly proportioned for maximum density and carefully placed at a right consistency, and protected from rapid drying while hardening.

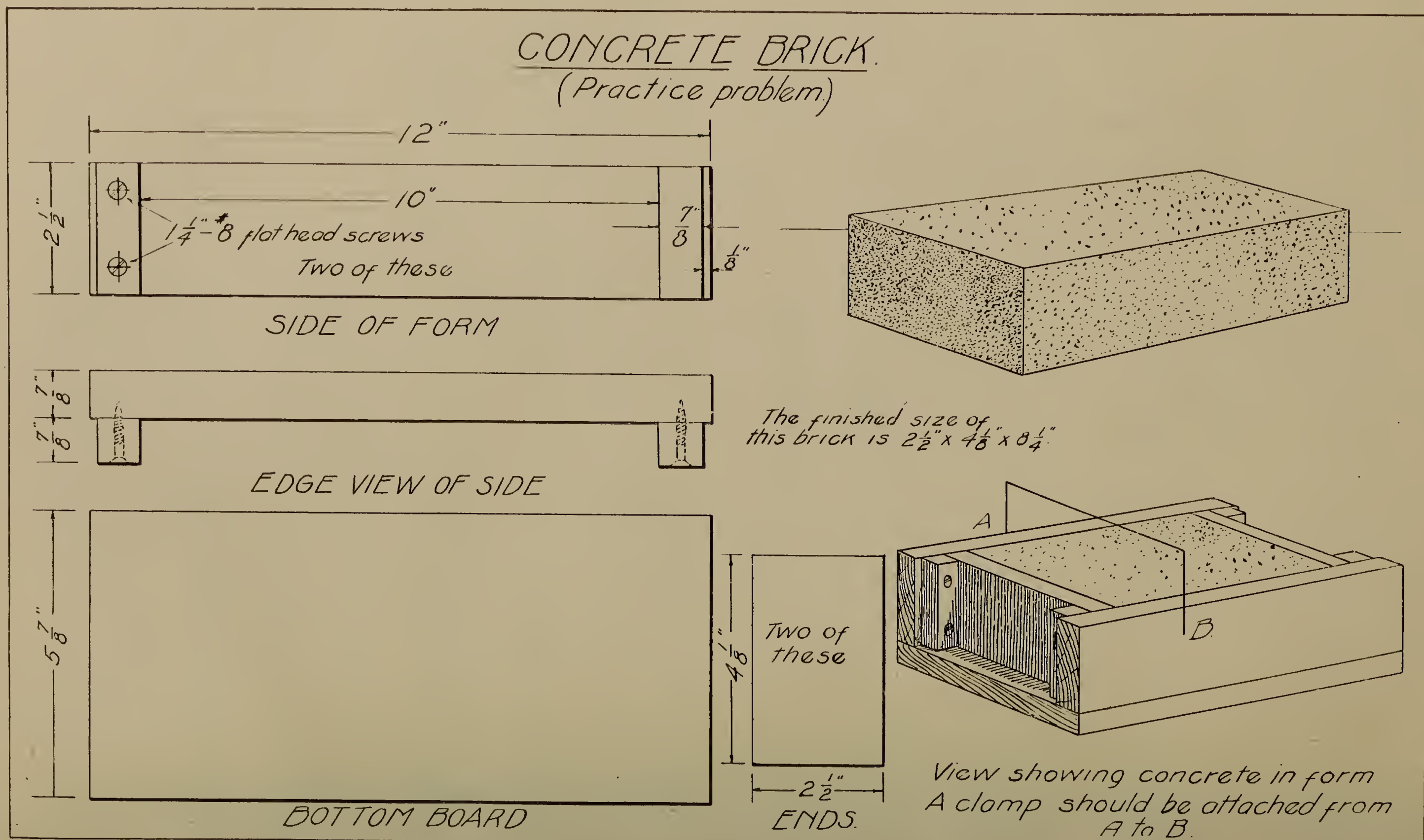
20. How can concrete be prevented from sticking to the molds or forms?

For some work a thorough wetting down of forms is often all that is required to prevent concrete from sticking. Sometimes soft soap, or a mixture of equal parts of boiled linseed oil and kerosene is used. Wetting down, however, is necessary at each use of the forms.

PART II

Problems

PLATE 5


CONCRETE BRICK.
(Practice problem)
12"
10"
$1\frac{1}{4}$" - #8 flat head screws
Two of these
$\frac{7}{8}$"
$\frac{1}{8}$"
$2\frac{1}{2}$"
SIDE OF FORM
$\frac{7}{8}$"
$\frac{7}{8}$"
EDGE VIEW OF SIDE
$5\frac{7}{8}$"
BOTTOM BOARD
The finished size of this brick is $2\frac{1}{2}$" x $4\frac{1}{8}$" x $8\frac{1}{4}$"
$4\frac{1}{8}$"
Two of these
$2\frac{1}{2}$"
ENDS.
A
B
View showing concrete in form
A clamp should be attached from A to B.

A Concrete Brick

(Practice Problem)

Plate 5 shows the drawing of a form for making a concrete brick, 2½ in. thick by 4⅛ in. wide by 10 in. long.

This problem is designed chiefly to familiarize the pupil with the making of a simple form and the proportioning, mixing and casting of concrete.

The base-board for the form is 5⅞ in. x 12 in., made from ⅞ in. material. The ends are ⅞ in. x 4⅛ in. Two of these are required.

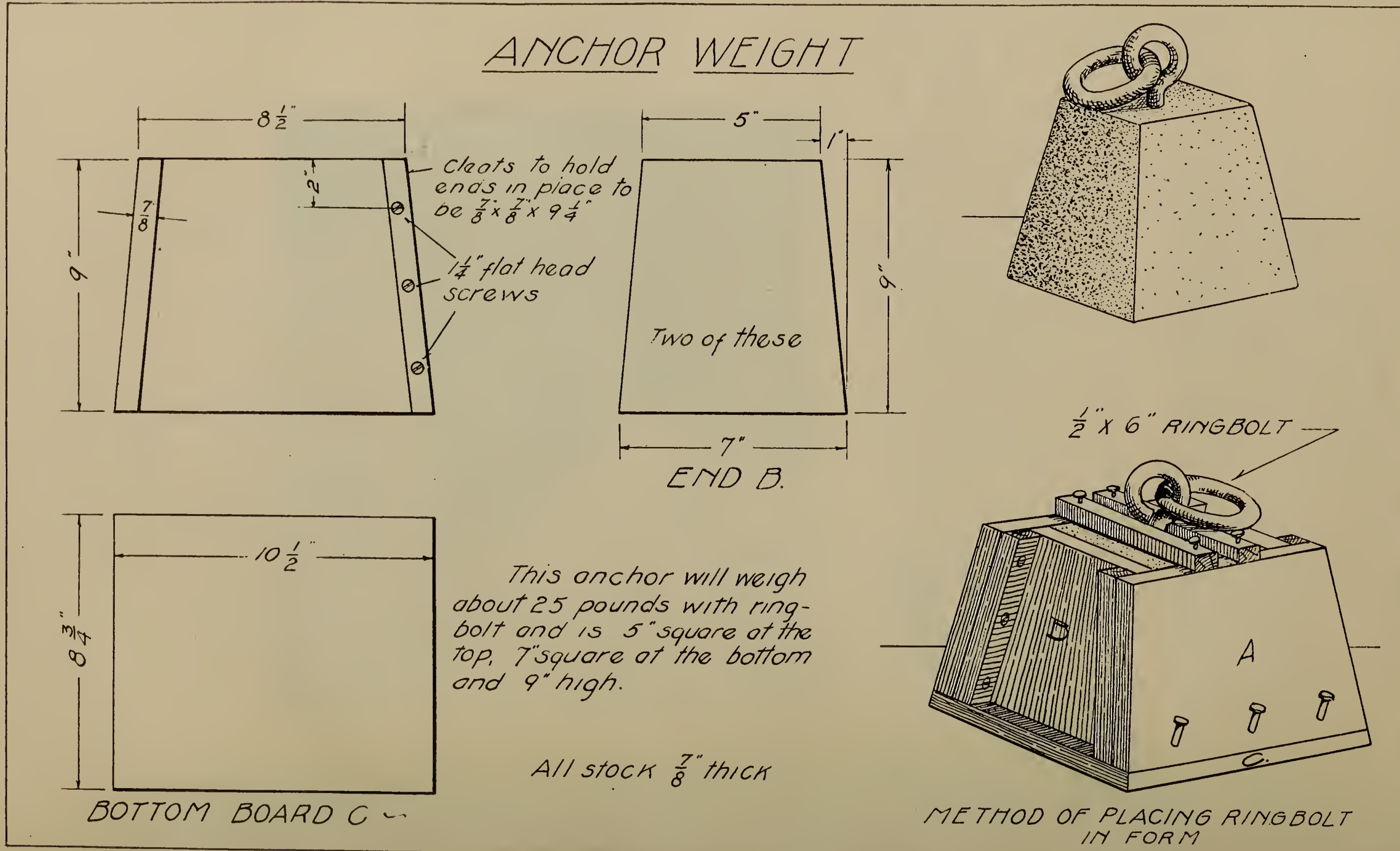
The two sides are ⅞ in. x 2½ in. x 12 in., with two blocks ⅞ in. x ⅞ in. x 2½ in. attached ⅛ in. in from the ends with screws, as shown.

Mix the necessary amount of cement and sand in proportions of 1 part cement to 3 parts sand as described in chapter under "Mixing."

Place a wooden clamp in place shown in sketch and leave 24 hours.

Illus. 7. Concrete Steps Laid by Eighth Grade Boys.

PLATE 6.


ANCHOR WEIGHT
8 1/2"
9"
7/8
2"
Cleats to hold ends in place to be 7/8" x 7/8" x 9 1/4"
1 1/4" flat head screws
5"
1"
Two of these
9"
7"
END B.
10 1/2"
8 3/4"
BOTTOM BOARD C
This anchor will weigh about 25 pounds with ringbolt and is 5" square at the top, 7" square at the bottom and 9" high.
All stock 7/8" thick
1/2" X 6" RINGBOLT
A
D
C.
METHOD OF PLACING RINGBOLT IN FORM

Anchor Weight

Plate 6 shows the drawing of the form for a concrete anchor weighing about 25 lbs.

This problem, while a very little more difficult than that of Plate 5, is simple enough in construction for a fifth or sixth grade boy.

The two larger sides A, are cut 9 in. x 10½ in. and then tapered on one end to 8½ in., as shown.

Attached to the two sloping edges are two pieces ⅞ in. x ⅞ in. x 9¼ in.

Sides B are first cut 7 in. x 9 in. and tapered to 5 in.

The base C is ⅞ in. x 8¾ in. x 10½ in. The top and bottom edges of A and B are leveled as indicated in sketch.

Two scrap sticks are partly nailed on to the edges of sides A, as shown, and the ringbolt suspended while the form is being poured. The sides A are also lightly nailed to the base so as to be easily removed when the form is hard. Leave in the form 24 hours.

An interesting feature of this problem is the figuring out beforehand of the weight of the anchor. This is done as follows:

The shape of the anchor is in the form of a truncated pyramid. It is necessary to first find the cubical contents, which is obtained by taking a section through the average height, which is 4½ in. perpendicularly up from the base (the total height being 9 in.). This gives us the average section, square in shape, and 6 in. on a side.

The area of this section is then 6 in. x 6 in. or 36 sq. in. Multiplying this by the height, 9 in., we have 36 x 9 in., equalling 324 cu. in. in volume. There being 1728 cu. in. in a cubic foot, we have 324 cu. in. divided by 1728, which equals 3/16 cu. ft.

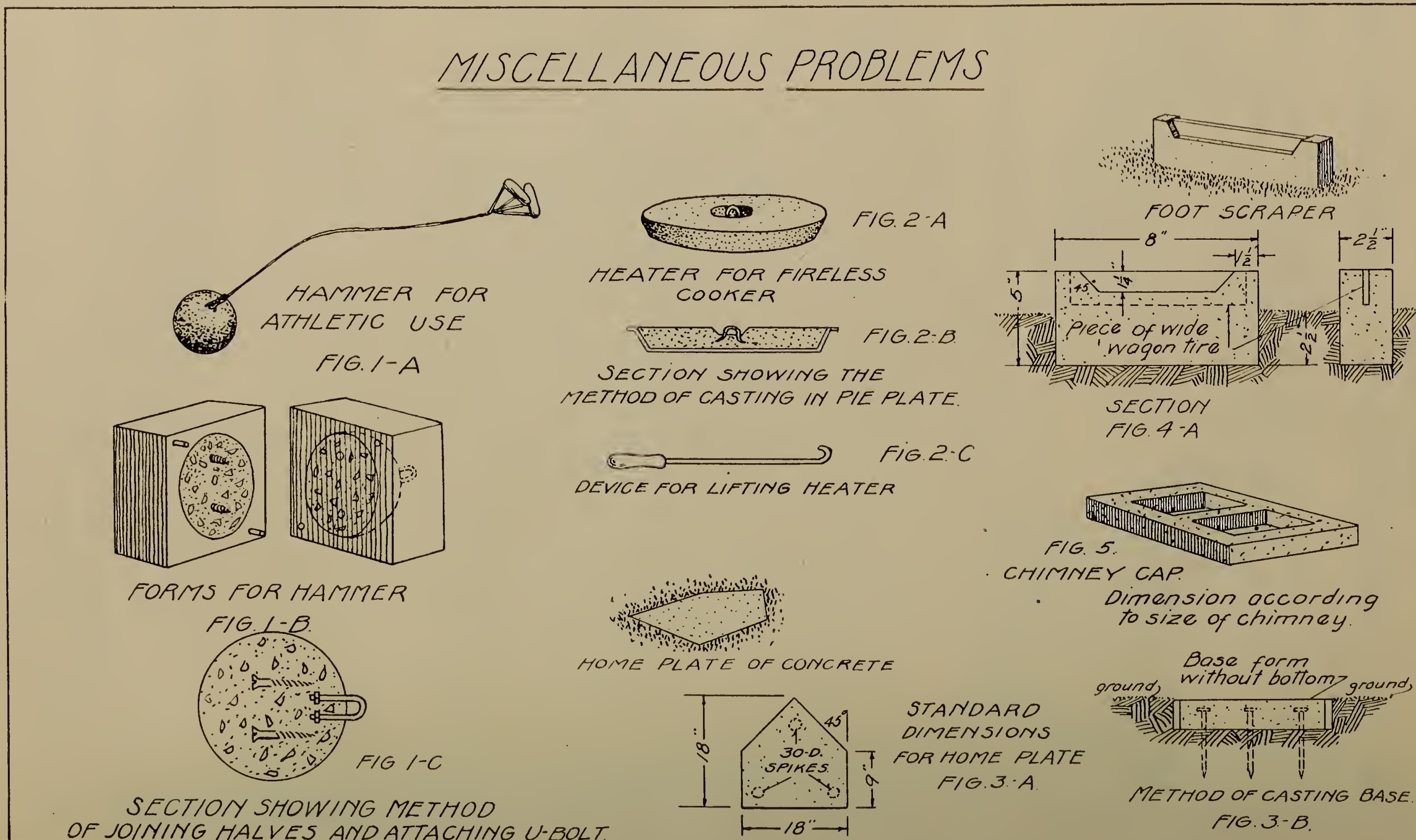
A cubic foot of concrete weighs from 130 to 140 lbs. varying according to the kind of crushed stone used, granite being the heaviest.

Taking 135 lbs. as the average weight we find that 135 divided by 3/16 equals 25 5/16 lbs., the weight of the anchor.

The writer has found that the boys are extremely interested, after figuring out beforehand the weight of the anchor, to verify their calculations by actually weighing the finished problem.

A very serviceable horseweight can be cast, on the same principle, by reducing the dimensions of the form.

PLATE 7.


MISCELLANEOUS PROBLEMS
HAMMER FOR ATHLETIC USE
FIG. 1-A
FORMS FOR HAMMER
FIG. 1-B.
FIG 1-C
SECTION SHOWING METHOD OF JOINING HALVES AND ATTACHING U-BOLT.
FIG. 2-A
HEATER FOR FIRELESS COOKER
FIG. 2-B
SECTION SHOWING THE METHOD OF CASTING IN PIE PLATE.
FIG. 2-C
DEVICE FOR LIFTING HEATER
HOME PLATE OF CONCRETE
18"
45°
30-D. SPIKES
9"
18"
STANDARD DIMENSIONS FOR HOME PLATE
FIG. 3-A
FOOT SCRAPER
8"
1/2
2 1/2
5"
1/4
45
Piece of wide wagon tire
2 1/2
SECTION
FIG. 4-A
FIG. 5.
CHIMNEY CAP.
Dimension according to size of chimney.
Base form without bottom
ground
ground
METHOD OF CASTING BASE.
FIG. 3-B.

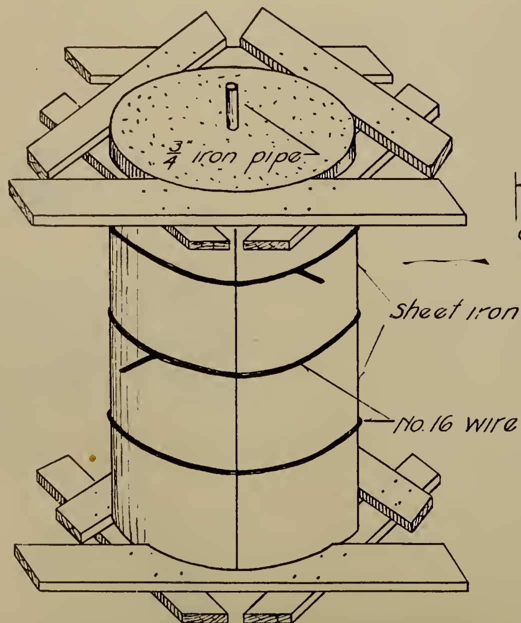
Miscellaneous Problems

Plate 7 gives a few simple miscellaneous problems in concrete and are self-explanatory.

Illus. 8. Concrete Steps and Walk Laid by Eighth Grade Boys.

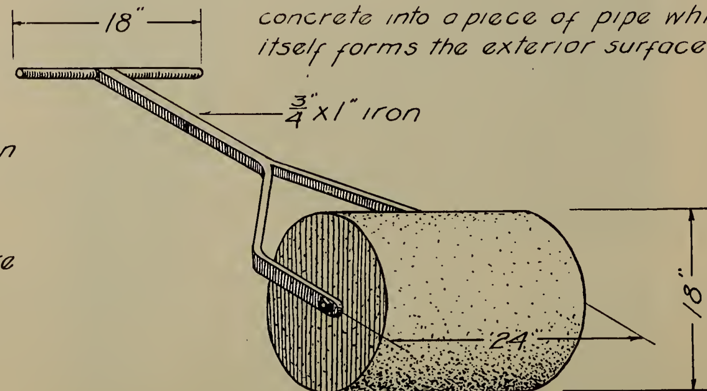
PLATE 8.

CONCRETE ROLLER



VIEW SHOWING FORM FOR CASTING ROLLER

A smaller roller, suitable for rolling seeded ground or golf greens, may be made by pouring concrete into a piece of pipe which itself forms the exterior surface



TYPE OF HEAVY ROLLER

Concrete Roller

Plate 8 shows drawings and sketch of a concrete roller weighing about 265 lbs. and is suitable for rolling lawns, etc., requiring two men to operate.

The form for this roller is made from a piece of sheet iron cut 24 in. by 56½ in. The edges must be cut square and even. Make two sets of wooden clamps, like the circular form shown in the drawing. Bend the piece of sheet iron in a circle and nail, if necessary, to the two wooden 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 the axle or shaft, place a ¾ in. or ⅞ in. iron pipe in the center of the form. The axle can be cast in the roller itself if desired instead of casting a ¾ in. or ⅞ in. pipe in the roller in which to place the axle.

