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CEMENT AND CONCRETE FENCE POSTS

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CEMENT AND CONCRETE FENCE POSTS*

H. M. BAINER†
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PART I.

INTRODUCTION.

The average life of the best wood fence posts that have not been specially treated is from 12 to 15 years; while the poorer ones often last but from 3 to 5 years. Good wood posts are gradually becoming harder to secure and the cost of them is increasing each year. The cost of maintaining the farm fences and especially the posts is a great one when we consider that they must be replaced so often.

The cheaper and poorer grades of woods used for fence posts can be treated and thus made to outlast the best grades of untreated timber. The cost of the untreated post will vary from 10 to 15 cents each and the cost of treating them according to experimental data at hand will add from 10 to 15 cents each to the first cost, thus making the total cost of the treated post from 20 to 30 cents.

With the present enormous and increasing demands made upon our forests for all classes of lumber, shingles, pulp wood, cooperage stock, mine timbers, lath, wood for distillation, poles and fence posts, there is no wonder that the prices for these products are becoming greater. The cost of the average fence post is almost double what it was a quarter of a century ago and in another quarter of a century, there is no doubt but that its cost will be double that of the present.

Iron fence posts cannot be generally used as substitutes, as their cost is prohibitive. Stone posts are used in some localities, but they do not give general satisfaction and they cannot be profitably shipped.

Cement and concrete posts are just beginning to be manufactured and used as substitutes, and there is no doubt but that they will become more generally used. It is true that they may be considered as expensive, but they are long-lived, present a good appearance, and can be made by the farmer, providing the necessary materials are available. It is the purpose of this bulletin to show how to make the posts and also to determine the best forms, mixtures, reinforcements, wire fasteners, cost, and general practicability.

MATERIALS TO USE.

Cement.—There are but two general classes of cements which could be used for post construction—Natural and Portland. The

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materials found in Natural cement are mixed by nature in approximately the correct proportions and when burned does not always make a cement of uniform strength. Portland cement is mechanically mixed in chemically correct proportions. Portland cement makes a uniformly stronger mixture than the Natural cement and is always used where great strength is required.

In cement fence post construction, it is desirable that the post be made as light and as strong as possible, and thus it is practical to use nothing but the best grade of Portland cement.

Sand.—Clean, sharp sand with grains varying in size from small to large makes the best mixture. By clean sand is meant that which is free from clay, loam, or foreign materials. These tend to retard the proper setting of the cement and destroy its adhesive quality. In many sections mica is found mixed with sand in large enough quantity to seriously interfere with the strength of a mixture made from it.

Sharp sand is composed of sharp, angular grains of all sizes and makes better mixture than that which is smooth and round, or "river worn."

A sand composed of fine and coarse grains mixed, is to be preferred, because less cement will be required to fill the voids than either used by itself.

Leaves, sticks, stones or gravel should be removed by screening.

Gravel.—The same general rules used in the selection of a good grade of sand will apply to gravel. It should be composed of clean, sharp pebbles of all sizes. For post construction, the pebbles must not be too large, as they will interfere with the proper placement of reinforcement.

Broken Stone.—Broken stone used for post construction must contain no large pieces as they will interfere with the placement of the reinforcement. It is necessary to use some sand with the stone to fill voids and thus save cement. It is not desirable to use soft sandstone, soft limestone, slates, or shales. Granites, hard limestones, and coarse gravel which has been crushed, is considered best.

Water.—The water used in making a cement or concrete mixture should be clean and free from alkali. Satisfactory experiments have not been conducted to show the effects of alkali water used in making a mixture of this kind, but enough is known as to its effect on cured cement constructions to justify not using it in the mixture.

PROPORTIONS.

On account of a difference in the total open space or voids in sands or gravel composed of different sized particles and also that more cement is required in some conditions than in others, it is often necessary to make a rough determination of the percentage of voids to the total aggregate. Where maximum strength is required about 10 per cent. more cement should be used than the total voids.

The determination may be made as follows: Secure a water tight box or pail of known capacity, fill it with the aggregate to be used so that when it has been well shaken it will smooth off even at the top. Pour water of known amount into this until full. The volume of water used in proportion to the total volume of the receptacle determines the total voids.

For example, suppose the total volume of the receptacle in which the aggregate is placed is 2,032 cubic inches and that it takes two gallons of water to fill it. One gallon of water contains 231 cubic inches and two gallons would contain 462 cubic inches. The total volume of water used, divided by the volume of the receptacle holding the aggregate represents the proportion of voids. Thus, 462 divided by 2,032 equals 22.73, or the voids make up 22.73 per cent. of the total volume. For the maximum strength 10 per cent. should be added to this. Ten per cent. of 22.73 equals 2.27. By adding this 2.27 to 22.73 we obtain 25, or in other words, 25 per cent. of the total volume should be cement. The mixture in this case would be represented by one part of cement to four parts of aggregate.

The proportions used in the constructions of the fence posts in this bulletin varied from 1 part cement and 3 parts of sand to 1 part of cement and 5 parts of sand. In others gravel was used in the proportion of 1 part cement, 3 parts sand, and 3 parts gravel. It is a difficult matter to use broken stone or gravel in large quantity and place the reinforcement properly.

Measure all materials in correct proportions. This may be done with a shovel, a pail, wheel barrow, or barrel. It will usually be advantageous to measure the water, especially where small quantities are mixed or where the same amount of mixture is made several times.

MIXING.

Hand Mixing.—Where the mixing is done by hand, a flat water-tight platform, or shallow box is convenient. Measure the sand and place it in a uniform layer and over this spread the proper amount of cement. Mix this thoroughly before adding water until it shows a uniform color. The rule is to shovel it over at least three times. Now spread out the mixture, making a sort of basin in the middle into which the greater part of the water may be poured. Work in the dry edges until the water disappears, then add enough more water in small amounts to make the mixture of the desired consistency. Do not mix more material than can be used in twenty minutes.

Machine Mixing.—It is usually customary to use mixing machines on large jobs. It is not only economical, but does better work. Where power is available it is often advantageous and economical to construct a mixer for small jobs, also.

A small mixer can be cheaply constructed which can be driven with a two or three horse-power gasoline engine. With this, it was found that two men were able to do the work of at least four men doing hand mixing, and the machine work was done more thoroughly.

In many instances, mechanical mixers, which are driven by hand power instead of by an engine are better than hand mixing with shovels or hoes. A mixer of this kind can be made from a barrel or box, pivoted in the center and driven by means of a crank on which one or two men can work.

The mechanical mixer first mixes the materials in a dry condition, then some provision is made for turning in the water without stopping the machine. With most mixers of this kind, one revolution does as much mixing as one turning by hand. Six turnings by hand are considered enough, and it is seldom that a machine is stopped with less than double this number of revolutions; in fact, it may be turned 15 or 20 times; thus this method of mixing is very much more thorough and desirable.