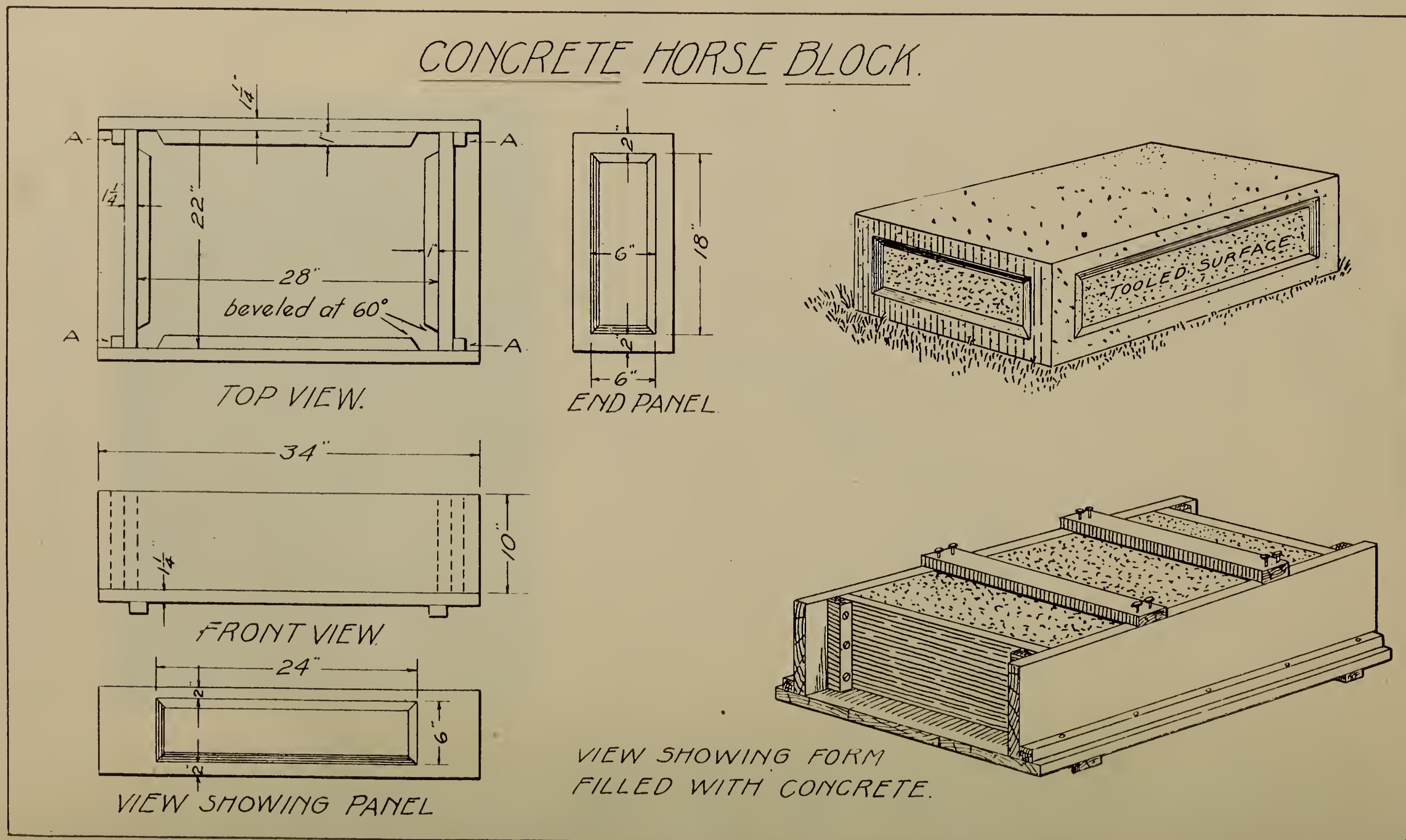
The concrete should be made of 1 part cement, 2 parts of sand and 4 parts of stones or gravel. It will take a little less than 1 bag of cement for a roller of the above dimensions.

The handle may be made of 1 in. iron bent and welded together as shown in the figure. A discarded lawnmower handle could be used and the iron work bolted to the same.

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

Illus. 9. Tearing Up Old Tar and Gravel Walk, Old Walk to Be Used as Large Aggregate in New Concrete Walk.

PLATE 9


CONCRETE HORSE BLOCK.
TOP VIEW.
22"
28"
beveled at 60°
1"
1¼"
A
END PANEL.
18"
6"
2
34"
10"
FRONT VIEW.
24"
VIEW SHOWING PANEL
TOOLED SURFACE
VIEW SHOWING FORM FILLED WITH CONCRETE.

Horse Block

Plate 9 shows the method of making a form for a horse block.

Horse blocks can be built solid in place or they may be cast in a form like the drawing with paneled sides.

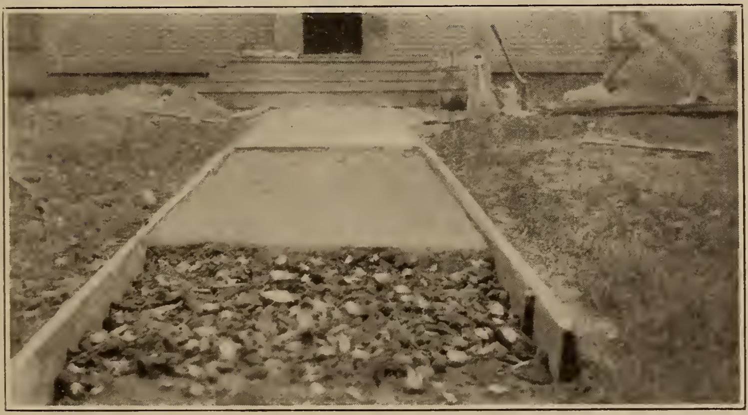
Make the forms as shown in the drawing so that the inside dimension is 10 in. high, 22 in. wide and 28 in. long.

The panels for the sides are ⅞ in. x 6 in. x 24 in. and those for the ends ⅞ in. x 6 in. x 18 in., leveled as shown. These should be placed carefully in the center of the sides and ends and attached firmly in place with nails or screws. Make the four braces ⅞ in. x ⅞ in. x 10 in. and screw them in place. Nail the two cross braces lightly across the top so they may be easily removed.

Grease the forms thoroughly and fill with a mixture of 1 part cement, 2½ parts of sand and 5 parts of gravel or broken stone.

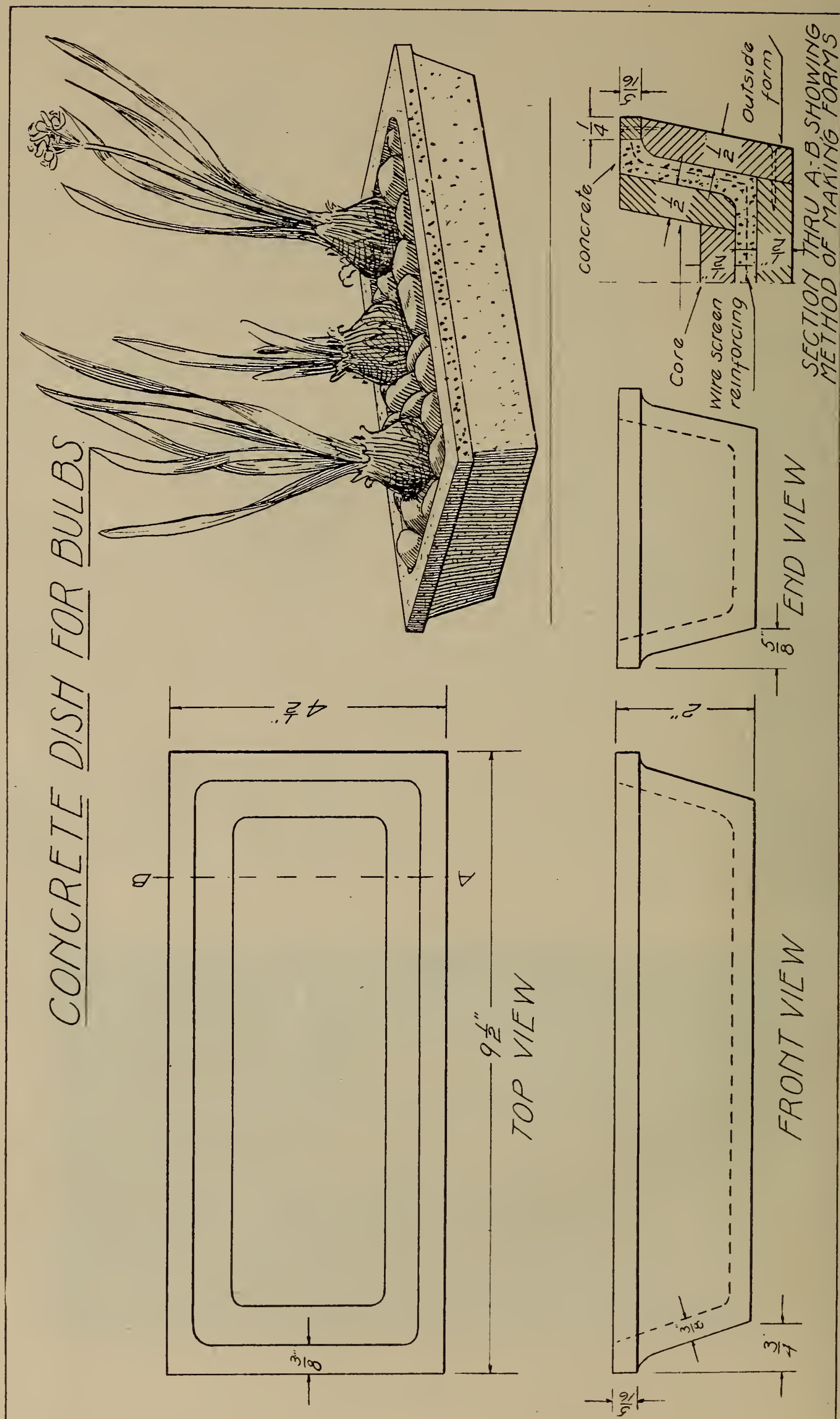
Smooth off the top surface with a trowel when first laid, then in a few hours scrape off any light colored scum with a wire brush or horse curry comb, and trowel the surface again, preferably with a wood float, but using no fresh mortar.

The form should be removed in 24 hours, or as soon as it is hard enough not to show thumb marks, and while the concrete is still green rub down the sides with a wood float or brick. Keep damp by sprinkling for a week.



Illus. 10. Showing Gravel Sub-Base, Rough Concrete Undercoat and the Top or Finished Coat.

PLATE 10


CONCRETE DISH FOR BULBS
4 1/2"
9 1/2"
3/8
A
B
TOP VIEW
2"
3/4
3/16
3/8
FRONT VIEW
5/8
END VIEW
concrete
1/4
3/16
1/2
1/2
outside form
Core
wire screen reinforcing
SECTION THRU A-B, SHOWING METHOD OF MAKING FORMS

Concrete Dish for Bulbs

Plate 10 shows a simple design for a concrete dish suitable for bulbs.

The sectional diagram will explain the method of making the form and there is a good chance here for original designing.

The form is made in two parts, the outer box form and the inner core.

Assemble the box and core, suspending the core as shown in Plate 11, by means of a small cross brace of scrap wood.

The forms should be thoroughly greased and the concrete mixed 1 part of cement to 2 parts of sand.

Reinforcing should be used consisting of ½ in. galvanized square-mesh wire, which is placed in position by making a basket so that when put in place in the form, it will be half way between the upper and lower surface of the concrete.

This basket may be held in place by slipping blocks between it and the inside form, these to be removed after the concrete has been deposited a little over half way up the forms. A trowel or a thin flat stick with a chisel end, should be worked up and down along the inside of the form so as to force the coarse particles of the mixture away from the surface.

First place a layer of concrete in the bottom of the form, then set the wire reinforcing basket on this. Add more of the mixture, working it into all corners, then press the core into place and fill up the sides thoroughly using the chisel end paddle to help fill in.

Leave in the mold at least 24 hours and then use a great deal of care when removing so as not to damage the green concrete.

After the form has been removed the outside surface of the concrete should be brushed with a stiff brush. The dish should then be allowed to air-dry for 2 or 3 hours, but be kept from drying out too rapidly; never place in the sunlight.

The dish should then be carefully placed in water and allowed to soak for two or three days.

A very smooth surface may be obtained by sprinkling dry cement over the wet surface, after removing from the water, and rubbing the cement in with a scrubbing brush or with a block of cork.

Flower Boxes

Plates 11 and 12 are drawings showing construction of flower boxes of concrete. These are made up, cast and finished the same as the bulb dish in Plate 10.

PLATE II.

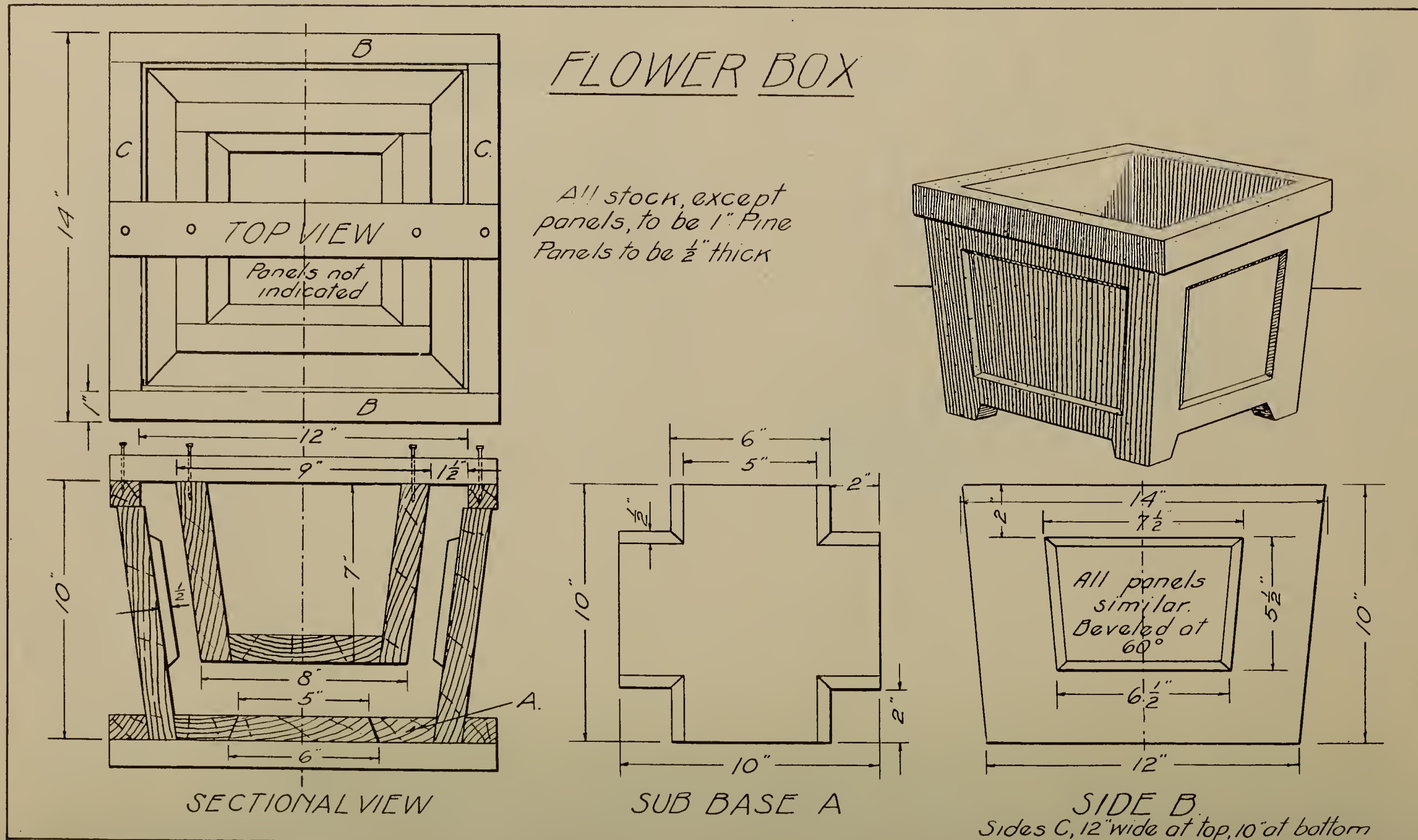
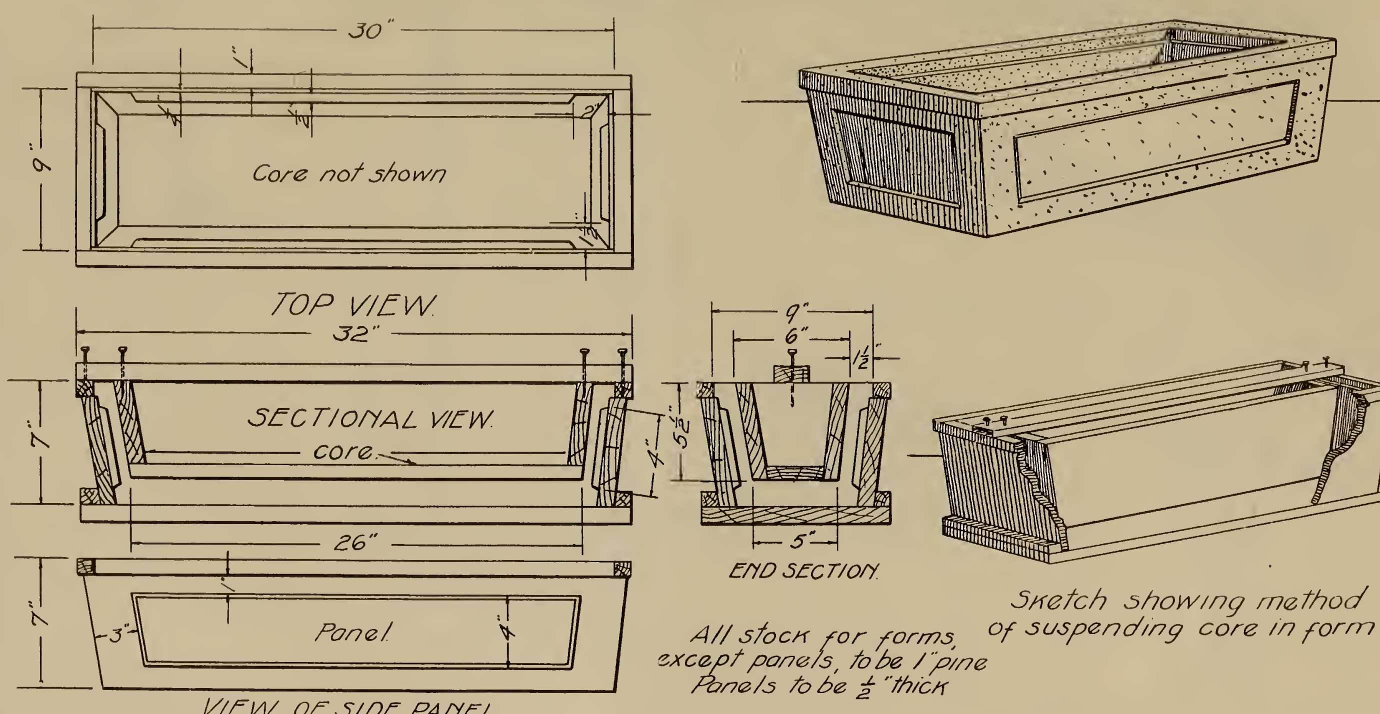

FLOWER BOX
All stock, except panels, to be 1" Pine
Panels to be ½" thick
TOP VIEW
Panels not indicated
B
C
14"
1"
12"
9"
1½"
7"
8"
5"
6"
10"
½"
A.
SECTIONAL VIEW
SUB BASE A
2"
All panels similar. Beveled at 60°
14"
7½"
5½"
6½"
12"
SIDE B.
Sides C, 12" wide at top, 10" at bottom

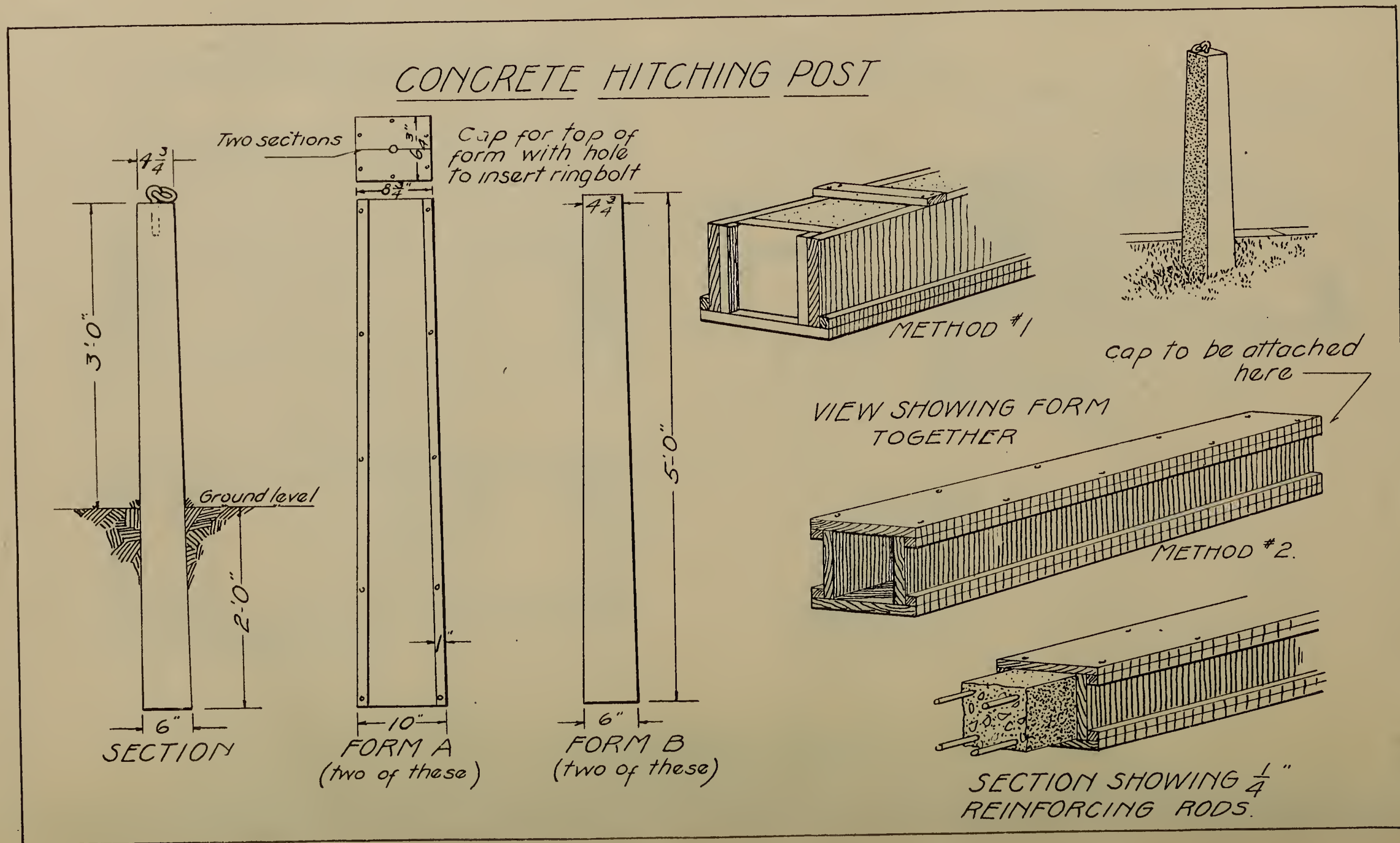
PLATE 12.