HOME MADE CONCRETE MIXERS

To many people, the idea of mixing the concrete by hand appears to be an unnecessary task. But the price of a modern concrete mixer is so large that it would not be good economy to purchase one for what little mixing is done on the average farm.

The ingenious farmer will find that a suitable mixer may be constructed at home with little expense and work. All that is necessary is the ability to put a few pieces of old machinery together in such a way that the barrel or box may be turned upon an axis and stopped at the desired time. This is very easy in case the power is furnished by hand, but in case of a power-driven mixer, more ingenuity is required.

The home made mixer shown in the cut illustrates how a few pieces of board and timber may be turned into a very serviceable machine. Two pieces of 4x6 form the sills. Upon these, two uprights about three feet high, are fastened. A 1½ inch pipe passes through holes bored in the top of the uprights. Upon this pipe the mixing box is turned, and through the pipe the water is added to the mixture at the desired time. The water is poured in at the top of the upright pipe and flows down and out through holes which are drilled in the lower side of it. The other end of the pipe is closed by a wooden plug. The ends of the box are made of pieces of 2x8 bolted together. A hole bored in the center of each end forms the bearings. The sides of the box are made of one-inch lumber and are simply nailed to the ends with 12d nails. One-half of the box is made so that it can be detached and lifted off when the mixer is to be filled, or emptied. The detachable half is secured to the other half by means of strong hooks so placed that by slipping this half about an inch to one side all of the hooks are loosened at once. After it is in position, the removable portion is held in place by means of a barn door latch.

The driving gear is simple but very effective. It consists of the rim taken from the wheel of an old "rubber tire buggy." With the tire removed the grooved rim makes a very satisfactory wheel upon which to run a ¾-inch rope belt. The belt is driven by a small shieve pulley which is fastened to the counter shaft. A belt tight-

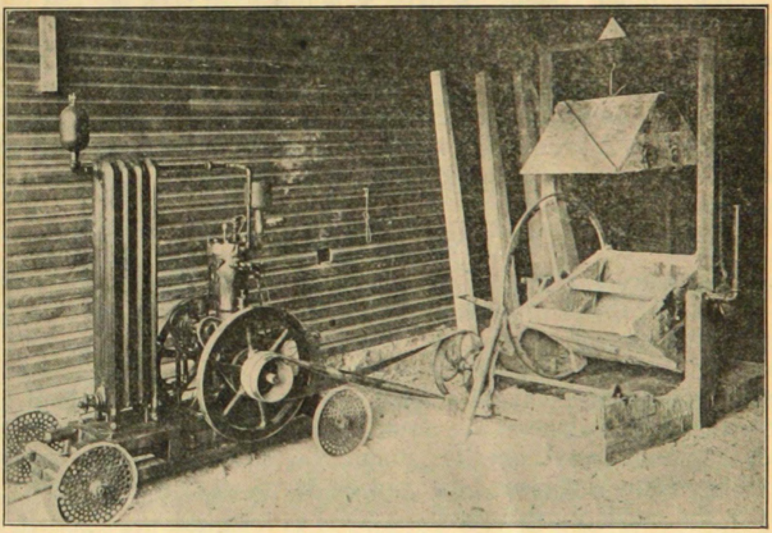

Figure 1.
Home made concrete mixer operated by 2-horse-power hand portable gasoline engine

ener is used upon the rope, and by using a very loose belt, the tightener is made to act as a friction clutch.

This particular mixer is driven by a two-horse gasoline engine, which is belted to the counter shaft. The engine runs continuously and the mixer is started and stopped by means of the belt tightener.

The operator first fills the mixer about half full of sand, gravel and cement in the correct proportions. He next lowers the lid, which until this time has remained supported upon the hook. The lid is now pushed into place and the latch fastened. The supporting hook is next removed from the staple in the lid and hooked into a staple in the lid support. The machine is now ready to start, the clutch is thrown in, and the box revolves upon the pipe. When three or four turns have been made, water is poured into the upright pipe until the desired amount has been added. By this time the concrete is thoroughly mixed. The clutch is loosened, the box stops revolving, the hoisting hook is hooked in the staple of the lid, the latch is loosened and the lid raised to the top of the lid support by means of the counter weight and rope. Now, by slightly setting the clutch, the contents of the mixer are dumped into the box beneath. The operator of the machine may now refill the mixer, while the other workmen take care of the mixed material. In this way a large amount of material may be run through the machine and perfect mixing is guaranteed.

Many other systems of driving might have been used in place of the rope belt. The main gear of an old self-binder makes an excellent gear for a mixer. An old mower gear may also be put to good use in this connection.

It is not necessary to have the mixer driven by an engine or horse power. A crank may be attached and the machine turned by hand. Many prefer turning such a machine rather than mix the concrete with a shovel.

POURED POSTS.

There are two general classes of mixtures which may be used in the construction of posts; the poured and the tamped: In the poured mixture, enough water is used in mixing to make it thin enough to pour from a pail or scoop almost like water. The mixture is poured into a mold and allowed to remain in it until it has set, which is from one to five days, depending upon the time of year and the weather. In drying summer weather, from one to two days is usually sufficient. In cool or damp weather they must be left in the molds much longer.

In order to make several posts of the poured type at once, it is necessary to have several molds ready for use. With 6 molds only 6 posts could be made at once, and it would be necessary to wait until the cement was set before 6 more could be made.

It was found that to make a good poured post, the mixture should be stirred or shaken immediately after placing in the mold. This should be done carefully to prevent displacement of reinforcement wires. This helps to remove the air from the mixture and makes a post of smooth finish.

The experiment showed that a poured post of a certain mixture was stronger than a tamped post of the same mixture. It is enough stronger to justify anyone in constructing it in preference to the tamped one at the necessary additional expense for molds. The poured post is smoother, more nearly impervious to water, not so hard to cure, stronger, somewhat more expensive, and can be better recommended than the tamped one.

TAMPED POSTS.

The tamped post is one in which the mixture contains very much less water than the poured one. It contains just enough water to make it hold together well when tamped. In the manufacturing of this type of post, only one mold is necessary. The mixture is tamped into it, and the sides of the mold can be removed immediately, the post remaining on the bottom piece until the cement has set. Thus the same mold can be continuously used for making as many posts as are desired. The necessity for but one mold makes this type of post less expensive than the poured one. The results of the tests made, show that the tamped post is inferior to the poured one and cannot be placed in an equal class with it.

On account of less water being used in the mixture for a tamped post than in the mixture for a poured one, the tamped post requires more water and attention in curing. It is of more open texture, less impervious to water, not as strong, and not as desirable as the post of the poured type.

POST MOLDS.

In general, the molds in which cement or concrete posts are made may be divided into three main classes.

First, those molds which are designed exclusively for manufacturing tamped posts.

Second, those which are made exclusively for manufacturing poured posts.

Third, those which may be used for either tamped or poured posts.