FLOWER BOX



All stock for forms,
except panels, to be 1" pine
Panels to be ½" thick

PLATE 13


CONCRETE HITCHING POST
Two sections
Cap for top of form with hole to insert ringbolt
$4\frac{3}{4}$
$6\frac{3}{4}$"
$8\frac{3}{4}$"
3'0"
2'0"
Ground level
6"
SECTION
1"
10"
FORM A
(two of these)
$4\frac{3}{4}$
5'0"
6"
FORM B
(two of these)
METHOD #1
cap to be attached here
VIEW SHOWING FORM TOGETHER
METHOD #2.
SECTION SHOWING $\frac{1}{4}$" REINFORCING RODS.

Concrete Hitching Post

Plate 13 gives the method of making a form for a concrete hitching post.

The finished post is 5 ft. tall, tapering from 6 in. square at the base to 4¾ in. square at the top.

The forms are made to the dimensions shown on the drawing with cleats screwed to the wider sides as shown.

If the ringbolt is to be placed at the top a cap 6¾ in. x 8¾ in. is attached at the upper end and a ringbolt of any desired size suspended from it.

This cap is made in two pieces, 3⅜ in. x 8¾ in., with a hole through which the ringbolt is placed.

This problem brings in reinforcing with ¼ in. iron rods placed as indicated in the section.

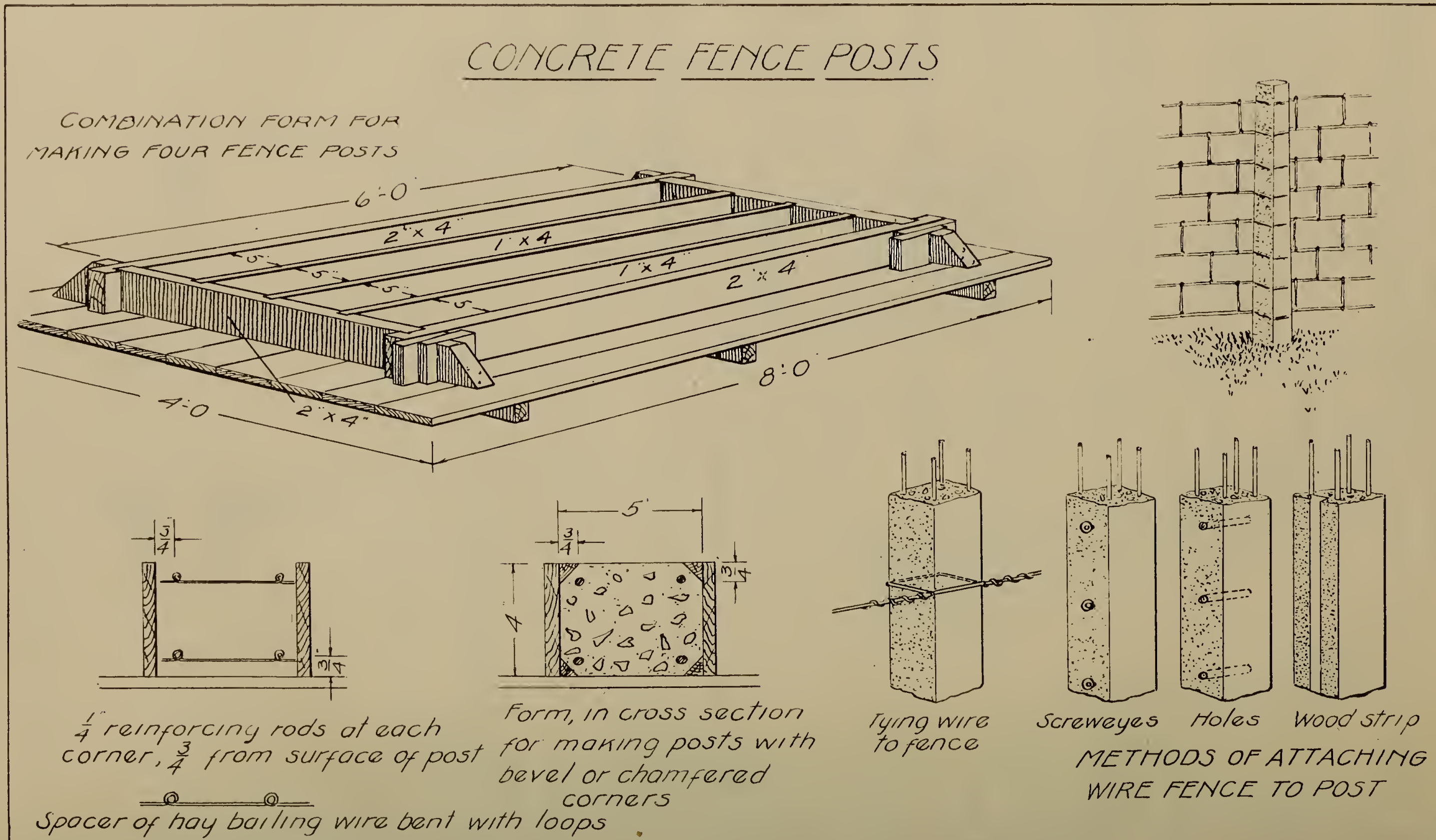
The form may be made according to method No. 1, where the post lays on its side and the concrete is placed from the upper side and smoothed, or it may be made as in method No. 2 where the form is tube-like and the concrete poured in at the lower end.

The post should not be handled or moved inside of a week, as it is liable to crack.

Let the post dry out for about two weeks before using and keep it damp by sprinkling with water daily.

Posts similar in design but on a larger scale could be made up to be used as clothes posts.

PLATE 14


CONCRETE FENCE POSTS
COMBINATION FORM FOR
MAKING FOUR FENCE POSTS
6'-0"
2"x4"
1"x4"
1"x4"
2"x4"
5"
5"
5"
5"
8'-0"
4'-0"
2"x4"
$\frac{3}{4}$
$\frac{3}{4}$
$\frac{1}{4}$" reinforcing rods at each
corner, $\frac{3}{4}$ from surface of post
Spacer of hay bailing wire bent with loops
5"
$\frac{3}{4}$
$\frac{3}{4}$
4
Form, in cross section
for making posts with
bevel or chamfered
corners
Tying wire
to fence
Screweyes
Holes
Wood strip
METHODS OF ATTACHING
WIRE FENCE TO POST

Concrete Fence Posts

Concrete fence posts are coming more and more into general use, due not only to their permanency but also their greater strength.

Plate 14 shows the method of casting individual posts and also a combination form for casting four posts at a time.

In the drawing of the section of the single form there is shown the methods of reinforcing with hay bailing wire and ¼ in. iron rods.

These single posts are cast in a similar way to the hitching post shown in Plate 13.

The combination form may be easily taken apart, to remove the finished posts, and is a saving in time and material.

A platform of matched boards is laid, 4 ft. wide by 8 ft. long, and on this the form proper is laid. The two outside pieces and the two ends are made from 2 in. x 4 in. material, while the inside separating boards are made up of 1 in. x 4 in. stock.

Blocks are nailed at the corners, as shown, and wedges driven between the blocks and the sides of the forms to hold in place.

It will be noticed that the partitions and the end piece are notched in.

The form should be properly greased before placing the concrete.

To fill this form once, that is to make four posts of the size given (using a mixture of 1 part cement, 2 parts sand and 3 parts gravel or crushed stone not larger than ⅜ in.) will require about 1 bag of cement, 2 cu. ft. of sand and 3¼ cu. ft. of stone or gravel.

Iron rods for reinforcing must be used. First place 1 in. of concrete and then place 2 rods on top of the concrete.

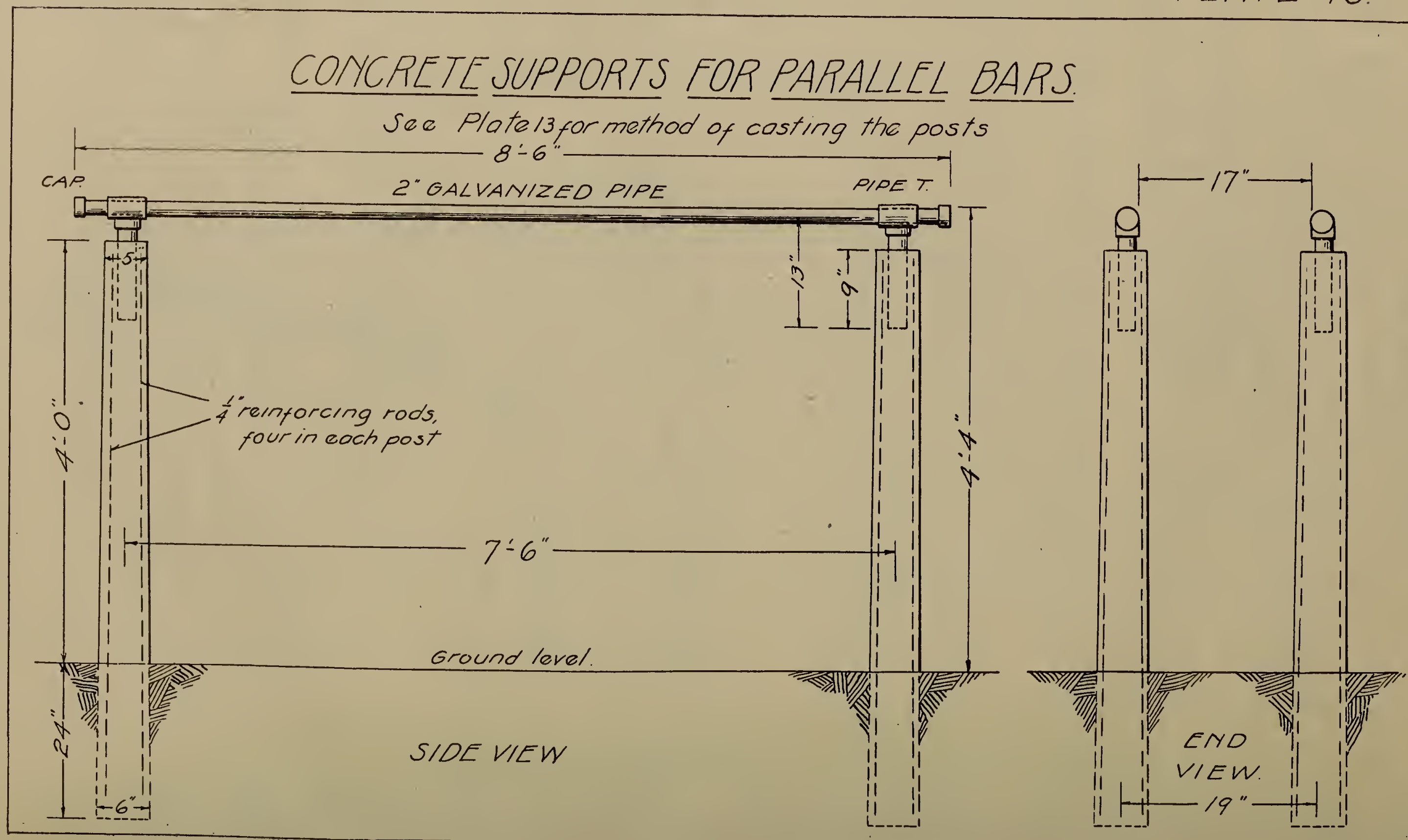
Then fill to within 1 in. of the top of the forms, place the other 2 rods, and finish filling.

Concrete fence posts must be carefully protected until they are hard. Don't move them until at least 10 days old or they will crack. Keep them moist by sprinkling and then store them out of the sun until they are at least a month old.

There are several methods of fastening woven wire to concrete posts and four good methods are illustrated in the drawing.

The screw eyes are inserted in the fresh concrete. The holes are made by placing 1 in. greased dowels in the forms and removing them when the concrete is about a day old. The wood strip is placed in the bottom of the form before placing the concrete and its tapering leveled edges hold it in the hardened concrete allowing the wire to be nailed direct to it.

PLATE 15.


CONCRETE SUPPORTS FOR PARALLEL BARS.
See Plate 13 for method of casting the posts
8'-6"
CAP.
2" GALVANIZED PIPE
PIPE T.
17"
5"
13"
9"
4'-0"
$\frac{1}{4}$" reinforcing rods, four in each post
4'-4"
7'-6"
Ground level.
24"
6"
SIDE VIEW
END VIEW.
19"

Concrete Supports for Parallel Bars

Plate 15 gives a drawing of parallel bars suitable for the school playground.

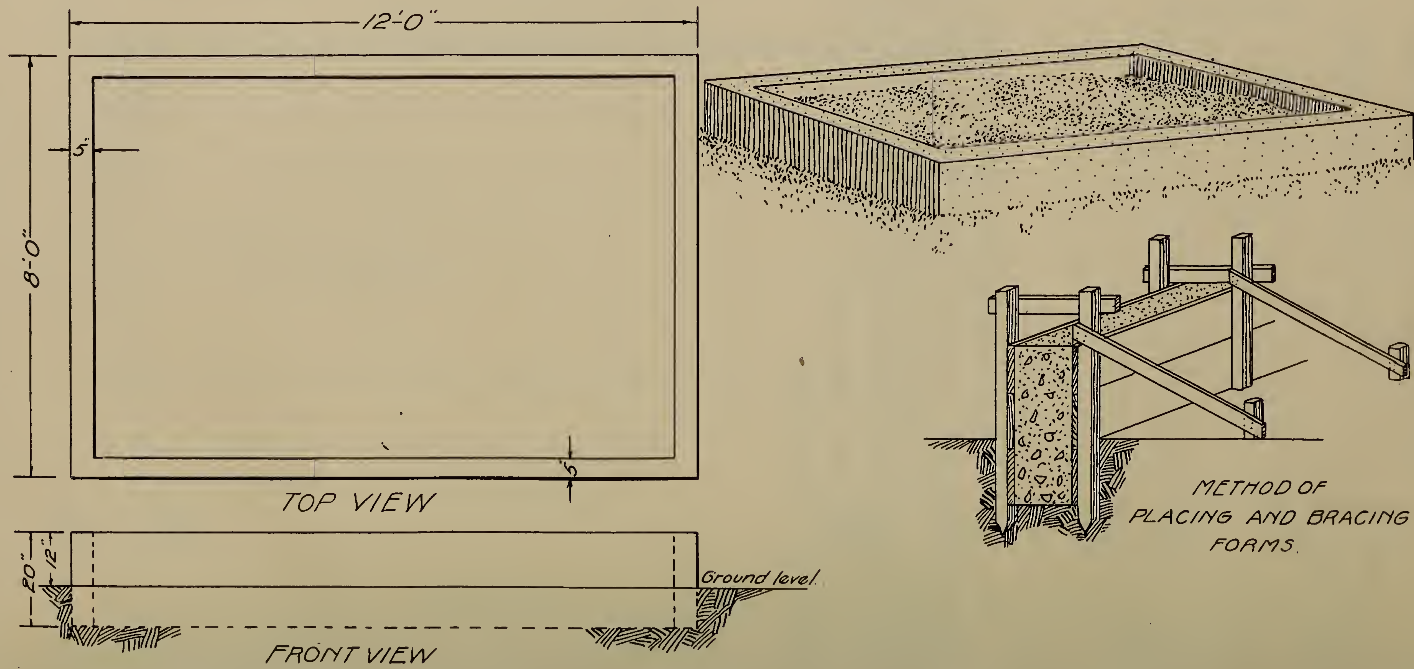
Plate 13 gives the method for making the form and casting posts of this description. The bars themselves consist of 2 in. galvanized iron piping, 8 ft., 6 in. long, with caps screwed on the ends. These bars are suspended in a pipe T which itself is attached to an upright piece of piping cast in the concrete, as shown.

Reinforcing rods, ½ in. in diameter are placed, as in Plate 13, to add strength to the posts.

These posts should remain in the forms at least 10 days, being constantly sprinkled. After removing from the forms they should be allowed to season for about a month before being used. When the posts are placed in the ground the hole should be made 3 or 4 in. larger all around than the posts and this space filled in with concrete and thoroughly tamped down.

PLATE 16

CONCRETE SAND BOX



Concrete Sand Box

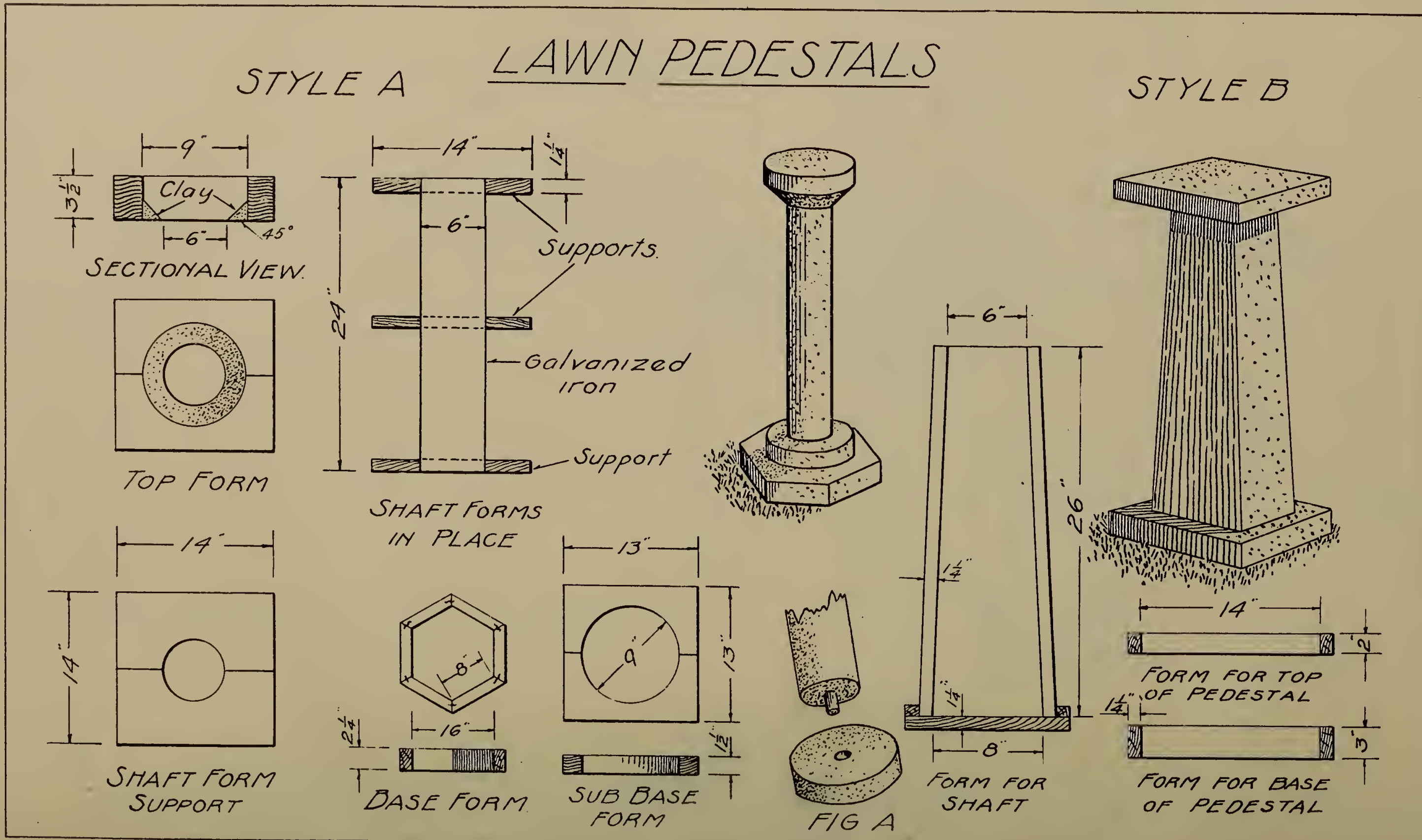
Another interesting addition to the playground equipment is the concrete sand box shown on Plate 16.

This may be made of any desired size, the one shown in the drawing being 8 ft. x 12 ft. and 20 in. high. The walls are 5 in. thick and extend 8 in. below the level of the ground.

The method of placing the form is clearly shown. A trench is first dug as long and deep as needed and after the form is set in place the concrete, consisting of a mixture of 1 part cement, 2 parts sand and 4 parts gravel or broken stone, is poured.

The forms should be removed in about 48 hours and the surface of the concrete rubbed down with a wet brick, using a neat cement mixture under the brick to help smooth up the surface. The concrete should be protected for about a week, wetting down each day. The concrete box should then be filled three-quarters full of clean, sifted sand.

PLATE 17


LAWN PEDESTALS
STYLE A
STYLE B
9"
3½"
Clay
6"
45°
SECTIONAL VIEW.
TOP FORM
14"
SHAFT FORM SUPPORT
14"
¼"
6"
24"
Supports.
Galvanized iron
Support
SHAFT FORMS IN PLACE
8"
16"
2¼"
BASE FORM
13"
9"
13"
1½"
SUB BASE FORM
FIG A
6"
26"
1¼"
1¼"
8"
FORM FOR SHAFT
14"
2"
FORM FOR TOP OF PEDESTAL
1¼"
3"
FORM FOR BASE OF PEDESTAL

Lawn Pedestals

Plate 17 shows the drawing of two simple lawn pedestals, the first having a circular shaft and the second a shaft square in section.

The shaft for the first pedestal is cast in a similar manner to the concrete roller, using a piece of galvanized iron bent to a 6 in. diameter and 24 in. long. The supports are made of wood with a hole cut in them of sufficient size to allow the shaft form to pass through.

The top form should be turned down on a lathe out of a plank 3½ in. thick, or of built up stuff, as shown in the sectional view.

The sub-base is cut from 1½ in. stock with a hole 9 in. in diameter. The base is hexagonal in shape and is held together by patent corrugated fasteners.

A ¾ in. iron rod about 8 in. long should be inserted in the center of the base, when being cast, and projecting enough to go through the sub-base and flush with the bottom side of the base proper.

The top of the pedestal should be held in place in a similar way with the exception that the rod should not penetrate the top more than 2 in. When assembling, each piece should have a thin layer of neat cement grout, consisting of cement and water, spread upon it to form an attaching mortar, to help hold the various parts together.

The shaft should be reinforced with ½ in. iron rods, 4 in number, placed at equal intervals, 1 in. from the surface. The top, sub-base and base should be reinforced with ¼ in. wire mesh laid flatwise across their centers.

After remaining in the forms for about 10 days they should be carefully removed and set away 3 or 4 weeks to season. Wet regularly.

Style B pedestal is very easily cast, the operation being similar to that of casting the hitching post, Plate 13, and reinforcing and assembling same as Style A.

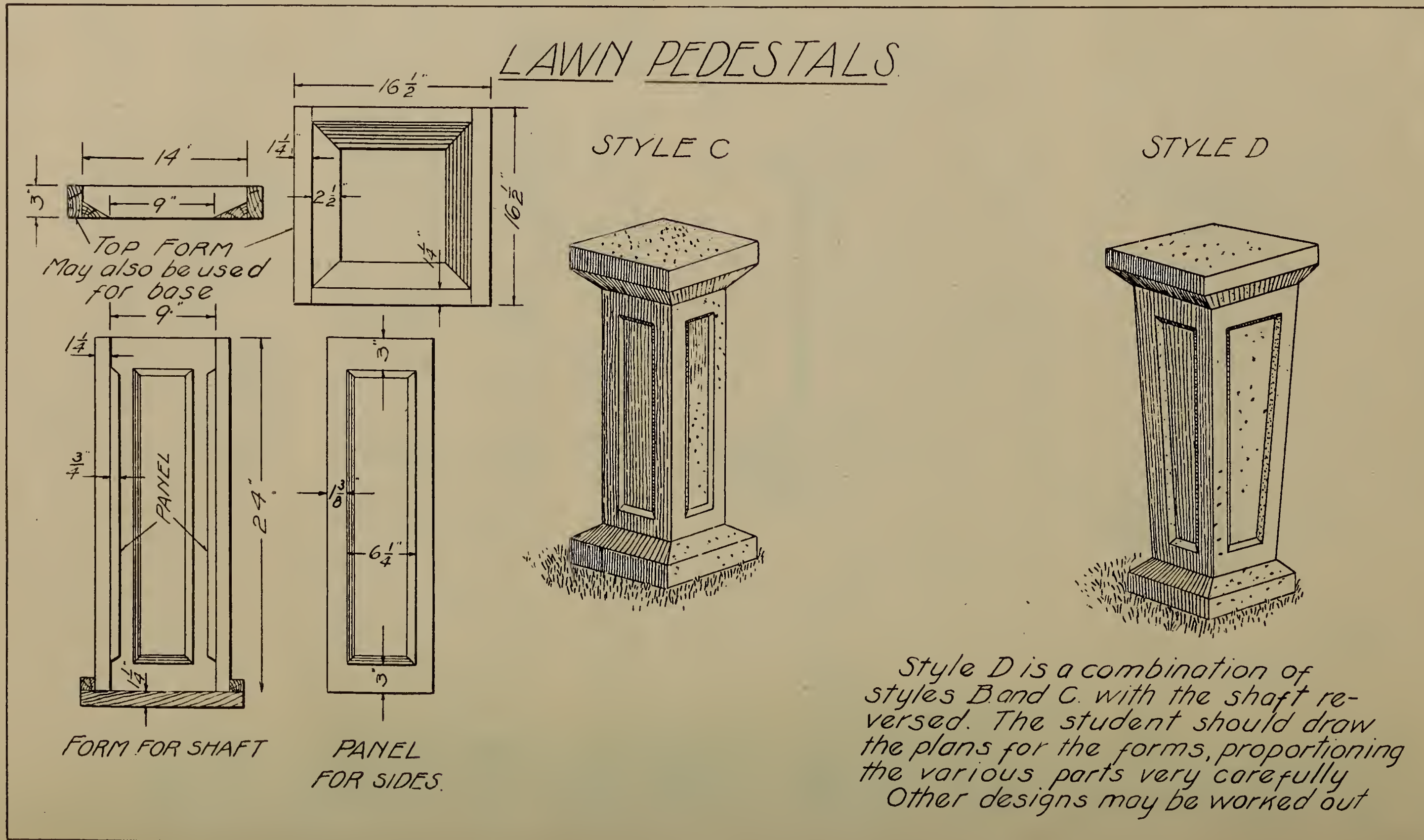
The pedestals shown on Plate 18 are made up similarly to Style B on the preceding plate, the only addition being in the paneling, which is provided for on Plate 9, in the drawing of the horse block. The method of making the form and constructing and placing the panels are self-evident in Plate 18.

Sun-Dials

The pedestals shown on Plates 17 and 18 can easily be made into excellent sun-dials by purchasing commercial dials and attaching them in the following manner.

The sun marks on the trees and flowers the passing of the seasons, so it is fitting that on the dial-face it should mark the flight of the quiet hours spent in the garden.

PLATE 18


LAWN PEDESTALS
STYLE C
STYLE D
16 1/2"
14"
9"
3"
1 1/4"
2 1/2"
16 1/2"
1/4"
TOP FORM
May also be used
for base
9"
1 1/4"
3/4"
PANEL
24"
1/4"
3"
1 3/8"
6 1/4"
3"
FORM FOR SHAFT
PANEL
FOR SIDES.
Style D is a combination of
styles B and C. with the shaft re-
versed. The student should draw
the plans for the forms, proportioning
the various parts very carefully
Other designs may be worked out

Setting of the Sun-Dial

The pedestal should be firmly placed on a foundation that reaches below the frost line.

The plate is set with the base of gnomen pointing south, but as the true south varies from the magnetic meridian, a compass will not accurately determine the position. A more accurate judgment can be obtained by using a table of time variation which shows the daily discrepancies between sun and standard time. With the aid of this table the dial can be set by the sun, mid-day being the best time to make the adjustment.

The dial plate must be level, and when properly adjusted, should be securely attached to the top of the pedestal with cement mortar.

Concrete Garden Bench

Plate 19 shows a drawing of a concrete garden bench.

Plate 20 shows the details of the form construction. The top of the bench is cast on a base of sufficient size to hold the frame, which is 18 in. by 54 in. inside and 3 in. high.

This is held by two cross braces temporarily nailed as shown.

The top is reinforced, as indicated in Plate 19, by ¼ in. iron rods, laid ¾ in. from the under surface of the seat.

The end supports for the seat may be cast by either Method No. 1 or Method No. 2, Plate 20. A little study of these drawings will show the method of construction.

The ends should be dowelled into the top by means of ¾ in. iron rods, as shown on both Plates 19 and 20.

The concrete mixture should be composed of 1 part cement, 2 parts sand and 2 parts of crushed stone or gravel, averaging in size from ¼ to ½ in.

If however, no coarse aggregate is used, a 1 to 3 part mixture of cement and coarse sand should be used.

After placing about ¾ in. of concrete in the mold, lay the reinforcing carefully as shown, continue filling the form, taking care to work the mixture into all corners carefully. This top surface will be the top of the finished seat, therefore it will pay to use care in finishing it to as smooth a surface as possible. An edger is run around the inside of the form to give a rounded edge to the top of the slab.

The sides of the form may be removed in about 48 hours but the form under the slab should not be removed for at least 7 days.

Original designs may be worked out in garden seat construction.

Concrete Troughs

Plate 21 shows the construction of concrete troughs suitable for feeding hogs.

PLATE 19

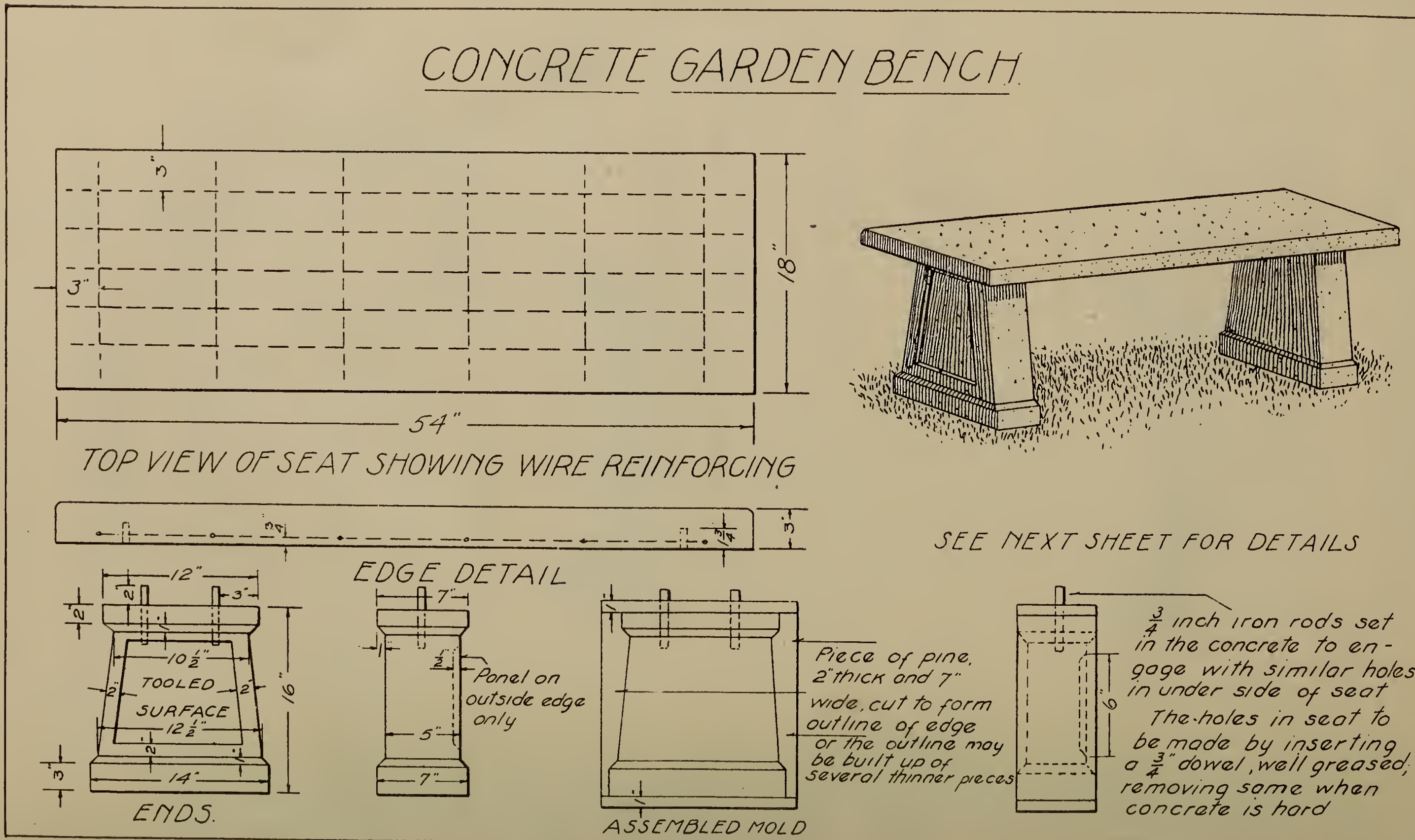

CONCRETE GARDEN BENCH
3"
3"
18"
54"
TOP VIEW OF SEAT SHOWING WIRE REINFORCING
3/4
1/4
3"
SEE NEXT SHEET FOR DETAILS
12"
2
3"
2
10 1/2"
TOOLED
SURFACE
12 1/2"
2
2
2
16"
14"
3"
ENDS.
EDGE DETAIL
7"
1/2
Panel on outside edge only
5"
7"
Piece of pine, 2" thick and 7" wide, cut to form outline of edge or the outline may be built up of several thinner pieces
ASSEMBLED MOLD
9"
3/4 inch iron rods set in the concrete to engage with similar holes in under side of seat
The holes in seat to be made by inserting a 3/4" dowel, well greased, removing some when concrete is hard

PLATE 20

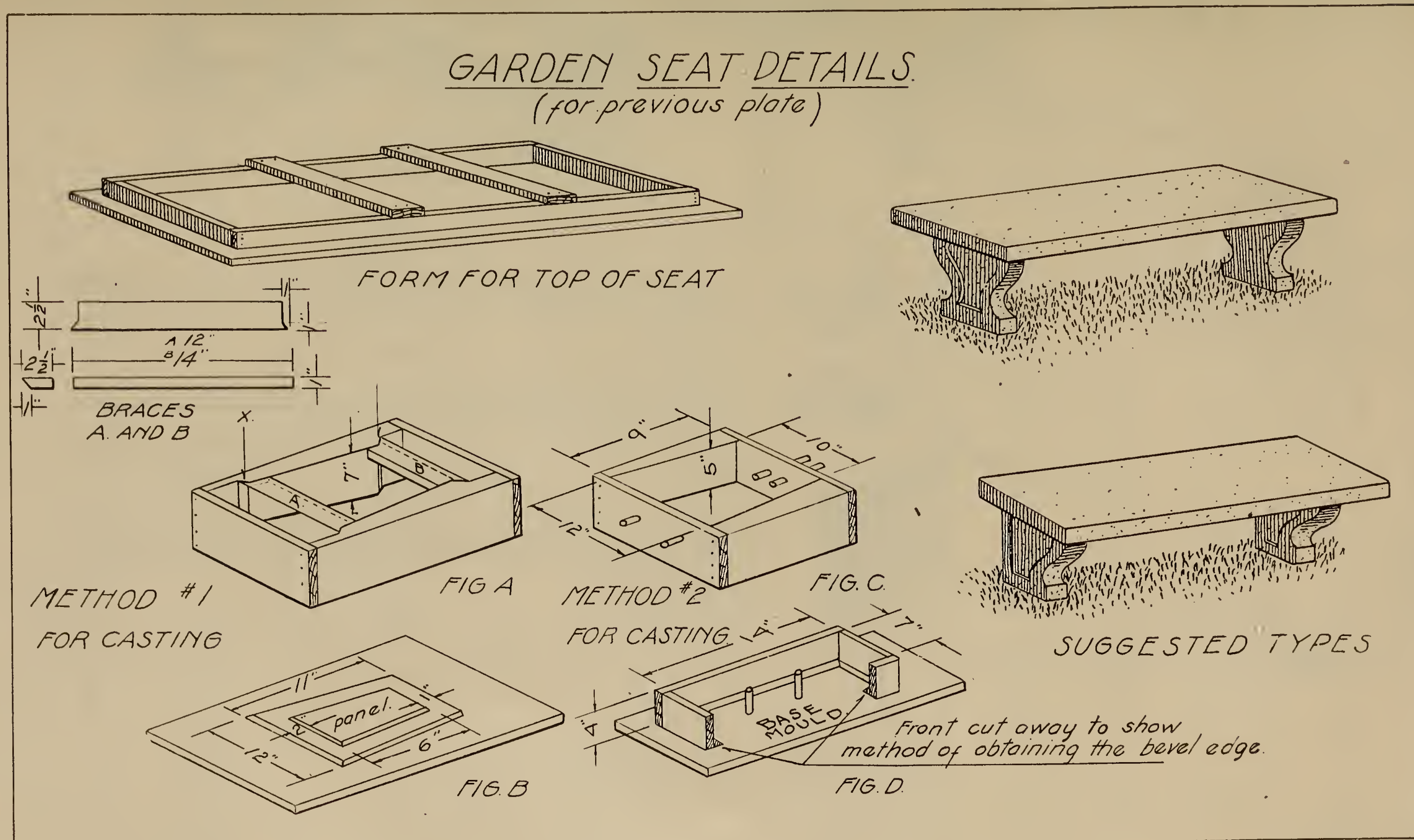
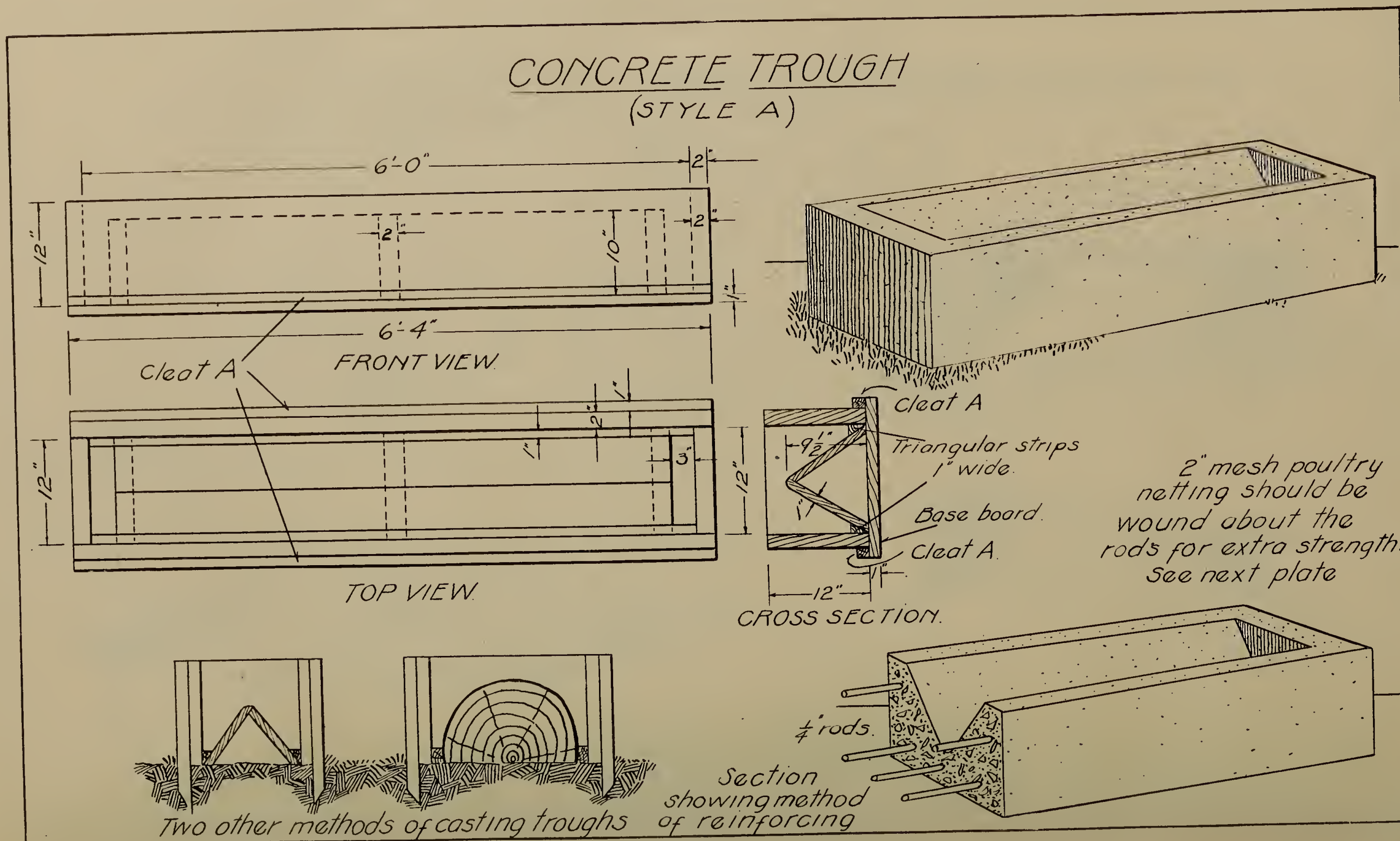

GARDEN SEAT DETAILS.
(for previous plate)
FORM FOR TOP OF SEAT
A 12"
B 14"
2½"
BRACES
A. AND B
X.
7"
A
B
FIG A
METHOD #1
FOR CASTING
9"
5"
10"
12"
FIG. C.
METHOD #2
FOR CASTING
4"
7"
BASE MOULD.
Front cut away to show
method of obtaining the bevel edge.
FIG. D.
11"
panel.
2
6"
12"
FIG. B
SUGGESTED TYPES

PLATE 21


CONCRETE TROUGH
(STYLE A)
6'-0"
2"
12"
2"
10"
2
1"
6'-4"
FRONT VIEW
Cleat A
1"
2"
1"
3"
12"
TOP VIEW
Cleat A
Triangular strips
1" wide
9 1/2"
12"
Base board
Cleat A.
12"
1"
CROSS SECTION.
2" mesh poultry
netting should be
wound about the
rods for extra strength.
See next plate
1/4" rods.
Section
showing method
of reinforcing
Two other methods of casting troughs

There are various methods of casting troughs and also various types of troughs.