In the first class of molds we find mostly the heavy cast iron forms which are built of strong and heavy material. The most of these molds are designed to be laid upon pallettes or upon a smooth floor. The mixture is first tamped in the mold to a depth of about one inch. The reinforcement is then placed and the mold is next filled, and the mixture tamped, so that only about one inch of material remains to be filled in. The second set of reinforcement wires is put in place next and the mold is tamped full to overflowing. The last step consists in smoothing off the top of the post with a trowel and removing the mold. This is done by unfastening some form of hook or clasp, slipping the sides of the mold a little distance away from the post, and then removing the molds to the position chosen for the next post.

The principal advantage of these molds lies in the fact that they being made of heavy iron need no center stays. This gives greater speed in operation, due to the fact there are no cross pieces to interfere with the placing of the reinforcement, the tamping of the mixture, and the smoothing off of the top of the post at the finish.

The cast iron molds being heavy, are rather hard to handle, and this feature, in connection with the high price of them, explains why they are not more commonly used.

In the second class of molds (molds for poured posts) we find a far greater variety. The more common forms are made of sheet

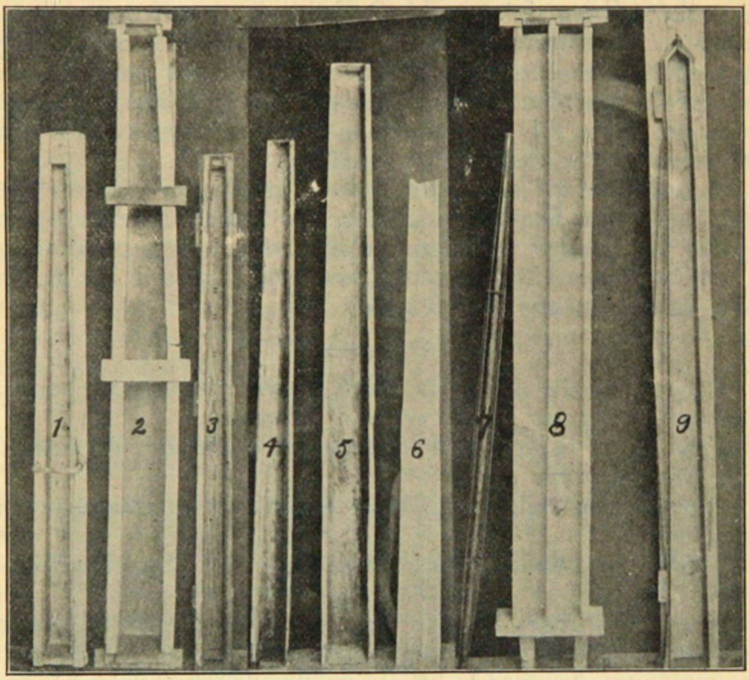

Figure 2.

Different Types of Post Molds.—1. A 5-inch home made mold for making poured or tamped posts. 2. An 8-inch home made mold for making corner posts. 3. A 4-inch commercial post mold. 4. A 4-inch heavy sheet iron mold. 5. A 7-inch heavy sheet iron mold for corner posts. 6. A triangular sheet iron mold. 7. A commercial reinforcing truss. 8. A double mold lined with sheet iron. 9. A heavy cast iron mold made especially for tamped posts.

iron, either galvanized or plain. For posts having a continual taper from top to bottom, sheet iron molds prove very satisfactory, providing sufficiently heavy material is used in their construction. A mold made of thin iron soon loses it shape and the posts made in them are necessarily unsightly. If properly taken care of, there is no advantage whatever in galvanized iron molds over those made of plain iron.

The advantages of the sheet iron mold are many. They are light to handle and easy to keep clean. If properly made they are nearly water tight. This insures the user against the possible loss of cement by leakage. As the cement travels to some extent with the currents of water, it can easily be seen how a leak in a mold may materially weaken a poured post by allowing a portion of the cement to be carried out of it. Another marked advantage of the sheet iron mold lies in the fact that the surface being smooth, im-

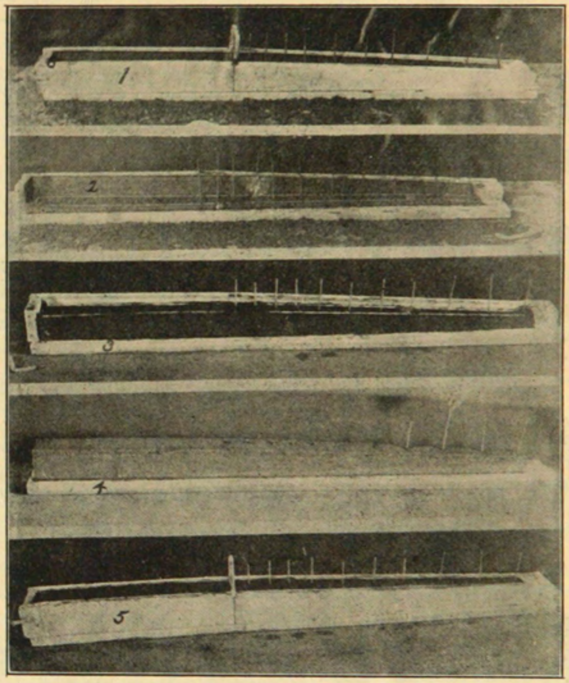

Figure 3.

1. Empty mold ready to be filled, showing tie hole pins in place. 2. First layer of mixture and first reinforcement wires in place. (Side of mold removed.) 3. Second filling of mixture and the second reinforcement wires in place. 4. Post completed, mold removed and the hole pins being pulled. 5. Post complete ready to remove mold.

parts a very smooth, glossy finish to the surface of the post. This not only adds beauty to the post, but aids in keeping out water, which might otherwise enter the cured post.

As the sheet iron molds are made in one piece, no pallette is necessary. At first glance this looks like a great advantage, but upon further consideration we find that the mold must be left upon the post until the mixture has set to such an extent that the post may be removed and handled without fear of breaking. In hot weather the post may be removed after 48 hours, but in cold weather a much longer time is required.

In making poured posts in these molds exactly the same process is followed as with tamped posts in molds of the first class just described; with the exception that the mixture is not tamped and greater care must be exercised in preventing the reinforcement from being misplaced.