The drawing shown is a trough with a V shaped interior and the form is made similar to that of fence posts with the exception of the additional V shaped core in the middle.

The drawing is self-explanatory and the reinforcing is placed as shown in the sectional sketch. Another method of casting the same style trough is shown together with a round bottomed trough with a smoothed up tree trunk core.

On Plate 22 is shown still another method of obtaining a rounded interior, in this case the core being made up of clay shaped by means of a template, as shown.

Style C, Plate 22, shows a flat bottom type trough with its box core. All reinforcing should consist of ¼ in. iron rods and fine mesh poultry wire.

The forms should be thoroughly greased. The mixture for the concrete should be 1 part cement, 2 parts sand and 4 parts gravel. Tamp it lightly into place and smooth off the exposed surface. Let it stand until it is dry. Remove the inner forms and paint the inside with a cement grout mixed as thick as cream. Do not use the trough for at least 10 days.

Wet down each day to insure drying out evenly

Small Concrete Watering Trough

Plate 23 gives the drawing for a small watering trough.

The trough proper is cast in the same way that the hog trough on Plate 22, Style C, is done. This is cast separate from the ends. The reinforcing is the same as for the hog trough with the proportions of 1 part cement, 2 parts sand and 4 parts gravel.

The sketch shows very clearly the method of building up the end forms. These should be reinforced with ½ in. rods and poultry wire.

If these forms are thoroughly greased the draft of the form will allow its being raised clear of the mould by the handles. The forms may be removed in 24 hours and the concrete rubbed down with a brick dipped in cement grout or with a carborundum stone.

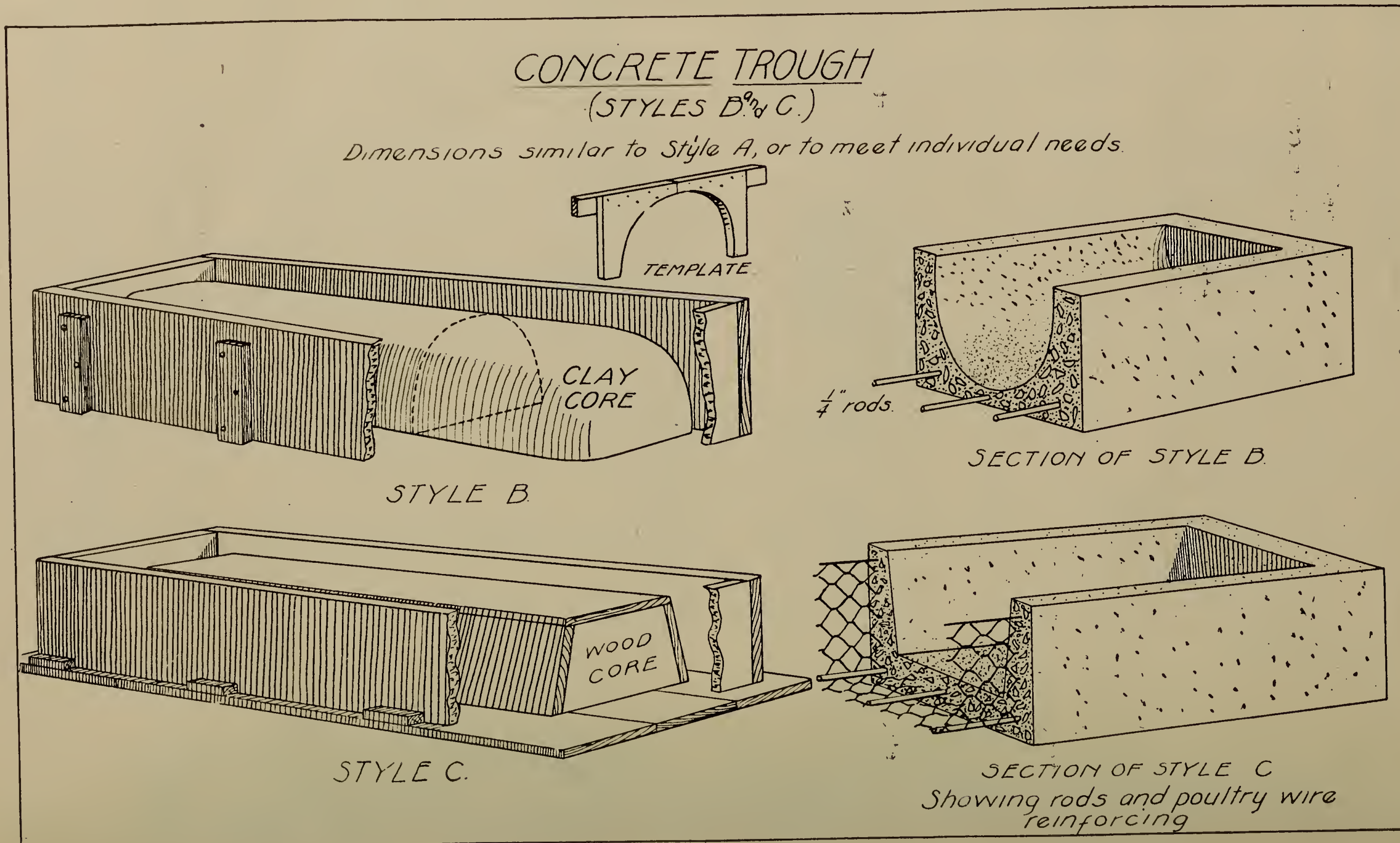
Foundations for the two ends to set upon should be cast in the ground the proper distance apart and of the size shown on the drawing.

Protect the newly cast trough for at least 2 weeks before using, wetting down daily. Arrange for intake and overflow pipes to meet local conditions.

Circular Watering Trough

Plate 24 shows a design for a circular watering trough which is very simple in construction.

PLATE 22.


CONCRETE TROUGH
(STYLES B and C.)
Dimensions similar to Style A, or to meet individual needs.
TEMPLATE
CLAY CORE
STYLE B.
1/4" rods.
SECTION OF STYLE B.
WOOD CORE
STYLE C.
SECTION OF STYLE C
Showing rods and poultry wire reinforcing

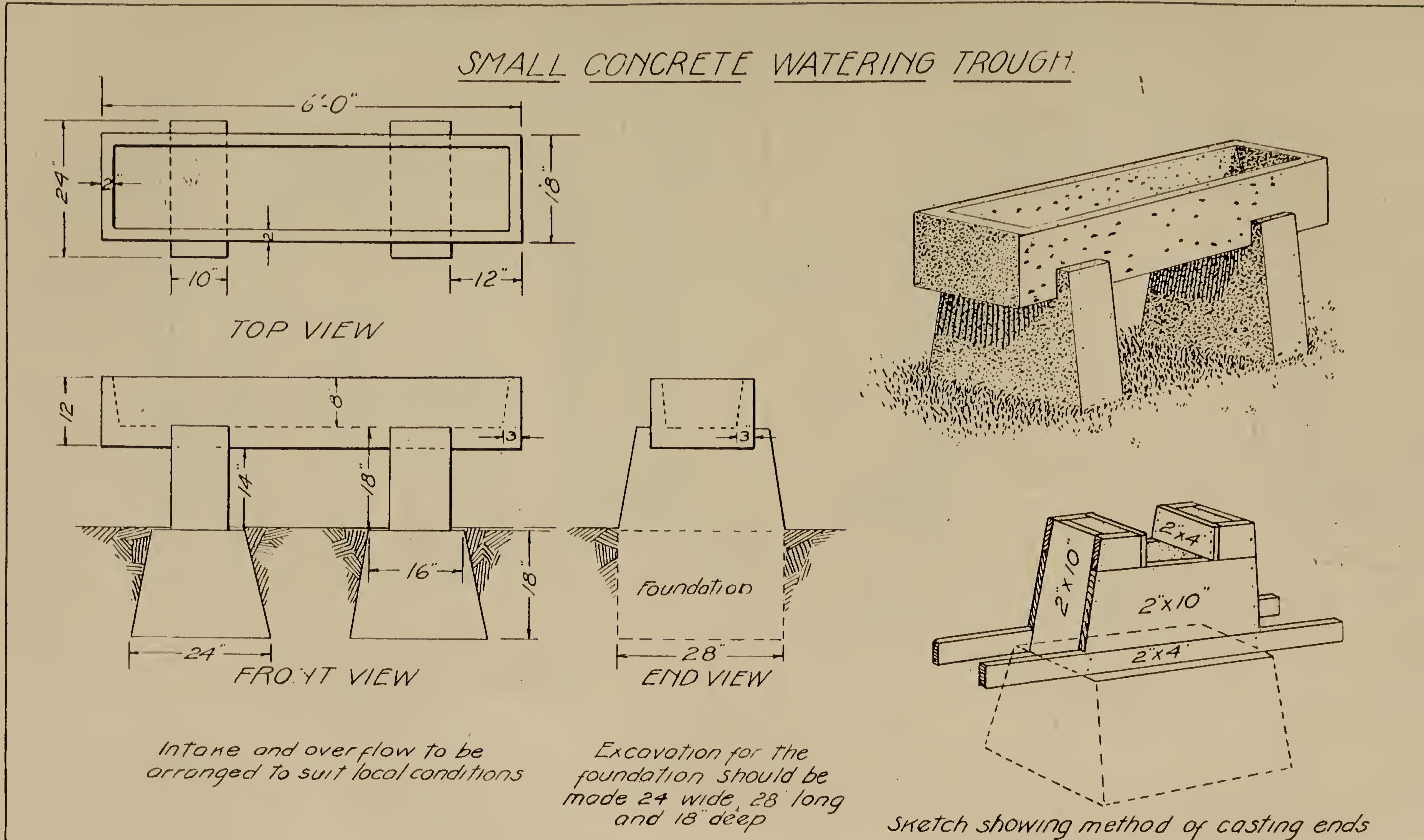
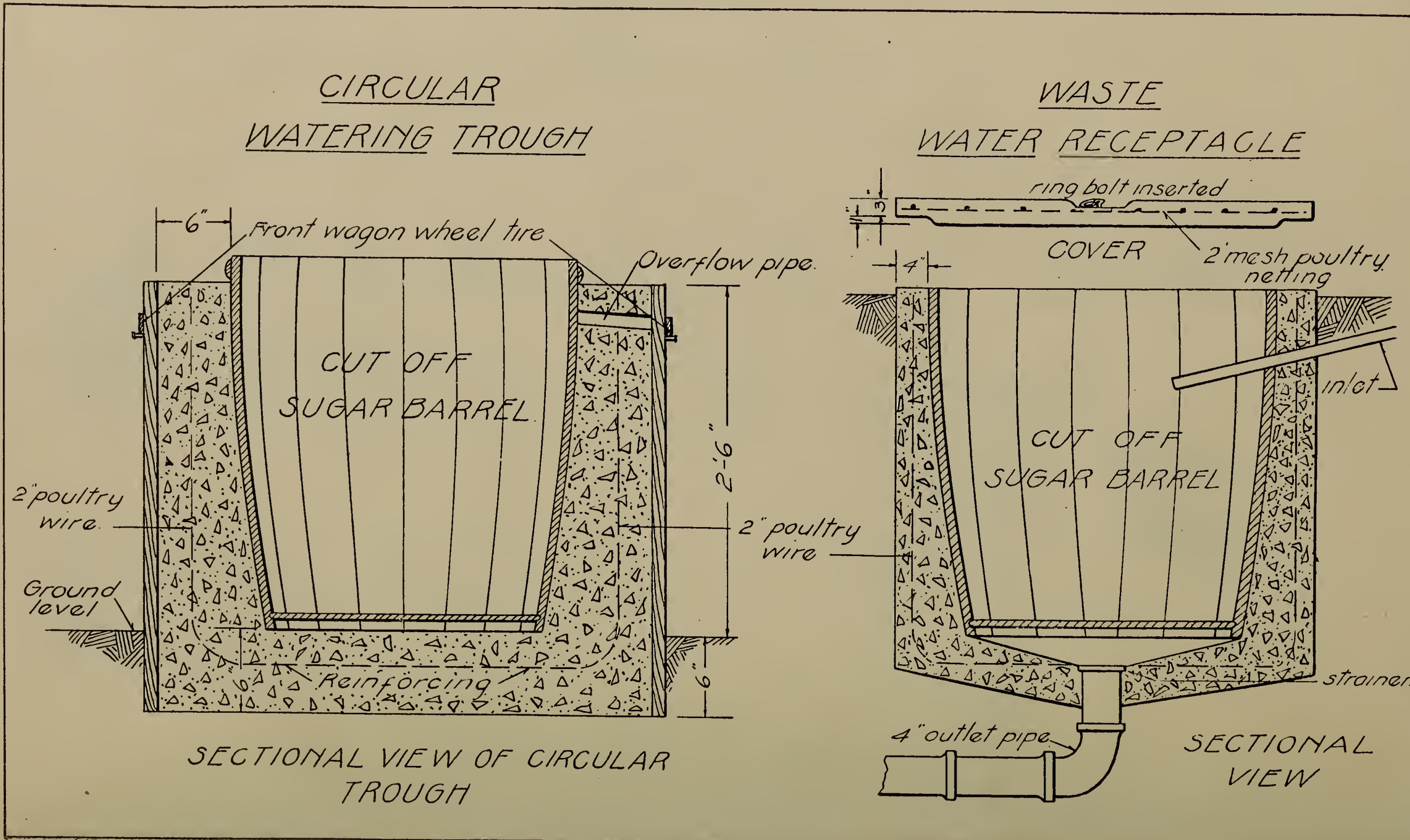

SMALL CONCRETE WATERING TROUGH
6'-0"
24"
18"
2"
10"
12"
TOP VIEW
12
8
3
14"
18"
16"
18"
24"
FRONT VIEW
3
Foundation
28"
END VIEW
Intake and overflow to be arranged to suit local conditions
Excavation for the foundation should be made 24 wide, 28 long and 18" deep
2"x4"
2"x10"
2"x10"
2"x4"
Sketch showing method of casting ends

PLATE 24


CIRCULAR
WATERING TROUGH
6"
Front wagon wheel tire
Overflow pipe.
CUT OFF
SUGAR BARREL
2'-6"
2" poultry wire
2" poultry wire.
Ground level
Reinforcing
6"
SECTIONAL VIEW OF CIRCULAR TROUGH
WASTE
WATER RECEPTACLE
ring bolt inserted
3
COVER
2" mesh poultry netting
4"
inlet
CUT OFF
SUGAR BARREL
2" poultry wire
strainer.
4" outlet pipe
SECTIONAL VIEW

If it were not for the more complicated form work, the circular shapes would be built more frequently, because of the attractive effects which can be produced.

Lay an old wagon or buggy tire on the ground and mark a line on the inside of the tire. Excavate the inside of the tire to the depth of 6 in. and place endwise three 1 in. x 2 in. stakes about 3 ft. long on the inside of the tire. Raise the tire 2 ft. from the ground to make the total inside depth of the trough 3 ft., 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 1 part cement, 1½ parts sand and 3 parts screened gravel or broken stone and lay about 4 in. of concrete. Place the reinforcement as described for rectangular troughs, running it up on the sides so that it is about 2 in. from the outside surface. After placing the reinforcement, the rest of the operations are the same as for the rectangular troughs. 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 upper hoops.

The remaining construction is clearly shown in the drawing.

Allow for intake and overflow to suit local conditions.

This type of trough will take about 3½ bags of cement and a single load of sand and gravel. A single load of sand or gravel is considered as 20 cu. ft., or ¾ cu. yd., and a double load is 40 cu. ft. or nearly 1½ cu. yds.

Treat the finished concrete as in the rectangular trough.

Waste Water Receptacle

The waste water receptacle shown on this same plate is constructed in a very similar manner to the circular trough, the great difference being that it is sunk in the ground further and has a cover and drain.

The cistern itself can be made by using a cut off barrel, but no outer form is required as the earth wall, if fairly solid, will retain the desired shape if care is used in the excavating.

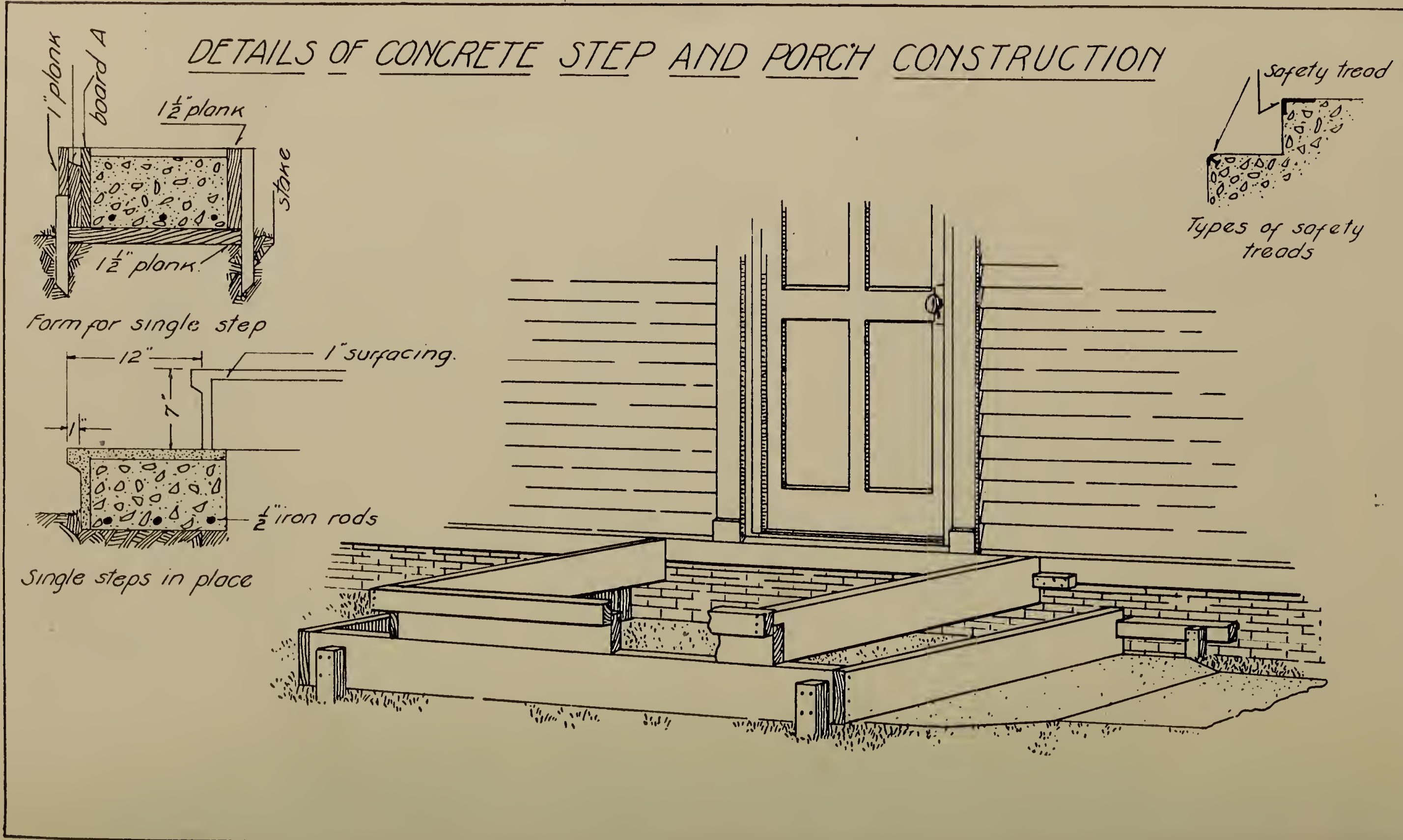
The bottom of the cistern slopes toward a drain covered with a strainer. The water drains through a 4 in. outlet pipe, as shown.

The cover is cast in a tire of suitable size and reinforced laterally with ¼ in. iron rods crossing each other at right angles and covered with poultry netting. A slight depression is made in the middle where a ringbolt is inserted to lift the cover by.

Place the inlet pipe where it is convenient.

Treat the finished concrete as for the rectangular trough.

PLATE 25


DETAILS OF CONCRETE STEP AND PORCH CONSTRUCTION
1" plank
board A
1½" plank
stake
1½" plank
Form for single step
12"
1" surfacing.
7"
1"
½" iron rods
Single steps in place
Safety tread
Types of safety treads

Concrete Steps and Porch Construction.

Plate 25 gives a sketch of a typical set of steps and a small porch, together with details showing the method of constructing individual treads.

Steps and stairs are of two kinds; those made in one piece, monolithic, and those cast in separate molds and put into place.

The risers on all steps and stairs should not be less than 6 in. nor more than 8 in., while the tread should be from 9 to 12 in., except where it is intended that more than one step should be taken on the tread, in which case 30 in. 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 lead, to avoid looking cramped, and in order to secure an artistic effect, should have some sort of projection or molding at their upper edge, if possible. A slight slope or pitch is also desirable to allow the water to drain off.

Use 1 part cement, 2 parts sand and 4 parts broken stone or gravel. Fill to within 1 in. of the top of the riser, and as soon as this concrete has stiffened slightly (which usually is within about one-half hour) fill the remainder with a mixture of 1 part sand and 2 parts cement. Allow this to harden about ½ hour and trowel lightly.

Early on the second day remove the form from the face of the riser and trowel very carefully.

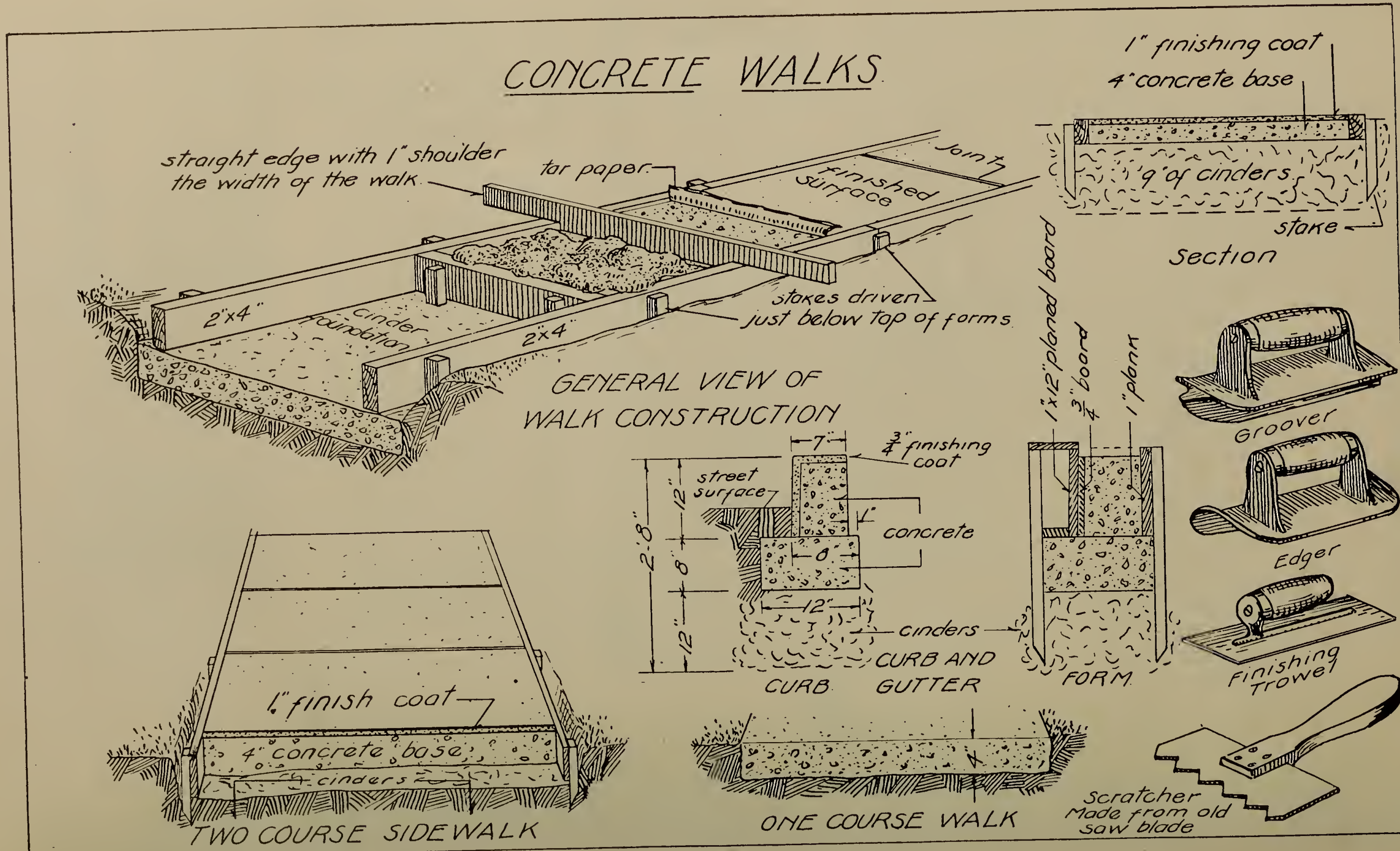
This plate also gives a section detail of the method of casting individual steps.

This step is 7 in. by 14 in. inside measurement and 1 in. projection. Fill to within 1 in. of the top with concrete, 1 part cement, 3 parts sand and 6 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 the step, also a small mold for the projection at the top of the step. Fill this with wet mortar, 1 part cement and 1½ parts coarse sand, and let it set. The forms may be removed and used again. Rub down the face of the riser with a brick or carborundum at the end of 24 hours.

Reinforce all steps cast separately by iron rods placed about 1 in. above the bottom of the slab.

PLATE 26


CONCRETE WALKS
straight edge with 1" shoulder the width of the walk
tar paper
joint
finished surface
1" finishing coat
4" concrete base
9" of cinders
stake
Section
2"x4"
cinder foundation
2"x4"
stakes driven just below top of forms
GENERAL VIEW OF WALK CONSTRUCTION
1"x12" planed board
3/4" board
1" plank
7"
3/4" finishing coat
street surface
12"
1"
concrete
2'-8"
8"
6"
12"
12"
cinders
CURB
CURB AND GUTTER
FORM
Groover
Edger
Finishing Trowel
1" finish coat
4" concrete base
cinders
TWO COURSE SIDEWALK
4
ONE COURSE WALK
Scratcher Made from old saw blade

Patent safety treads, of which there are many kinds on the market, are inserted as shown in the sketch when the mortar is still soft. This is not done on cheaper classes of work. It adds to the looks of the steps, however, and to the life of the nosing of the step, preventing the edge from being chipped off.

Concrete Walks

Plate 26 gives details and sketch of ordinary walk construction.

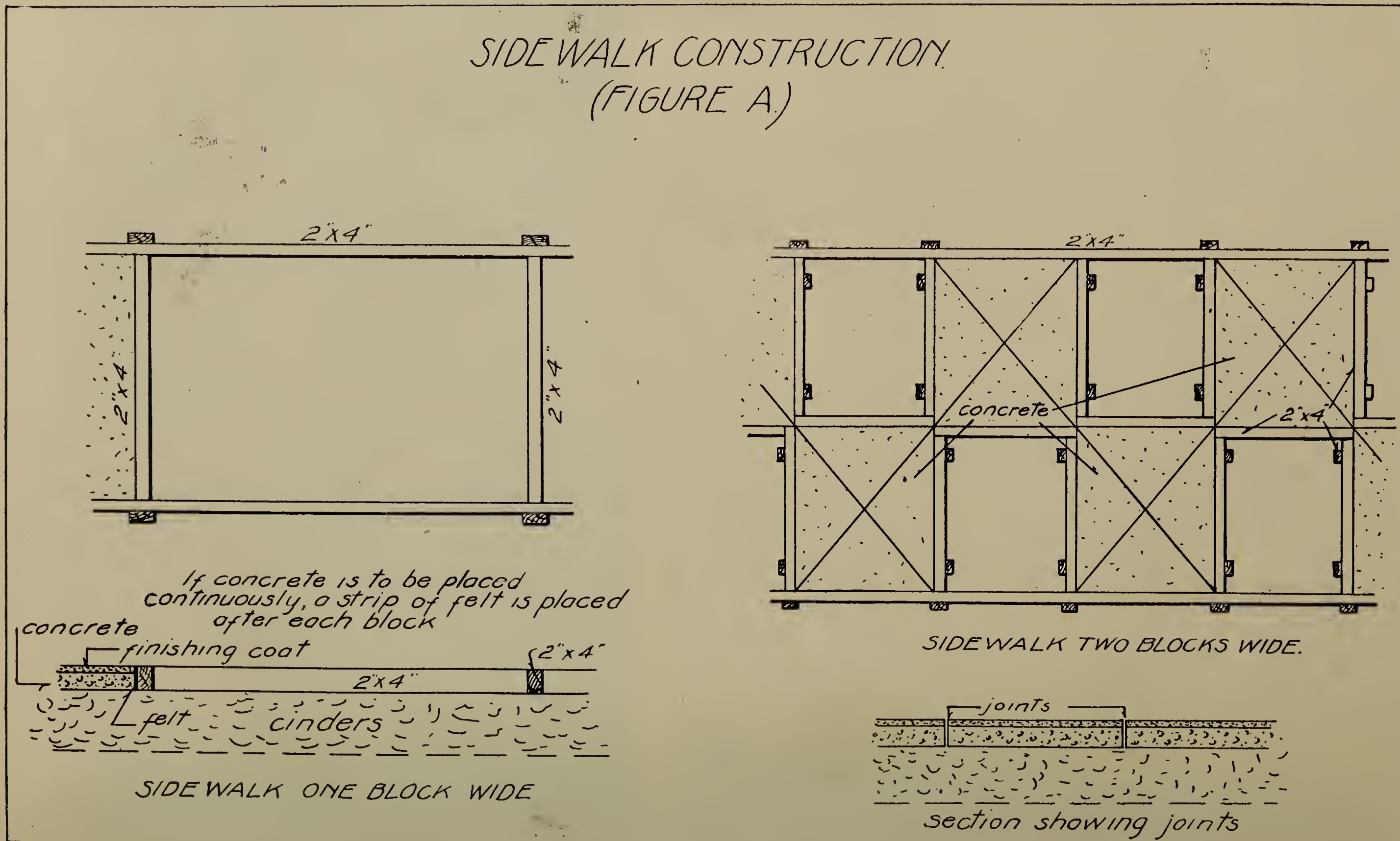
The laying of sidewalks is a simple operation if ordinary care is taken and several thousand running feet of walk have been laid by the author's pupils during the past few years and not a foot has ever failed.

St. Johnsbury, Vermont, is situated about 40 miles from the Canadian border and the temperature varies from the vicinity of 100° in the summer to as low as 50° below zero in the winter. A walk which will stand expansion and contraction resulting from this great climatic difference, proves itself a substantial proposition and shows that boys of the seventh and eighth grades, with proper instruction, in any climate, can lay any type of concrete work which they desire and build for permanence.

Before laying the concrete a foundation of porous material, such as cinders or screened gravel, must be placed to form a base through which moisture can quickly and easily drain. This sub-base should be placed with as much care as the laying of the walk itself.

Illus. 11. Leveling Up Forms, Tamping the Undercoat, and Using the Jointer and Edger.

PLATE 27


SIDEWALK CONSTRUCTION.
(FIGURE A.)
2"x4"
2"x4"
2"x4"
If concrete is to be placed continuously, a strip of felt is placed after each block
concrete
finishing coat
2"x4"
2"x4"
felt
cinders
SIDEWALK ONE BLOCK WIDE
2"x4"
concrete
2"x4"
SIDEWALK TWO BLOCKS WIDE.
joints
section showing joints

Illus. 12. A 140-ft. Drip Around a School.

Foundations should generally be 6 in. to 12 in. 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 or coarse gravel or tile pipe should be laid at the lowest point 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 in. wider on each side than the proposed walk, and fill with broken stone, gravel or cinders to within 4 in. 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 in. by 4 in. scantlings (preferably dressed on inside and top 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 from 1 to 2 in. lower than the inner edge of the walk. This will give a slight pitch to the finished surface and allow the water to run off. A good rule to follow is to allow ⅜ in. slope to every foot width of walk. For wide walks lay off the space between the scantlings into equal sections not larger than 6 ft. square, put 2 in. by 4 in. scantlings crosswise and in the center, see Fig. A, Plate 27. This will make every alternate space shown in the figure by diagonal lines, the size desired.

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

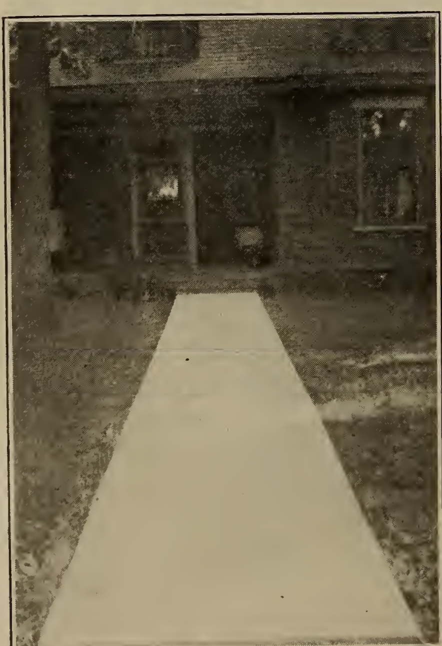
NOTE.—Four bags of cement equal 1 barrel.

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.



Illus. 13. Walk Laid by Eighth Grade Boys.

Fill these spaces with concrete to a depth of 3 in. (this depth should be 4 in. where there is more than ordinary traffic, or where the blocks are 6 ft. square) 1 part cement, 2 parts clean, sharp sand, and 4 to 5 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 or a greased clapboard on the edges to separate them from all other squares and fill in the spaces thus left with 3 in. concrete as before. Mark the scantling to show where the joint came.

The finishing coat should be 1 in. thick, of 1 part cement and 1½ parts clean, coarse sand or crushed stone screenings. This coat should be spread on before the concrete undercoat has taken its set, and smoothed off with a screed or straight edge (Plate 26) run over the 2x4 scantlings, the object being to thoroughly bind the finishing coat to the concrete base. If this bond is imperfect, the walk will give a hollow sound under the feet, and is liable to crack after having been down one or two years. Smooth with a wooden float, or trowel and groove with the groover exactly over the joints between the concrete (Fig. A), Plate 27, so as to bevel the edges of all blocks. Do not trowel the finishing coat too much, not until it has begun to stiffen as the steel in the trowel tends to separate the cement from the sand, producing hair cracks on the surface and giving a poor wearing surface beside weakening the job.

Plate 26 shows a popular type of groover. This is run alongside of a straight edge to insure a perfect joint.

The edger is used to give a slight curve on all outside edges of finished work. The finishing trowel is of steel and is used for surfacing completed work. An ordinary mason's trowel is also used for this purpose. The scratcher is used to roughen work to which a new surface of concrete is to be applied. It assists in securing a good bond and the one shown is made from a piece of old saw blade.

Illus. 14. Entire Basement Floor of This School and Walk 10 ft. by 90 ft. Laid by Eighth Grade Boys.

PLATE 28.

CURB AND GUTTER
(Single course construction)

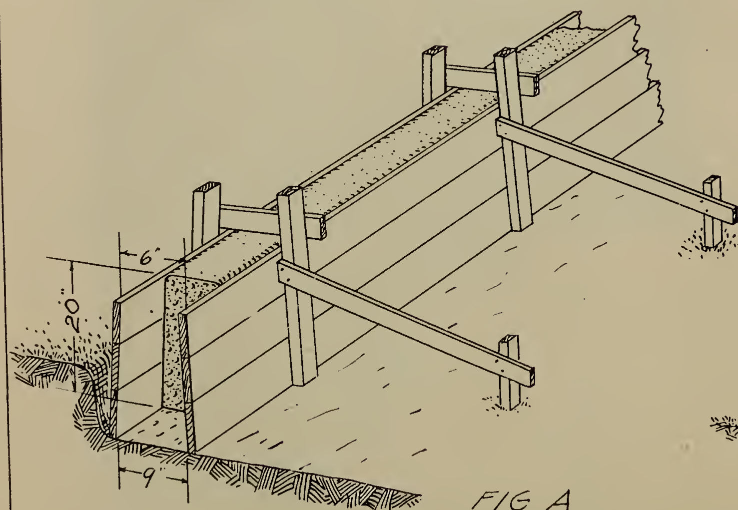


FIG. A.

FORMS, BRACING AND DIMENSIONS FOR A SINGLE CURB

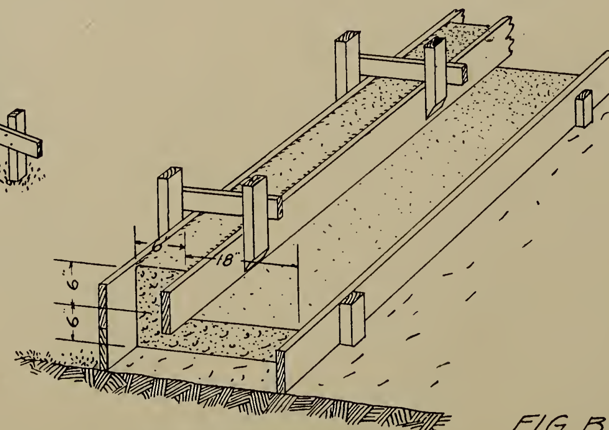


FIG. B.

FORMS FOR COMBINED CURB AND GUTTER

Keep the finished walks protected from dirt, currents of air, rain and hot sun during the process of setting, and further protect from the sun and traffic for 3 or 4 days, and keep moist by sprinkling daily. The covering may be sand, straw, sawdust, boards or building paper.

Most walks are made with the single block width and this is naturally much easier than walks of two blocks width. Plan on leaving the job either at the noon hour or the end of the day, at the end of a block, so that the work may be resumed against a joint edge.

Two Course Curb and Gutter

The foundations for curbs and gutters (Plates 26 and 28), like sidewalks, should be governed by the soil and climate.

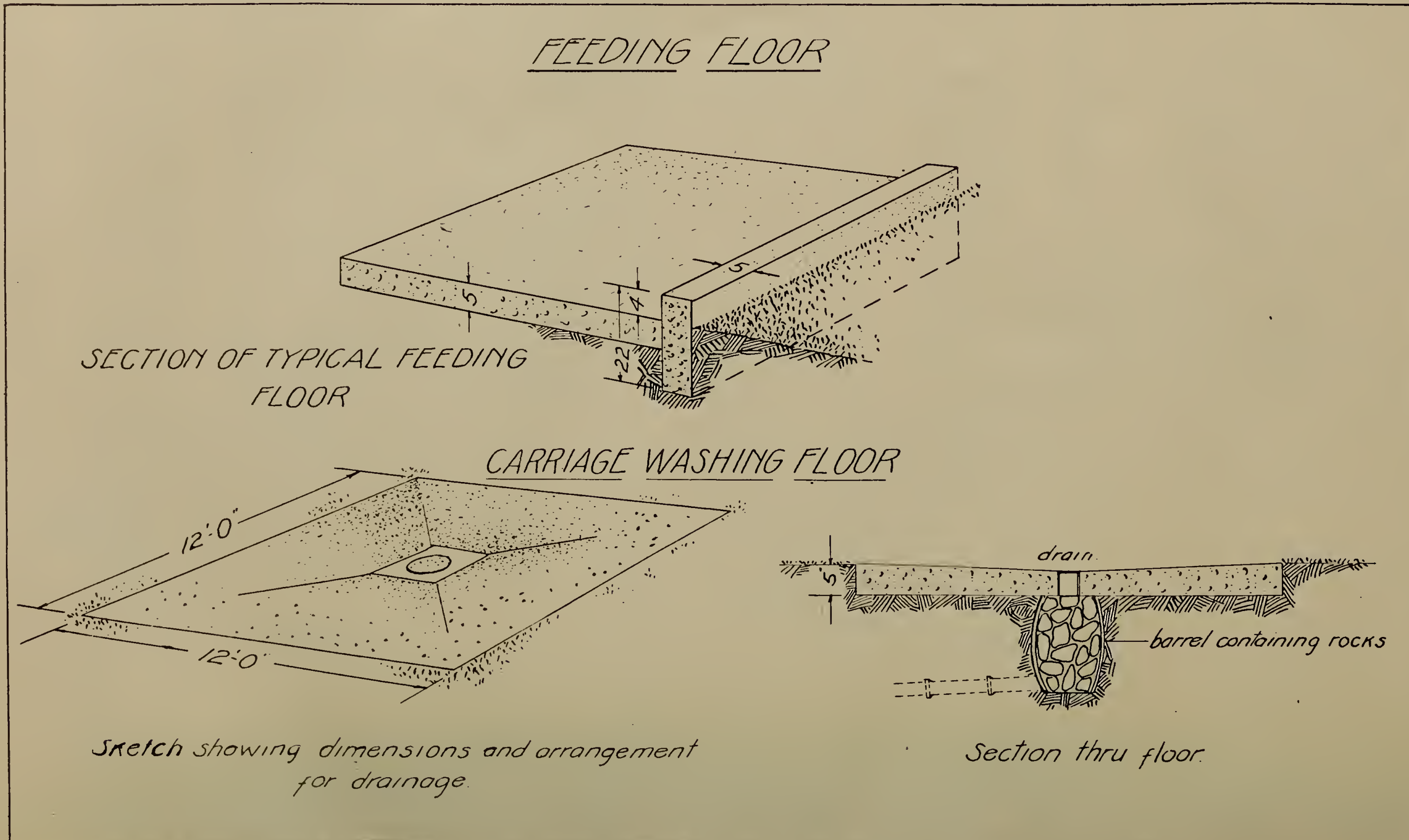
Concrete curbing should be built in advance of the walk, in sectional pieces, 6 ft. to 8 ft. in length, and separated from each other and from the walk by tar paper or a cut joint, in the same manner as the walk is divided into blocks.

Curbs should be 4 in. to 7 in. wide at the top, and 5 in. to 8 in. at the bottom, with a face 6 in. to 7 in. above the gutter. The curb should stand on a concrete base 5 in. to 8 in. thick, which in turn should have a sub-base of porous material at least 12 in. thick. The gutter should be 16 in. to 20 in. broad, and 6 in. to 9 in. thick and should also have a porous foundation at least 12 in. thick.