Some forms of wood molds are made and used for the purpose of making poured posts only. Any desired form may be given to

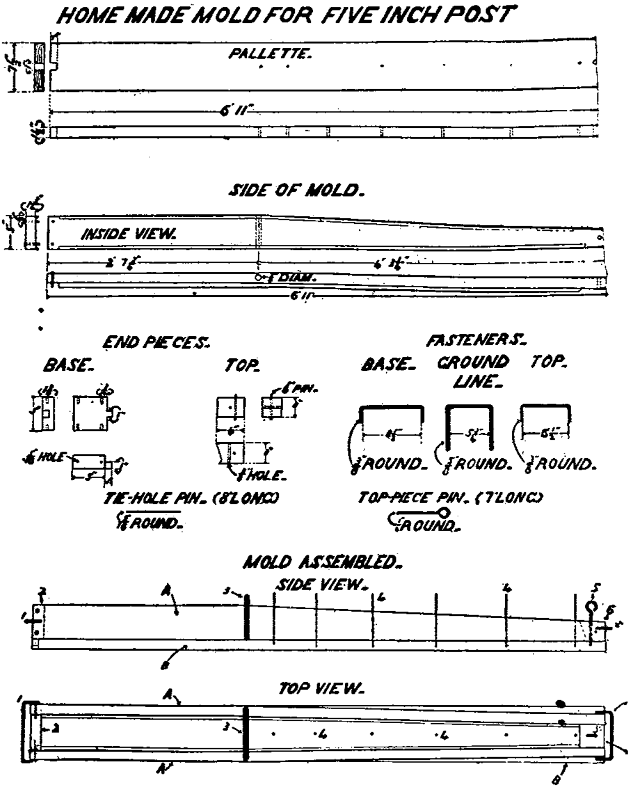

Figure 4.

A Home Made Mold Giving the Proper Shape to the Post.—1. Base fastener. 2. Base end piece. 3. Ground line fastener. 4, 4, etc. Tie hole pins. 5. Top piece pin. 6. Top end piece. 7. Top fastener. A. Side of mold. B. Pallette.

the post by properly shaping the mold. This point, in favor of the wood mold, is an extremely important one, as it permits the post to be made of uniform size from the bottom to the ground line, but with a rapid taper from this point to the top. Then, too, the sides of the mold may be removed after 24 hours and used again in connection with other pallettes; while the post which has not yet become sufficiently strong to be removed from the pallette lies unmolested in its original place until it is ready to move. This enables the maker of cement or concrete posts to produce at least twice as many posts with wood molds as with the same number of sheet iron molds, providing the required number of pallettes are at hand. The number, as well as the extent, of leaks in a wooden mold will depend upon the accuracy of construction, the care with which the molds are handled, and the care with which they are put together before filling.

The third class of molds (those which may be used for making either the tamped or the poured posts) are much the same as the wooden molds for poured posts, except that they are stronger. A mold which is to be used exclusively for manufacturing poured posts may be made of ¾-inch material and prove strong enough for the purpose; while if the mixture is to be tamped within the mold, at least 1½ inch material must be used. The extra thickness is required to prevent the molds from bulging at unsupported places during the tamping process.

The heavy cast iron molds could be used in making the poured posts as well as the tamped ones, but their original cost make them impracticable. The wooden molds serve the purpose equally well and are much cheaper.

Selecting the Mold.—The first and most important point to be considered in selecting the mold is the *shape and size* of it. Too many post mold manufacturers are turning out forms of molds that make "freak" posts, simply because it happens that they can manufacture them more easily and cheaply. It must be remembered that cement or concrete posts are made for long continued service and that simply because a certain mold works well is not a sufficient reason for purchasing and using it.

Next to the shape and size of mold we should look for ease of operation. Too many complications are likely to prove to be hindrances to the speed with which posts may be turned out. The simple mold almost always proves to be best, providing it has sufficient strength.

Care of Molds.—Before the molds are used they should be well coated with some kind of heavy oil. Crude petroleum is perhaps the best and cheapest material for this purpose. In case the petroleum cannot be obtained, a good oily mixture may be made by stirring about two pounds of axle grease into a gallon of gasoline. This mixture is applied to the molds with a brush. The gasoline evaporates, leaving a thin coat of axle grease spread over the entire surface of the mold. This oily mixture should be applied to the outside as well as to the inside of the mold, which makes it impossible for any of the material to cling to it. With the iron molds, the oil prevents rusting. In case the molds are made of wood, the oil helps to keep out the moisture, thus preventing shrinking and swelling, and also making them easier to keep clean.

As soon as the mold is removed from the post all material sticking to it should be scraped off and the inside surface covered with a thin coating of oil. In case tamped posts are being made, the oil need not be applied oftener than once for ten or twelve posts; but with poured posts, the oil should be applied each time the mold is removed. Great care should be taken not to allow the molds to become bruised or dented, as it not only causes the posts to have a bad appearance, but allows the mixture to adhere to the uneven spots; thus a great deal of unnecessary trouble is experienced in removing the posts from the molds.

If the molds are not to be used for a time, they should be thoroughly scraped and oiled, inside and out, and carefully laid away. When it is understood that the speed of operation and the value of the posts depend largely upon the condition of the molds, the importance of properly caring for them will be readily understood.

REINFORCEMENT.

Cement and concrete work has the property of resisting great crushing stresses, but when subjected to tensile stress, the best of it breaks very easily.

For this reason it becomes necessary to put some material possessing great tensile strength into the post, in order that the full crushing strength of the cement or concrete may be utilized. Iron is the most satisfactory material from which to make the reinforcement.

The reinforcement should be placed in the post as near the corner as possible. This places it as far as possible from the neutral axis, thus giving it the greatest advantage in strengthening the post. In order that the reinforcements may be properly held and protected by the cement, it is a good plan to place it from 3/8 to 3/4 inch in from each side. This insures a good, firm grip of the cement upon the reinforcement.

The material used for reinforcement should be strong, light, and rough enough to permit the mixture to get a firm grip upon it. It should be very rigid, with little or no tendency to spring or stretch.

A great many special reinforcements are now being made, but the farmer should see to it that the reinforcement which he is to use is reliable, rigid, and easily secured.

The experiment showed that ordinary iron or steel wire was cheapest, strongest and easiest to procure. In order to provide a means by which the cement may cling firmly to the wire, it is best to twist two small wires together instead of using one large one.

If the twisted wire can be bought, cut to the right length and packed in bundles in the same way as bailing wire, it is best to procure it in this way. In case the twisted wire comes in rolls, it becomes necessary to straighten each piece before it can be used. In this case, it is best to purchase common smooth wire of the desired size and twist it on the farm. The twisting is easily done by tieing one end of each wire to the opposite spoke of the fiy wheel of some machine; a corn sheller or hand cider mill will serve the purpose very well. By tieing the other ends of the wires to a weight which may drag along upon the ground, from 100 to 200 feet of wire may be twisted in a very few minutes.

In case a small engine is available the twisting becomes still easier. The advantage of the home twisted wire over twisted wire which is bought in rolls, lies in the fact that the former is straight at the end of the twisting process, while the latter is bent and must be straightened.

The cutting of the wire is best accomplished as follows: Set a cold chisel (with the edge up) in a low, rough bench, and at a distance exactly equal to the length of the reinforcement wire from the edge of the chisel, nail a block to the bench. Take a light hammer in the right hand and seize the twisted wire with the left. Then drag the wire over the chisel until the end of it strikes the block, when a light blow directly over the chisel easily cuts the wire. The piece which is cut off is now laid to one side and the end of the main wire is drawn to the block and another piece cut off.

SPECIAL REINFORCEMENT.