Keeping the above dimensions in mind, excavate a trench the combined width of the gutter and curb and put in a sub-base of porous material. On top of this place forms, as shown (Plate 26) and fill with a layer of concrete, 1 part cement, 3 parts clean, coarse sand and 6 parts broken stone, thick enough to fill the forms to about 3 in. below the street level. As soon as this concrete is sufficiently set to withstand pressure, place the forms for the curb and after carefully cleaning the concrete between the forms and thoroughly wetting, fill with 1 part cement, 2½ parts clean, coarse sand and 5 parts broken stone. When the curb has sufficiently set to withstand its own weight without bulging, remove the ¾ in. board shown (Plate 26), and with the aid of a trowel fill in the space between the concrete and the form with cement mortar, composed of 1 part cement and 1 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 and traffic for a few days.

PLATE 29.


FEEDING FLOOR
5
5
4
22
SECTION OF TYPICAL FEEDING FLOOR
CARRIAGE WASHING FLOOR
12'-0"
12'-0"
Sketch showing dimensions and arrangement for drainage.
drain
5
barrel containing rocks
Section thru floor.

One Course Curb and Gutter

Plate 23 shows forms and method of placing concrete for the one-course method of curb and gutter construction.

Excavate to the required depth, draining the soil if necessary by excavating 8 in. more and filling in with gravel or cinders. Build forms for the entire height (Plate 28), unless the earth is so firm that they need only be built for the part above ground.

Expansion joints should be provided about every 10 or 15 ft. in the length of the curb. This is done by placing a board at the end of the form against which the concrete is poured. This gives a square end.

Against this end place a thin piece of steel or wood or a couple of thicknesses of tar paper when the next section of the curb is poured to leave a slight opening.

This steel or wood should be removed, but the tar paper can be left in place.

The mixture should be 1 part cement, 2 parts sand and 4 parts gravel or crushed stone with particles not larger than 1½ in.

For every 100 ft. length of curb such as shown in Fig. A, Plate 28, using the above mixture, there will be needed 24 bags of cement, 48 cu. ft. of sand, and 6 cu. ft. of gravel or crushed stone.

For the same length of curb and gutter, made as in Fig. B, Plate 28, there will be needed 30 bags of cement, 60 cu. ft. of sand and 120 cu. ft. of gravel or crushed stone.

Illus. 15. Large Slab of Concrete Built by Boys for Convenience of Coal Teams.

The general tendency at the present time seems to be toward the one course method of curb and gutter construction. It is easier and cheaper to handle and if due care is taken in tamping and spading the concrete and then removing the forms as soon as possible and troweling the surface a good finish can be obtained.

Feeding Floors for Hogs and Cattle

There is more or less waste where feed is thrown carelessly on the ground for cattle. A concrete feeding floor overcomes this and does away with a muddy, disagreeable appearing barn yard. Wooden floors absorb moisture and eventually decay. Concrete floors are free of cracks and seams, economize on feed and manure, are easily constructed and will save their cost in a couple of years.

Arrange for a well drained, substantial foundation (see method of laying walks), and construct the floor 5 in. thick of 1 part cement, 2 parts sand and 4 parts gravel or crushed stone. Lay in 6 ft. sections using 1 in. x 6 in. boards staked upright for the side forms. Allow a slope of ¼ in. to the foot toward one side.

A curb may be built around the edge, 4 in. higher than the floor to prevent hogs and cattle shoving off the feed.

Illus. 16. Feeding Floor for Hogs.

Extend the curb about 18 in. into the ground to prevent hogs from rooting under the floor. Make this curb about 5 in. thick. Plate 29 shows the method of constructing the floor.

Make the inside form for the curb of 2 in. x 4 in. plank held in position by overhanging cleats from the stakes of the outside forms (see Fig. B, Plate 28).

Carriage and Automobile Washing Floors

Plate 29 also shows drawings for a good type of washing floor. Build the floor large enough to take in the wheels and shafts of the wagon and also of a size to allow the person who does the washing freedom to work. The average size is about 12 ft.

The concrete should be 5 in. thick and slope each way toward the center where a drain should be provided, as shown, otherwise the water will run off the sides taking with it the dirt from the vehicle.

Illus. 17. Carriage and Automobile Washing Floor.

Construct the drain by excavating, directly in the center of the floor, a hole large enough to contain a good-sized barrel which has the bottom removed. Fill this barrel with stones and, if necessary, run a drain from the barrel to some convenient point.

The concrete should be made up of 1 part cement, 2 parts sand and 4 parts crushed stone or gravel. Finish with a wooden float.

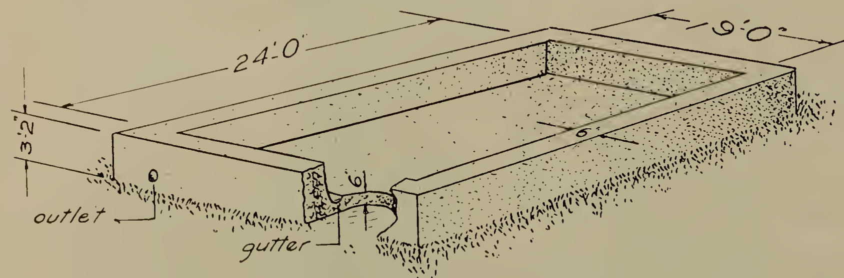
A floor of this size will require 13 bags of cement, 26 cu. ft. of sand and 52 cu. ft. of gravel or crushed stone. Protect the same as for walks.

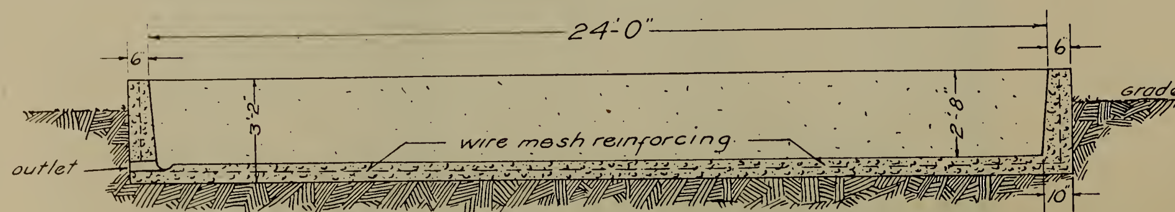
A Concrete Manure Pit

The soluble part of manure is the most valuable and a concrete pit preserves the full strength of the manure.

PLATE 30

MANURE PIT



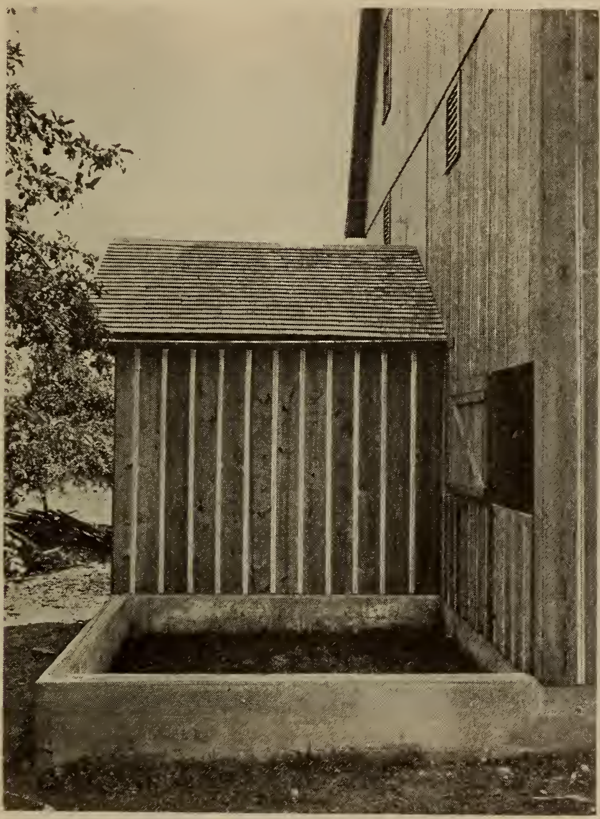


DETAIL SHOWING SECTION OF
SIMPLE MANURE PIT.

According to government reports one load of manure from a concrete pit is worth from 1½ to 2 loads of manure as commonly stored against the side of a barn.

The excavation should be about 2½ ft. deep, allowing for a 6 in. floor at the same time bringing the walls above ground.

Slope toward the end where the drain is to be situated, making one end about 6 in. lower than the other.



Illus. 18. Manure Pit.

For firm ground there is only need of outside forms above ground. Have the inside form slope slightly, as shown in Plate 30, making the top of the wall 6 in. wide and the bottom 10 in. wide. Make the gutter shape with a template shortly after the concrete has been poured. Reinforce with wire mesh as shown in drawing. See Plate 33 for method of making forms.

A mixture of 1 part cement, 2 parts sand and 4 parts gravel or crushed stone should be used and for a pit the size of the one given there are needed 93 bags of cement, 186 cu. ft. of sand and 372 cu. ft. of gravel or crushed stone.

A manure pit may be roofed over, which will assist in eliminating the fly nuisance.

Concrete Duck Pond or Wading Pool

A duck pond for the poultry raiser or a wading pool for the children may be made in a similar way to the manure pit.

The dimensions for a fair-sized duck pond would be 8 ft. wide, 12 ft. long and 6 in. for the thickness of the walls and the bottom.

Using a 1-2-4 mixture, with walls 18 in. deep on the outside, there will be needed 20 bags of cement, 40 cu. ft. of sand and 80 cu. ft. of gravel or crushed stone.

Illus. 19. Concrete Duck Pond.

Hot Beds and Cold Frames

Plate 31 gives a drawing for a suggested type of cold frame.

Excavations should be made below frost line and make forms for a 4 in. wall.

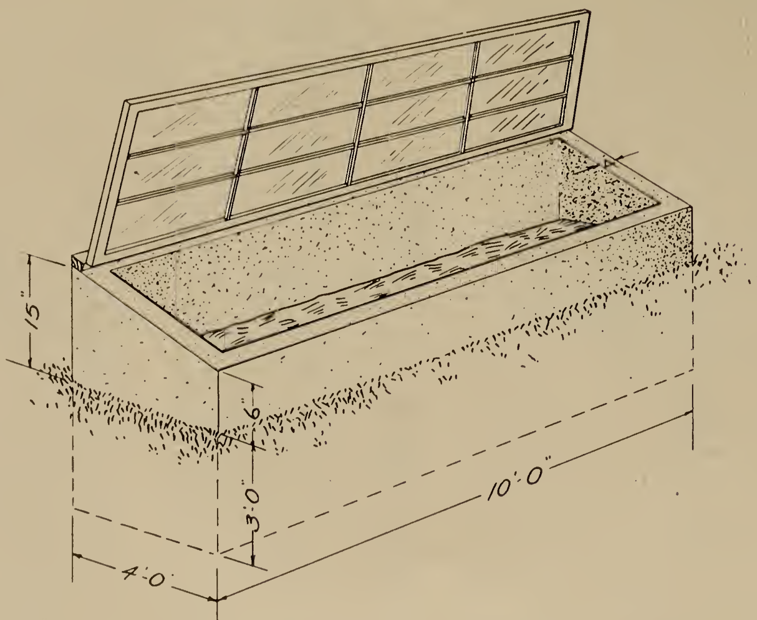
It is a good plan, if old window frames are available, to construct the forms to fit the window frames at hand.

The hot bed should have a slope as shown in the drawing and should be located so as to face the south or southeast.

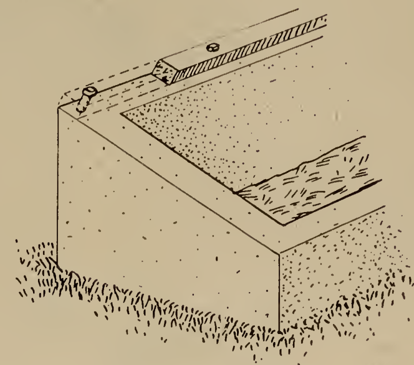
Use a mixture of 1 part cement, 2½ parts sand and 4 parts gravel or broken stone. Remove the forms in 2 or 3 days and keep damp for a couple of weeks.

PLATE 31

HOT BEDS AND COLD FRAMES



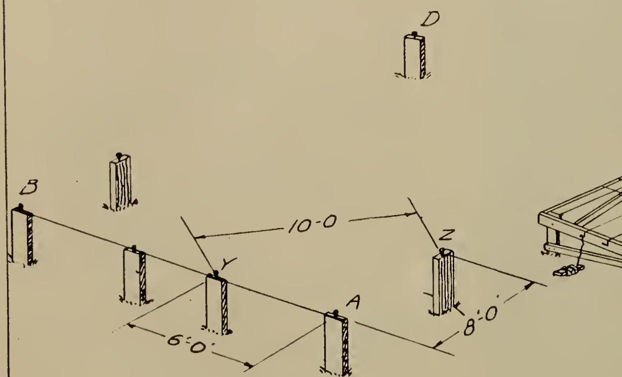
DETAILS OF COLD FRAME



DETAIL SHOWING METHOD OF BOLTING STRIP OF WOOD, 1½" x 3", TO REAR WALL, TO HOLD HINGES FOR SASH

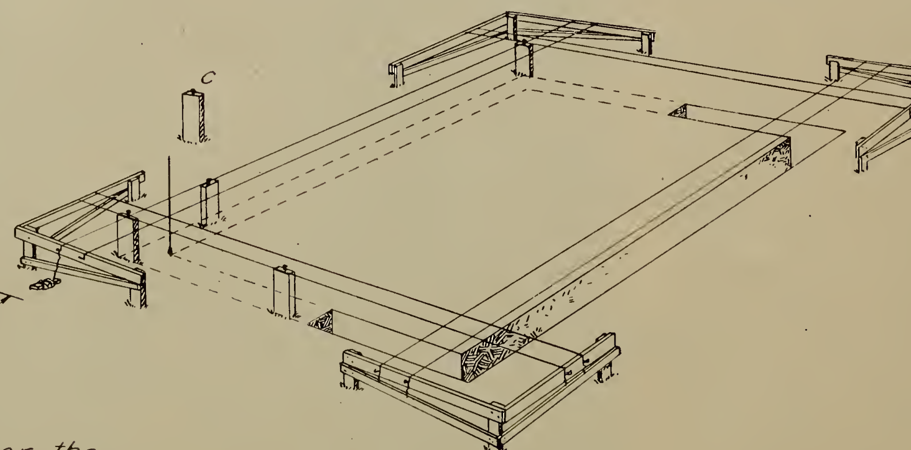
PLATE 32

LAYING OUT FOUNDATIONS



Method of placing stakes for the foundation

FIG A



Stakes and construction lines indicating location of the foundation walls

FIG B

Laying Out Foundations

Buildings are usually located with reference to some existing object, such as a highway, a drive or some other building.

When the location depends upon some other object the first line to be determined should be the one influenced by the location of that object. With this established, it may be used as a base line, and the corners which come on it should be located next. In case the building is not located with reference to some other object, the base line should be chosen arbitrarily, and the corners and other lines laid out from it.

One corner will probably be located with reference to some other object, and the other corner on the base line will be located a distance from the first equal to the length or breadth of the building. Mark these by stakes driven in the ground, the exact point being indicated by a nail driven in the stake.

Plate 32, Fig. A, gives a drawing of the method of laying out a simple foundation and the above mentioned points are indicated by A and B, AB being the base line.

After the corners on the base have been definitely located, proceed to locate another corner marked C. The line which runs from A to C, perpendicular to the base line must first be located.

To obtain a true right angle at A, measure accurately 6 ft. from A, along the base line toward B, and mark by a stake and nail, as shown at Y. Next measure out exactly 8 ft. from A on the direction of the corner to be found, and mark a curved line on the ground; measure from Y 10 ft. to a point on the curved line; drive a stake at this point and check the measurement. Mark the location accurately with a nail on the stake. This point is marked Z in Fig. A, Plate 32. The point C will lie on the line AZ projected. Corner D can be located from B in a similar manner.

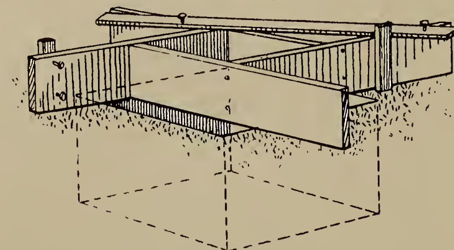
Fig. B, Plate 32, shows the method of locating construction lines, after the corners have been located. These lines remain permanent during the construction of the foundation.

The fence-like forms shown in Fig. B, should be located at least 8 ft. from the foundation lines and should be long enough to permit of marking both the inside and outside foundation lines on the top or horizontal boards. Brace the frames enough to withstand the pressure of the tightly drawn cords, which they must support as nearly horizontal as possible.

Locate the points on the corner boards by drawing a cord from one board to the other, bringing it directly over the nails at the two corners on the same line; these points should be accurately marked on the board by a notch, or by cutting a shallow groove with a saw.

PLATE 33

SIMPLE FOUNDATIONS



Simple box mold for column footing

FIG. B.

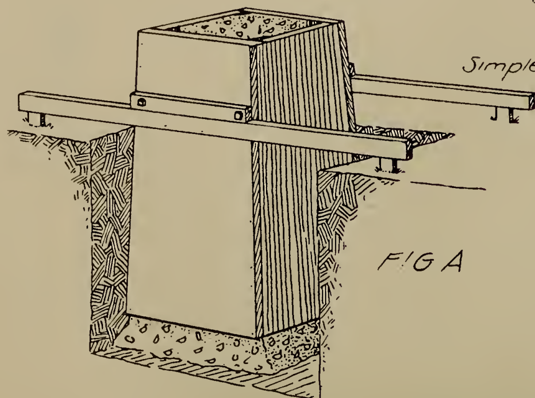


FIG A

Removable form for making piers or parts of foundation

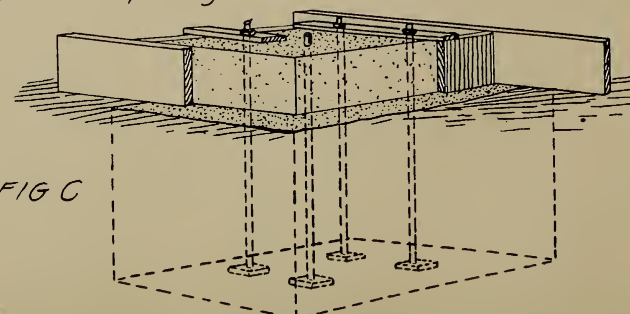


FIG C

Gasoline engine foundation

This cord represents the outside line of the foundation; the inside line will be indicated by measuring in a distance equal to the thickness of the proposed foundation and stretching a cord between these two points. Carefully mark these points on the board in some way different from the marks showing outside lines.

A plumb-bob suspended from these lines to the ground will indicate the line of excavation.

Simple Foundations

A form made like Fig. A, Plate 33, measuring 10 or 12 in. on each side at the top and a little more at the bottom, being sloped so that it may be lifted easily off the concrete, is a very useful form to make and keep around. Piers for the foundation of small buildings are easily made with this type of form. The top level of the form can be regulated by putting blocks under the handles of the form.

The hole for the base of the pier should be 6 or 8 in. bigger each way than the form, thus allowing the concrete to spread as shown.

Forms for taller piers should be very strongly braced all around each side by pieces of 2 in. x 4 in. material spiked together and spaced about 18 in. apart.

Columns over 6 ft. in height should have yokes of 4 in. x 4 in. material, held together by bolts and side pieces held in position by wedges. These should be spaced about 20 in. apart. These columns should be reinforced with ¾ in. iron rods.

A column which is to carry no great weight, may have the forms removed inside of 48 hours.

Fig. B, Plate 33, shows a simple box form for column footings. The drawing is self-explanatory.

Fig. C, Plate 33, shows form and method of casting a concrete foundation for a gasoline engine. The foundation consists of a block of concrete resting on a firm sub-base, with anchor bolts properly set, by means of which the engine is held in place. Concerns manufacturing engines usually state the length of anchor bolts, the location in regard to each other, and the size of the foundations needed for the various sizes of machines.

PLATE 34

VARIOUS TYPES OF FOUNDATIONS

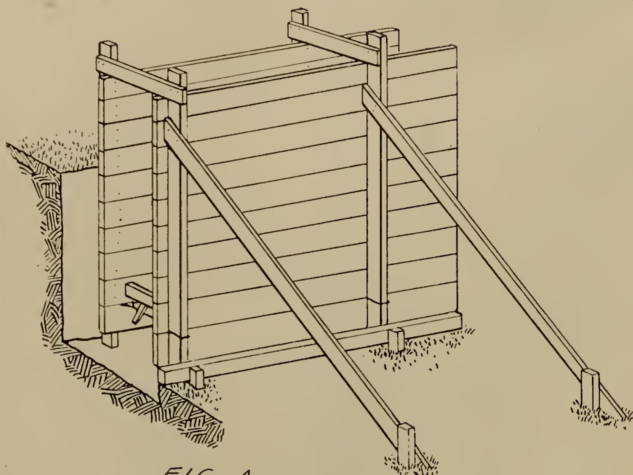


FIG. A

Foundation wall forms for use where the ground is not firm enough to place concrete without forms

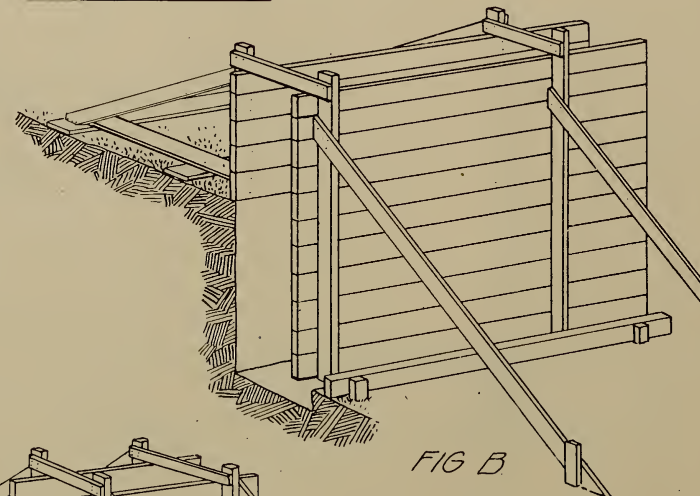


FIG. B

Foundation wall form for use where inner form only is required to extend below ground line

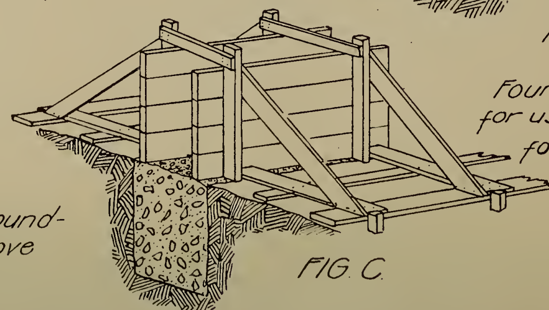


FIG. C

Form for foundation wall above ground

Various Types of Foundations

Plate 34 shows three different types of foundations.