Some have suggested that a piece of wood be placed in the center of the post as a reinforcement. This must be considered a failure, as the wood shrinks and expands by differences in moisture conditions. When it absorbs water, it is likely to swell and burst the post, and again when it dries it will shrink away from the cement.

Gas pipe has also been suggested as one of the best materials to use as a reinforcement. In case plenty of strong second hand pipe is at hand, this may be true. As the pipe is placed in the center of the post, it is not in position to act to the best advantage as a reinforcement, and for this reason it should be strong enough to withstand almost all the strain. New pipe would make the posts altogether too expensive.

Crimped wire is also claimed, by some, to be superior to that which has been twisted, but as the pull comes upon the wire there is a tendency to straighten the crimps. When the wires happen to be near the surface, there is great danger of the post being split by this straightening process.

Band iron and strap iron are also being used as reinforcement. In case the mixture has a good chance to get a grip on the iron, it will probably prove satisfactory, but unless the iron is roughened there is a danger of it slipping.

For very large posts, the twisted steel rods will prove as satisfactory as twisted wire. Smooth rods or smooth wire slip.

CURING THE POSTS.

In order for the cement to become thoroughly cured or "set," water must be supplied to aid in the action. This action goes on for a long time, some authorities estimating the total period at from 15 to 20 years. For the first thirty days the cement should be kept wet if the best results are to be expected. This means that the posts must be kept wet, and the question arises, what is the best system of keeping them in this condition?

The answer is a simple one. The most favorable conditions for conserving the moisture consists in curing the posts in a shed where the wind does not strike them. Under these conditions neither the sun's rays nor the wind have a chance to dry out the posts too rapidly. The only thing that now remains is to keep the posts in a wet condition.

After the posts are placed in an upright position in the curing shed, as described in "Handling the Posts," sprinkle them thoroughly every day. This may be done either by a hose and nozzle in connection with some form of pressure supply tank or by means of a garden sprinkler. In the latter case provision must be made so that the person doing the work may walk upon some structure above the tops of the posts.

The posts should be thoroughly sprinkled every day for at least 30 days.

HANDLING OF POSTS.

In removing the posts from the molds great care must be taken not to allow the posts to sag or crack. A post may be cracked in handling and still be fit for service, but it cannot be considered to be as valuable as an uncracked one.

There are two general methods of removing the posts from the molds.

The first method consists of laying the molds with the posts in them on a level bed of soft sand. The mold is then turned upside down and the post allowed to settle into the sand. The mold is next removed and the post allowed to lay undisturbed for several days. When the post is sufficiently strong it is placed in an upright position to be cured. While this method requires more space it is perhaps a little better for the posts than the second method.

The second method consists in removing the posts from the molds while in an upright position. The post is then allowed to lean against a wall or some other support. Thus only one handling is necessary. Care should be taken to have the bottom of the post close to the wall, as it is very likely to break if not kept very nearly in an upright position.

After the posts are cured and ready to set they should be moved from the curing shed and hauled to the fence line in a wagon having a strong, rigid bed. The bottom of the bed should be covered with a layer of straw to prevent breakage. Not more than three to four layers of posts should be placed in the wagon, depending upon road conditions. It must be remembered that a five-inch post weighs 100 pounds or more. When this is considered, we see how easy it is to load a wagon and also how sufficient weight may be placed on the posts in the lower layer to cause them to break.

In handling and setting care must be taken not to drop the posts. The weight of the post places unnecessary stress upon the different parts, and in case it is dropped there is great danger of it being cracked or destroyed.

A careless workman can easily do more damage to the posts than his services are worth.

WIRE FASTENERS.

In case of the wood post the method of fastening the wire consists of simply stapling the wire to it. In order to fasten a wire to a cement or concrete post a different system must be used.

With the ordinary wood staple in mind, one inventor has designed a small cast iron socket or staple holder which is placed where it is desired in the face of the post before the cement has hardened. When the post is set in the ground, the wire is fastened to it by simply driving an ordinary staple into the socket. The staples pull out much easier than they do from the wood post. The jar of driving in the staples tends to split and crush the post at the point where the cast staple holder is placed. Moreover, the cost of the staples and holders adds greatly to the expense of the post.

Another system consists of two staples which have the prongs bent to the side. The staples are placed about one-quarter inch apart, with the prongs projecting to the side. The line wire is placed between the two staples and a nail or piece of wire is driven down through the staples, outside of the line wire. As the tips of the staple touch the reinforcement wires, direct electric connections are established between the line wire and the ground at the bottom of the post. This, it is claimed by the patentee, insures the user against loss of stock by lightning. The system is called the "Double Staple." (See Fig. 5.)

A "single staple" may also be used, but the wire is fastened to the staple by a small "cold shut link," or wire ring. The latter system is not a very strong method of fastening, owing to the ease with which the cold shut links open. (See Fig. 5.)

Perhaps the most common method of fastening wires to cement or concrete posts consists of tieing in the line wire to the post by means of a piece of smaller wire called a "tie wire" (usually No. 14 or No. 15 wire). The single tie consists of wrapping one end of

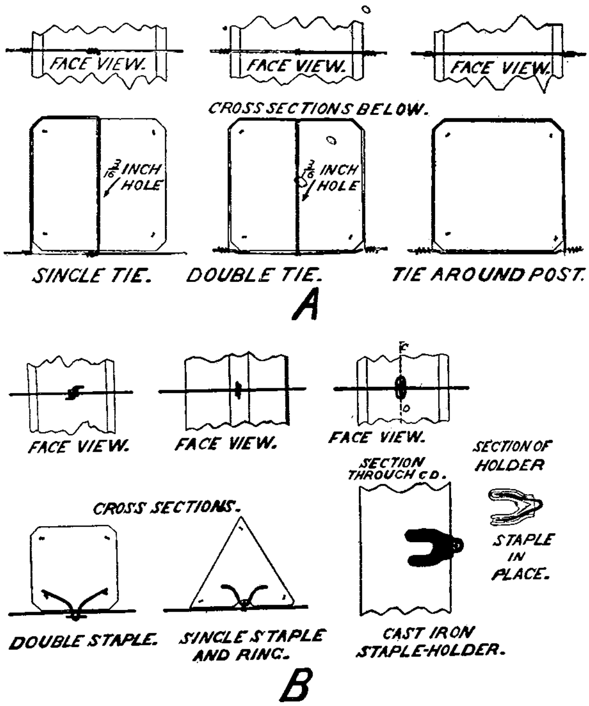

Figure 5.

Different Types of Wire Fasteners.—A, Home made fasteners. B, Commercial Fasteners.

the tie wire three or four times around the line wire, then passing the long end through a hole in the post and bringing it around to the face of the post where it is also wrapped around the line wire. (See Fig. 5.)

The tie around post is much the same as the single tie, except that the tie wire passes around the post instead of through the hole. (See cut.) Neither the single tie or the tie around post are very strong unless the tips of the tie wire are hooked over the body of the tie wire after the wraps have been made. This is known as the "special tie."

The strongest and perhaps the most satisfactory system of tie-

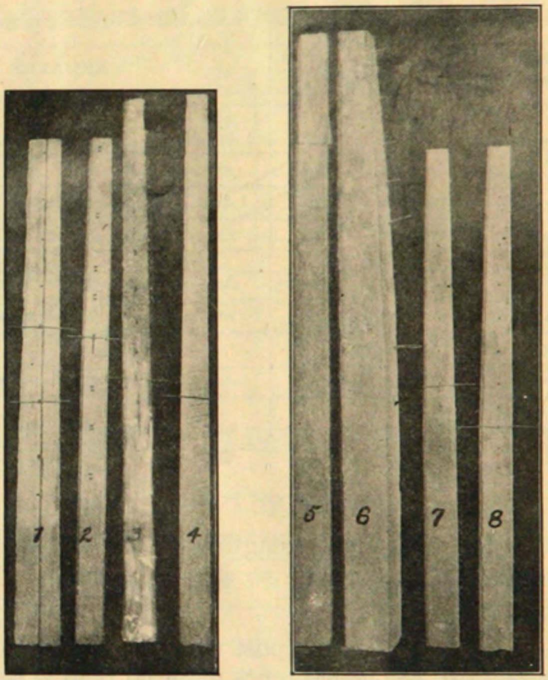

Figure 6.

Different Types of Cement Posts and Wire Fasteners.—1. Triangular post with single staple and ring wire fastener. 2. A square post with double staple fastener. 3. A seven-foot post with cast staple holders. 4. A seven-foot post with tie around post. 5. A 7-inch eight-foot corner post. 6. An 8-inch eight-foot corner post with staples cast in post. 7. A 5-inch tamped post with single tie wire fastener. 8. A 5-inch poured post with double tie wire fastener.

ing in the wire is the "Double tie." The tie wire is bent into the form of a long staple, straddled over the line wire and both ends passed through a hole in the post. One end is brought to either side and wrapped about the line wire at the face of the post. This system insures a solid fastening and is equal in strength to any ordinary wood post fastening.

The holes in the posts are formed by No. 6 wires being placed in the post while it is soft. These wires are called "Tie Hole Pins." (See cut.) They are removed from the poured post after the cement has set for 24 hours. The pins are removed from the tamped posts immediately before the molds are removed.

The following table shows the comparative holding strength of various wire fasteners, as determined by the tests:

WIRE FASTENERS (See description of same.)	KIND OF POST	No. Lbs. Required to Pull Fastener	REMARKS
Ordinary 1¾ in. staple	New Cedar	425	Ave. of three pulls. Staple was well driven into post.
Single special tie	Cement	520	Ave. of 2 pulls. Fence wire broke.
Double tie	Cement	510	Ave. of 2 pulls. Fence wire broke.
Double staple	Cement	245	Ave. of 3 pulls. Staples pulled.
No. 14 wire plain single tie	Cement	115	Ave. of 2 pulls. The wire untwisted.
No. 14 wire around post	Cement	110	Ave. of 3 pulls. The wire untwisted.
Cast staple holder with ordinary 1¾ in. staple driven into it	Cement	85	Ave. of 2 pulls. Staple pulled out of holder
Cold shut-link in single staple	Cement	83	Link opened in every case,. Ave of 3 pulls.

TAPER OF POSTS.

To obtain the maximum strength with the least amount of material, the cement post must be so shaped as to have its greatest strength at the ground line.

While it is easy to make a post which tapers from the bottom to the top it requires somewhat more material than is necessary and it is smaller at the ground line than at the base. Thus the gradual taper not only uses more material than is necessary, but it reduces the strength at the place where it is most needed.

By making the post of uniform size from the base to the ground line, no material is wasted. The post may then be tapered from the ground line to the top.

Many of the posts which are being made now taper only one-half inch on each side from the base to the top. It has been found that in a 5-inch post which projects 4 feet above the ground, a taper of one inch on each side from the ground line to the top, insures almost equal strength throughout. This design gives more strength with less material than those with the continuous taper.

TESTS OF THE CEMENT USED.

Several tests were conducted to determine the strength of the cement used at different times during the post experiment.

The Cubes and Briquettes were made in the same manner as the posts, *i. e.*, they were kept in the shed and thoroughly wet once a day for 28 days, at which time they were tested.

The following table represents inch Briquettes tested in tension. The figures represent an average of three tests:

SAMPLE NO.	MIXTURE		STRENGTH IN LBS.
	PROPORTION	KIND	
1	1—3	Tamped	172
1	1—3	Poured	186
2	1—3	Tamped	171
2	1—3	Poured	193
3	1—3	Tamped	176
3	1—3	Poured	184
1	1—2—3	Tamped	88
1	1—2—3	Poured	97

Three-inch cubes tested in compression. Figures represent an average of three tests:

SAMPLE NO;	MIXTURE		STRENGTH IN LBS. Per Square Inch.
	PROPORTION	KIND	
1	1—3	Tamped	971
1	1—3	Poured	989
2	1—3	Tamped	970
2	1—3	Poured	982
3	1—3	Tamped	980
3	1—3	Poured	1015
1	1—2—3	Tamped	357
1	1- 2—3	Poured	375

PART II.

THE EXPERIMENTS.

These experiments were conducted for the purpose of determining the method of building the best posts at the least cost.

Apparatus.—Various commercial molds of different shapes and construction were secured. In each of these molds several posts were made in order to determine the practicability of the mold; also the best combination of mixtures and reinforcements.

The Farm Mechanics Department designed, built and used a simple home made mold which makes a post of uniform size from the base to the ground line with a rapid taper from the ground line to the top. (See Fig. 4.) The department also designed and built a simple home made concrete mixer which was used in the experiment. (See Fig. 1.)

A shed which was closed on all sides with a sliding door on the east was used as the work and curing room.

TABLE NO. 1—Poured Posts.

Size, 5x5 inches from base to ground line, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 115 to 120 pounds. Mixture, 1 part cement and 3 parts sand, by measure. Cost for cement per post, 16.2 cents; sand, 3.7 cents. Fort cost of reinforcement, see table.