Sometimes because of the nature of the soil, or possibly because a team and scraper are used in removing the earth, the walls of the excavation cannot be kept perpendicular.

In such cases forms must be placed for that portion of the foundation below ground as well as for the portion above, if there be any.

Unless forms for the whole foundation are to be put up at one time, it will be best to build them flat on the ground, in units of convenient length, and then erect them in place. By having the forms constructed in this way they may be removed and used again, with the minimum amount of damage to the lumber. In building forms flat the stringers should be carefully leveled and the uprights and sheathing carefully placed in their correct relative positions, otherwise the forms will be askew when erected.

If the forms are to be built in position, first place the stringers shown at the bottom of the inner form (Fig. A), so that when the upright 2x4's and the sheathing are in place, the inside face of the sheathing will be in line with the inner face of the proposed wall. Nail the lower end of the uprights to the stringer and attach the top board of the sheathing to hold the vertical 2x4's the proper distance apart.

The frame must now be plumbed carefully and held in place by the braces extending between the upper end of the 2x4's and stakes driven in the ground. The remaining sheathing boards may then be placed, starting at the bottom.

With so much of the inner form set, the outer form can easily be placed and fastened to the inner one, as shown in the sketch.

On account of the small place in which to work, the outer part of the form can more easily be built in sections, as described, and lowered into position. When the forms are not to be handled in sections, it will be advisable to "break joints" in placing the sheathing, for by so doing the form will be somewhat stiffer and the alignment be more easily maintained. In erecting forms one must bear in mind that they are to be removed, and when there is only a narrow space between the forms and the earth wall, provision should be made for their removal by a means that will be of least damage to the lumber.

Instead of supporting the outer part of the form by independent bracing into the earth, it will be better to wire it to the inside section. Spacing blocks of a length equal to the thickness of the walls should be inserted to keep the two sections of the form in their relative positions. The wires are then twisted with a piece of iron or a large spike, until the outer section is drawn tightly against the spacing block.

The top of the two sections are held together by cleats, as shown. If the wall is very high it may be necessary to place additional wires near the center of the uprights.

Some means must be provided for removing the spacing blocks as the concreting progresses. This can be done by attaching a wire to the block by which it can be withdrawn after being knocked loose.

Figure B shows a type of form used when the character of the soil permits of placing concrete directly against the earth, doing away with the outer form below the ground level. When depositing concrete in this type of form, care must be exercised, as dirt is likely to be knocked off the sides of the bank into the concrete. The edge of the excavation should be protected with boards.

If a smooth face is desired, dressed lumber should be used.

Figure C shows a type of form for use on a sub-base of concrete the finished part being entirely above ground.

The form shown can be constructed in sections or built in place, depending somewhat on local conditions. If the inner and outer parts of the form are built separately in sections, they may be leveled carefully and plumbed as units, while if built in position, care must be taken in placing each timber. In all cases the bottom boards of the sheathing should be flush with or a little below the top edge of the trench. The top boards should be the height of the finished wall.

It will be seen from the sketch that the forms are suspended over the trench and not allowed to rest on the sub-base. This is accomplished by placing stringers on the ground a short distance back from the trench, supporting the triangular frame bracing.

Illus. 20. Hot Bed Laid by These Boys.

Retaining Wall

The design for a retaining wall shown on Plate 35 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 amount of material per foot of length of wall, assuming the concrete is made of 1 part cement, 2½ parts of sand and 5 parts of gravel or crushed stone.

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

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

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.

The exposed side or face of the retaining wall may be finished as described under chapter for finishing. 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.

Design for Small Dam

The second sketch on Plate 35 shows a suitable design for a small dam.

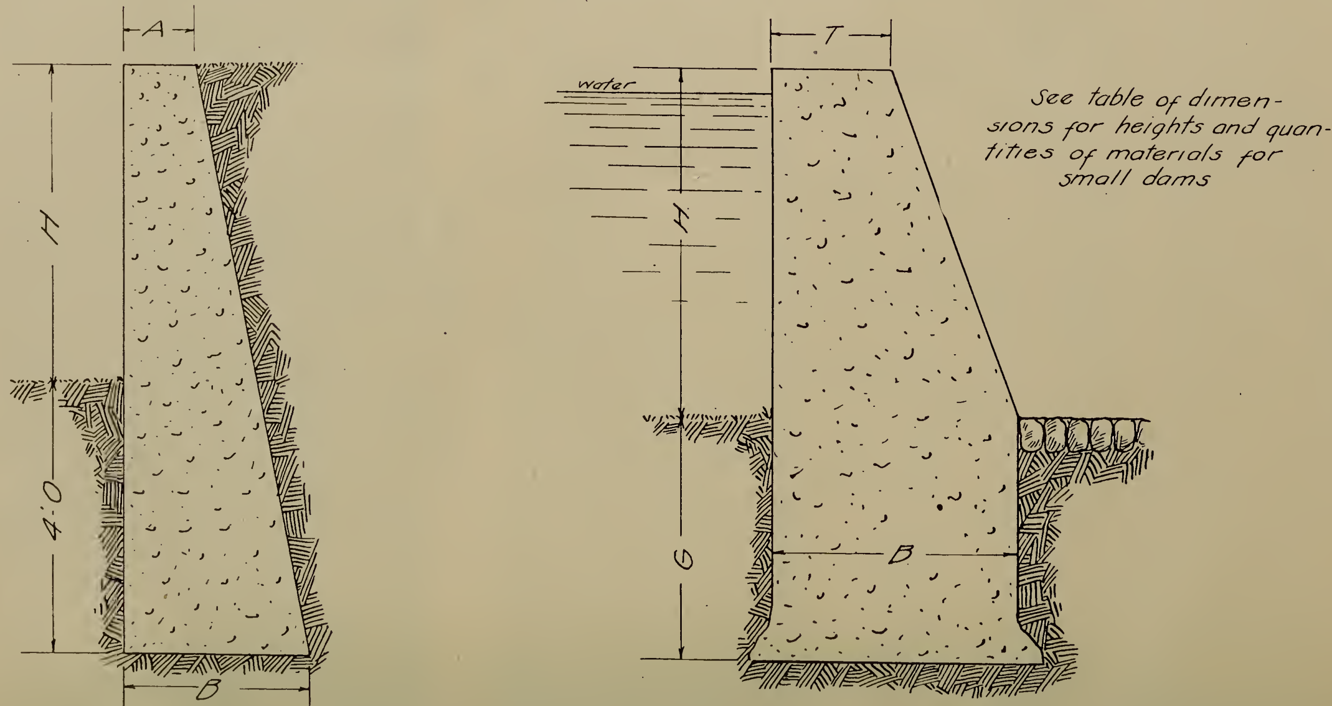
If a dam is to be built more than 4 or 5 ft. above the bed of the stream, an engineer should be called upon to design it and look after the construction.

For an ice pond or 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 on each side of it is finished carry the forms across the opening, and make it tight enough so that the water is quiet between them; then place the concrete in pails, placing a board over the top of the pail, and lowering it carefully to the bottom. Turn the pail upside down,

PLATE 35

DESIGN FOR RETAINING WALL AND SMALL DAM



DESIGN FOR RETAINING WALL

DESIGN FOR DAM

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, on account of the cement being washed away, leaving only the sand and stone.

Another method of placing 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 when 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.

Dig a trench across the stream slightly wider than the width of the base of the dam, carrying it down about 18 in. or 2 ft. below the bed of the brook, or, if the ground is soft, deep enough to reach good solid 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 in. tongued and grooved plank, can be pointed and driven with a heavy wooden mallet so as to prevent 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 very carefully, using 1 part cement, 2 parts clean, coarse sand to 4 parts screened gravel or broken stone.

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

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

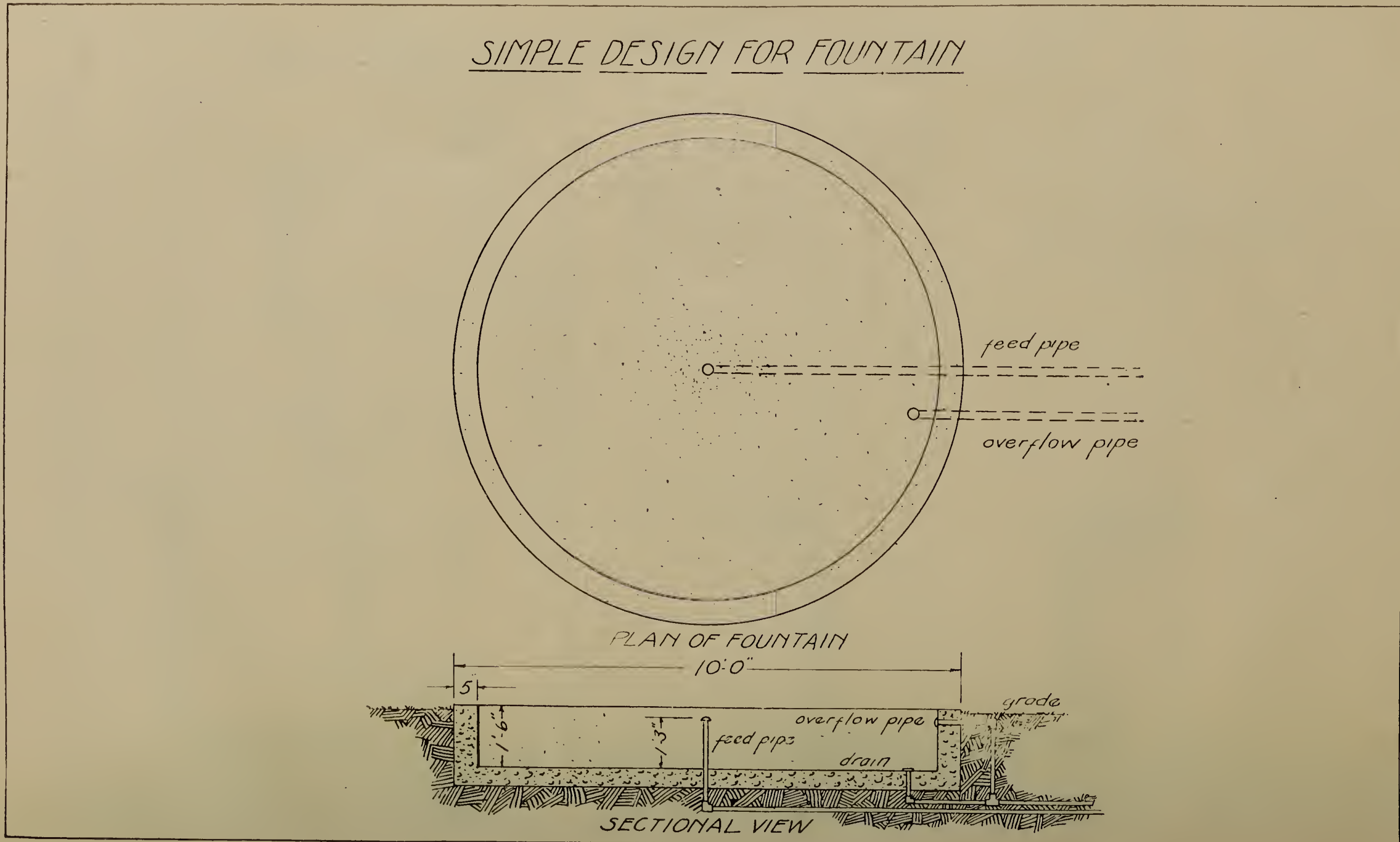
Height Above Bed of Stream	Depth Below Bed of Stream*	Thickness at Base	Thickness at Top	Amount of Materials per Foot of Length of Dam		
				Cement	Sand	Gravel or Stone
Feet H	Feet G	Feet B	Feet T	Bags	Cu. Ft.	Cu. Ft.
1	1½	1	1	½	¾	1½
2	1½	1	1	1	1½	3
3	1½	2	1½	1¾	4	8
4	2	2	1½	2¾	5	10
5	2	2½	1½	3½	6¾	13½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

*Make deeper if necessary to get a good foundation.

A wet mix will help make the concrete water tight, and if possible lay the entire dam in one day, not allowing one layer to set before the next one is placed.

If it is necessary to lay the concrete on two consecutive days, scrape off the top surface of the old concrete in the morning, thoroughly soak

PLATE 36


SIMPLE DESIGN FOR FOUNTAIN
feed pipe
overflow pipe
PLAN OF FOUNTAIN
10'0"
5
1'-6"
1'3"
feed pipe
overflow pipe
drain
grade
SECTIONAL VIEW

it with water and spread on a layer about ¼ in. 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 3 or 4 days, and the pond allowed to fill. The forms on the down-stream face should be left in place, well braced for 2 or 3 weeks. No finish need be given to the surface.

Illus. 21. Model Bridge with Concrete Abutments.

Design for Concrete Fountain

The design for a small fountain, shown on Plate 36, is simple in construction and not expensive to make.

There must first be a pipe laid to what will be the center of the fountain and it must connect with the regular water supply.

A circular excavation must first be made, 12 to 18 in. deep, to bring the water supply pipe up to the decided water line, usually at the height of the ground. A nozzle should be attached to this, to regulate the spray.

A drain pipe should be located even with the floor of the basin and an overflow pipe placed on the wall, a trifle below the height of the feed pipe, which runs into the drain outside the fountain wall, as shown in the drawing.

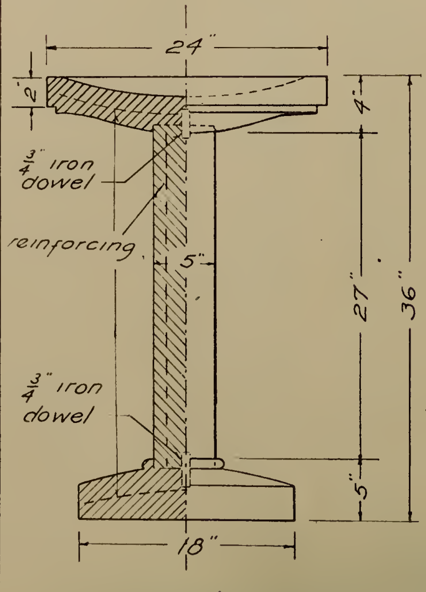
The bottom of the basin, around the piping, must be well tamped and covered with about 4 in. of cinders, which also require generous tamping, wetting them down well.

A concrete consisting of 1 part cement, 2 parts of good, clean sand and 4 parts of gravel or broken stone, should be mixed and deposited with care.

Protect the fresh concrete for several days, wetting each day to insure drying out evenly.

PLATE 37

BIRD BATH OF CONCRETE



SECTION AND ELEVATION

Construction of templates and method of sweeping forms

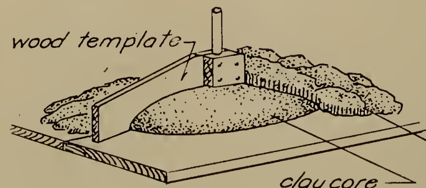
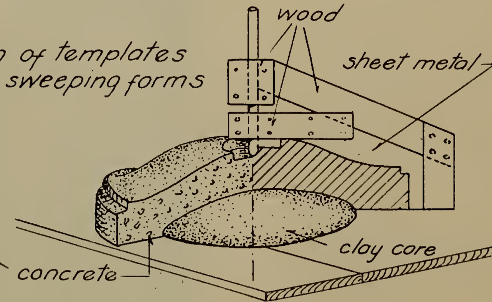
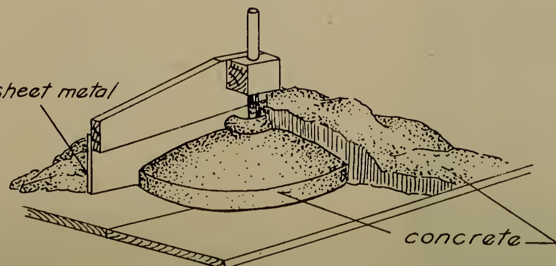


FIG. A



SKETCH AND SECTION OF TOP

FIG B



SWEEP FOR BASE

FIG C.

THE METHOD OF CASTING THE SHAFT IS SHOWN ON PLATE 17

Concrete Bird Bath

Plate 37 gives a simple design for a concrete bird bath, with sketches showing the various steps in molding and sweeping the concrete.

A strong, substantial table may be utilized for this work or it may be done on a plank platform of wood. See Fig. C.

A ¾ in. dowel should be attached to the table, letting the end project through to the underside and held firmly in place. It should be of sufficient height to allow the sweeps to be slipped on, as is shown in the sketches on Plate 37. A wooden sweep should be shaped to the required size for forming the inside of the top, Fig A, Plate 37. Place sufficient moist clay on the board and sweep as shown in Fig. A.

The form for the sweep, shown in Fig. B, which is the underside of the top, must be made of fairly stiff sheet metal, securely attached to the wooden frame, as indicated. Mix enough concrete, using a wet mixture, to build up the required thickness. This is placed on top of the clay mold previously made, and oiled and the metal template placed on the spindle. Sweep until the surface is smooth.

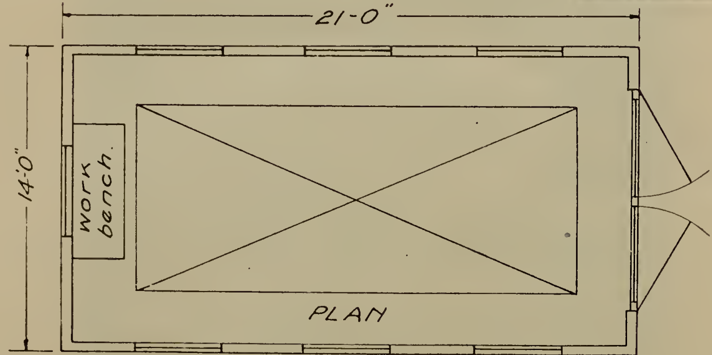
The base is swept as in Fig. C.

Illus. 22. Using the Sweep on a Plaster of Paris Form Preparatory to Casting the Top of a Bird Bath.

Illus. 23. Completed Top of Bird Bath and the Shaft.

PLATE 38.

SINGLE CONCRETE GARAGE



PLAN

CONCRETE MATERIAL LIST.	
CEMENT.	33 bbls
SAND	11 cub. yds.
STONE	20 " "
1/4" REINFORCING RODS.	1200 lin. ft
1/2" " "	50 " "

SIDE ELEVATION.

FRONT ELEVATION.

Pieces of fine mesh wire should be placed inside the concrete to stiffen it. Keep wet until thoroughly dry, which should be in two or three days. It will be noticed in the sectional view that the various parts are joined by means of a ¾ in. rod or dowel. When putting the bird bath together, a small amount of "neat cement," which is cement with enough water added to make a paste, is applied at all joints.

Another method of sweeping the molds is to mix up just enough plaster of Paris to place under the sweep and sweep this very quickly with the template. The plaster sets quickly and the work must be done without loss of time. After the core is hard it should be sand-papered and shellac applied to the surface.

Oil the core and cover it with the concrete, packing it down firmly, and building up to the required thickness.

Place the template for sweeping out the inner or bowl part of the top, and sweep to the desired smoothness.

This problem is not only interesting to construct, but is a valuable addition to any lawn or garden and at the same time attracts and benefits the birds.

Single Concrete Garage

The design of a garage is generally influenced by the architectural treatment of the house and neighboring buildings.

The logical location for the garage is at the rear of the house, but this point must be settled to suit local conditions, the main idea being the convenience and accessibility from the street.

Plate 38 gives a good type of concrete garage, but very few dimensions are given, as the size depends on the car to be housed and the amount of room available.

It is well to plan ahead for the possibility of two automobiles, or space for a visiting car, or perhaps the letting of one-half of the garage.

It is very necessary that the garage be as near fireproof as possible. Insurance companies allow lower rates on concrete constructed buildings. This type of garage is simple to construct, its upkeep is cheap, it is permanent and needs no painting or repairing, is clean and easy to keep clean.

The method of constructing forms and floors is shown on previous plates. The floor should have a slight pitch to a drain in the center (see Plate 29), and the material required for the entire building is given on the drawing.

This garage shows a shingled roof, but a concrete roof may be constructed instead, of a low arch type, the supporting forms being constructed on the inside of the garage.

A Class of Boys in "Elementary Concrete Work" Starting Out for a Job.

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