REINFORCEMENT			TEST			COST	REMARKS
KIND OF WIRE	WEIGHT PER POST	COST PER POST	FIRST CRACK IN LBS.	FINAL BREAK IN LBS.	LOCATION OF BREAKS ABOVE OR BELOW GROUND LINE.	COST OF MATERIAL IN POST	NEW WIRE IS FIGURED AT 4C PER LB. AND OLD WIRE AT 2C PER LB.
No. 10, 4 twisted strands of 2 wires.	2½ lbs	10c	250	307	Ground Line Ground Line 1 in. below.	29.9c	Wires broke they did not slip.
No. 10, 8 strands crimped.	2½ lbs	10c	243	254	6 in. below, Ground Line 3 in. above	29.9c	All wires slipped slightly before breaking.
No. 6, 4 long wires hooked at ends.	2⅔ lbs	10.6c	137	232	6 in. above Ground Line 1 in. below	30.5c	All wires slipped wires not crimped.
New Barbed 4 long strands	1⅔ lbs	6.6c	148	188	Ground Line 2 in. below 2 in. below	26.5c	Post 130 days old wires broke.
Old Barbed 4 long strands.	1⅔ lbs	3.3c	143	158	Ground Line Ground Line 4 in. below	23.2c	Wires broke.
Old Barbed 4 long and 2 short.	2 lbs	4.0c	167	200	10 in. above 4 in. above 16 in. above	23.9c	Mixture gave way above extra wires.
Old Barbed 4 long and 4 short.	2¾ lbs	5.5c	148	229	18 in. above 18 in. above 20 in. above	25.4c	All wires broke above extra wires.
No. 10, twisted 4 long and 2 short.	3 lbs	12c	128	290	1 in. below 3 in. below 5 in. below	31.9c	Extra wires did no good.

Materials.—The sand and gravel used was clean and sharp, with all sizes of grains varying from small to large. There was a very small percentage of mica in the sand, which was objectionable. One brand of Portland cement was used for making all posts.

A total of 238 line posts and 8 corner posts were built and tested during the experiment, the records of which are found in the following tables:

TABLE NO. 2—Tamped Posts.

These posts are of the same size and composition as those in Table No. 1, excepting that they are tamped instead of poured.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New Wire is Figured at 4c Per Lb. and Old Wire at 2c Per Lb.
No. 10, 4 twisted strands of 2 wires	2⅛	10.0c	162	240	1 in. above 15 in. above Ground Line	29.9c	Mixture broke wires did not slip or break
No. 10, 8 strands crimped	2½	10.0c	197	263	Ground Line 2 in. above 10 in. above	29.9c	Wires slipped
No. 10, twisted 4 long and 2 short	3	12.0c	130	160	30 in. above 30 in. above 30 in. above	31.9c	Mixture broke extra wires did no good
No. 6, 4 long hooked at ends	2⅔	10.6c	133	184	10 in. from top Ground Line Ground Line	30.5c	Straight wires, all wires slipped
New Barbed 4 long strands	1⅔	6.6c	70	123	Ground Line 2 in. above Ground Line	26.5c	Wires broke
Old Barbed 4 long strands	1⅔	3.3c	98	128	Ground Line Ground Line Ground Line	23.2c	Wires broke
New Barbed 4 long and 2 short	2	8.0c	83	198	Ground Line 6 in. below 1 in. above	27.9c	Wires broke
No. 15, 4 strands of 3 each twisted	1⅛	4.5c	82	125	Ground Line 7 in. above 3 in. above	23.6c	All wires broke did not slip

The Test.—In making the test, the posts were placed under as nearly fence conditions as possible. All line posts were set and firmly tamped into the ground so that 4 feet and one inch projected above the surface. By means of a wire, a dynamometer was attached to the post exactly 4 feet from the surface, as shown in Fig. 7. A steadily increasing force was applied to the dynamometer by means of a block and tackle, until the first visible crack appeared in the post when a reading was made. The force was then increased until the post gave way completely when the final reading was made.

TABLE NO. 3—Poured Posts.

Size, 5x5 inches from base to ground line, tapering to 3x3 inches at top. Length 6 feet 6 inches. Cured weight, 110 to 115 pounds. Mixture, 1 part cement and 4 parts sand, by measure. Cost for cement per post, 22 pounds, 13.2 cents; sand, 1 cubic foot, 3.7 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Material in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 strands or 2 wires twisted No. 10	2½	10.0c	147	222	28 in. above 30 in. above 42 in. above	26.9c	Mixture gave way, wires not well placed.
4 long and 2 short twisted strands No. 10	3	12.0c	237	322	8 in. below 7 in. below 11 in. below	28.9c	Mixture and wires about equal strength.
4 long straight wires hooked at ends No. 6	2⅔	10.6c	170	222	Ground Line 3 in. below	27.5c	Wires slipped
4 long old barbed wires	1⅔	3.3c	70	95	Ground Line 3 in. below 5 in. below	20.2c	Wires broke, they were poorly placed.
4 long and 2 short old barbed wire	2	4.0c	98	127	18 in. above 20 in. above 13 in. above	20.9c	Wires broke. Poor wire.
4 long and 2 short new barbed wire	2	8.0c	138	172	20 in. above 19 in. above 12 in. above	24.9c	Wires well placed. Cement broke.
4 long strands of 3 twisted wires No. 14	1⅔	6.6c	68	105	Ground Line Ground Line 3 in. below	23.5c	Wires broke.

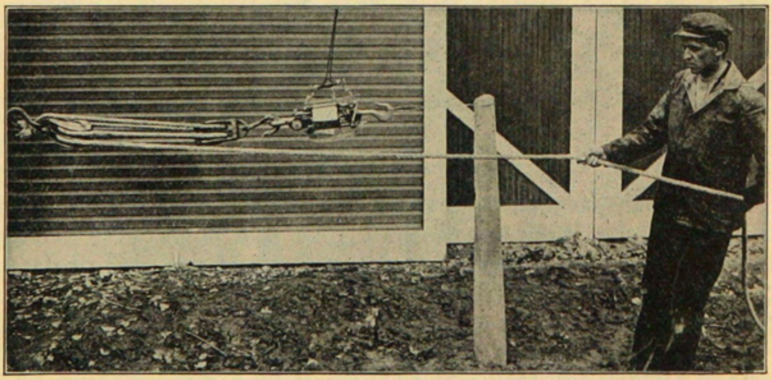

Figure 7.

Method Which Was Used in Testing All Line Posts.—The distance from the ground line to the point at which the hitch was made is four feet. The dynamometer records the exact number of pounds of pull required to break the post.

In making the posts, enough of the mixture was provided for the construction of three posts at once. The three were cured alike, for 60 days and were tested at the same time. The tables show the average results of the test on the three posts as one.

In the reinforcement the short wires mentioned are two feet long and are placed in the post so the top extends about 12 inches above the ground line and the bottom about 12 inches below. One of these extra wires is placed in the face side of the post and the other in the back, so that they help to bear the strains on the post.

In case of four extra wires, one is placed in each corner of the post with the other reinforcement wires.

Cost of Materials.—In figuring cost of materials the following prices were used:

Sand and gravel, $1.00 per cubic yard.
Cement, 60 cents per sack.
New reinforcement, 4 cents per pound.
Old barbed wire, 2 cents per pound.

TABLE NO. 4—Tamped Posts.

These posts are of the same size and composition as those in Table No. 3, excepting they are tamped instead of poured.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post in Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Material in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 long strands of 2 wires twisted, No. 10	2½	10.0c	122	192	Ground Line Ground Line 2 in. above	26.9c	Wires broke
4 long straight strands, No. 6	2⅔	10.6c	103	162	Ground Line Ground Line	27.5c	Wires slipped
4 long strands old barbed wire	1⅔	3.3c	117	137	14 in. above 30 in. above Ground Line	20.2c	Wires broke
4 long and 2 short old barbed wire.	2	4.0c	122	142	12 in. above 12 in. above 13 in. above	20.9c	Wires broke
4 long new barbed wire	1⅔	6.6c	140	160	Ground Line Ground Line Ground Line	23.5c	Wires broke
4 long and 2 short new barbed wire.	2	8.0c	80	170	11 in. below 16 in. above 13 in. above	24.9c	Wires not well placed
4 long and 4 short old barbed wire.	2¾	5.5c	112	196	18 in. above 8 in. below 24 in. above	22.4c	One post broke 8 in. below also 23 in. above Gr. L.

TABLE NO. 5—Poured Posts.

Size, 5x5 inches from base to ground line, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 110 to 112 pounds. Mixture, 1 part cement and 5 parts sand, by measure. Cost for cement per post, 17 pounds, 10.2 cents; sand, 1 cubic foot, 3.7 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Material in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 strands 2 twisted wires, No. 10.	2½	10.0c	197	235	2 in. below Ground Line 4 in. above	23.9c	Mixture broke. Reinforcement wires poorly placed
4 long and 2 short twisted strands No. 10	3	12.0c	197	220	3 in. below 5 in. below Ground Line	25.9c	Extra wires did no good. Mixture broke.
4 long strands old barbed wire	1⅔	3.3c	95	113	Lost 1 in. below 7 in. below	17.2c	Wires broke, not well placed.
4 long and 2 short old barbed wire	2	4.0c	97	137	4 in. above 10 in. above 7 in. below	17.9c	Mixture and wires about equal strength
4 long strands new barbed wire	1⅔	6.6c	78	123	2 in. below 16 in. above 4 in. above	20.5c	Mixture and wires about equal strength.
4 long and 2 short new barbed wire	2	8.0c	75	140	10 in. above 8 in. above 18 in. above	21.9c	Wires broke
4 long strands of 3 twisted wires No. 14.	1⅔	6.6c	103	130	Ground Line 2 in. below 3 in. below	20.5c	Wires broke
4 long and 2 short strands 3 twisted No. 14	2	8.0c	103	175	14 in. above 13 in. above 14 in. above	21.9c	Wires and mixture about equal strength

TABLE NO. 6—Poured Posts.

Size, 4x4 inches at base, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 80 pounds. Mixture, 1 part cement and 4 parts sand, by measure. Cost for cement, 13.5 pounds, 8.1 cents; sand, ⅔ cubic foot, 2.5 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 strands of 2 twisted wires No. 10	2½	10.0c	80	168	2 in. below Ground Line Ground Line	20.6c	Mixture broke on two posts, wires broke on the other
4 long strands old barbed wire	1⅔	3.3c	50	65	5 in. above Ground Line 3 in. above	13.9c	Wires broke
4 long strands new barbed wire	1⅔	6.6c	82	88	Ground Line 6 in. below Ground Line	17.2c	Wires broke on one and mixture on two posts.
4 long strands of 3 twisted wires No. 14.	1⅔	6.6c	58	62	2 in. below Ground Line 5 in. above	17.2c	Wires broke. Mixture broke on one post.

TABLE NO. 7—Tamped Posts.

These posts are of the same size and composition as those in Table No. 5, excepting they are tamped instead of poured.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 strands of 2 twisted wires No. 10	2½	10.0c	75	97	6 in. below 8 in. above 8 in. below	23.9c	Mixture gave way, posts split.
4 long and 2 short twisted strands No.10	3	12.0c	73	98	2 in. below 3 in. below	25.9c	Mixture gave way, posts split.
4 long strands old barbed wire	1⅔	3.3c	88	117	4 in. below 2 in. above Ground Line	17.2c	Wires broke
4 long and 2 short old barbed wire	2	4.0c	77	113	13 in. above 15 in. above Ground Line	17.9c	Mixture and wire about equal, one wire poorly placed
4 long strands new barbed wire	1⅔	6.6c	60	108	1 in. below Ground Line Ground Line	20.5c	Mixture and wires nearly equal strength.
4 long and 2 short new barbed wire	2	8.0c	47	103	12 in. above 16 in. above Ground Line	21.9c	Wires in 2 posts poorly placed.

TABLE NO. 8—Poured Posts.

Size, 4x4 inches at base, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 80 pounds. Mixture, 1 part cement and 3 parts sand, by measure. Cost for cement, 18 pounds, 10.8 cents; sand, ⅔ cubic foot, 2.5 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 strands of 2 twisted wire No. 10	2½	10.0c	162	183	Ground Line Ground Line Ground Line	23.3c	Mixture and wires about equal strength.
4 long strands old barbed wire	1⅔	3.3c	73	108	2 in. below 2 in. above 2 in. below	16.6c	Wires broke
4 long strands new barbed wire.	1⅔	6.6c	82	105	4 in. below 2 in. above Ground Line	19.9c	Wires broke
4 long strands of 3 twisted No. 14	1⅔	6.6c	78	102	Ground Line Ground Line Ground Line	19.9c	Wires broke
4 long, 2 short strands of 3 twisted No.14	2	8.0c	162	185	10 in. above 12 in. above 4 in. below	21.3c	Wires broke
(Specials) 4 long twisted strands No.9.	2¾	11.0c 11.0c	140 cracked	140 125	Ground Line Ground Line	24.3c 24.3c	These posts were secured from the manufactu'r.

TABLE NO. 9—Poured Posts.

Size, 5x5 inches from base to ground line, tapering to 3x3 inches at top. Length, 6 feet 6 inches. Cured weight, 115 to 120 pounds. Mixture, 1 part cement 3 parts sand and 3 parts gravel, by measure. Cost of cement per post, 14 pounds, 8.4 cents; sand and gravel, 1 cubic foot, 3.7 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
4 strands of 2 wires twisted No. 10	2½	10.0c	177	218	Ground line Ground line 4 in. below	22.1c	Wires broke on 2 and mixture broke on one.
4 long and 2 short twisted strandsNo. 10	3	12.0c	188	330	4 in. above 12 in. above 4 in. below	24.1c	Wires broke
4 long strands old barbed wire	1⅔	3.3c	88	110	Ground line Ground line Ground line	15.4c	Wires broke
4 long and 2 short old barbed wire	2	4.0c	70	118	20 in. above 24 in. above 15 in. above	16.1c	Wires broke, not well placed.
4 long strands new barbed wire	1⅔	6.6c	103	143	4 in. below Ground line Ground line	18.7c	Wires broke
4 long and 2 short new barbed wire	2	8.0c	115	123	Ground line 3 in. above 10 in. above	20.1c	Wires broke
4 long strands of 3 twisted wires, No. 14	1⅔	6.6c	102	123	Ground line 27 in. above Ground line	18.7c	Wires broke
4 long 2 short strands of 3 twisted No. 14	2	8.0c	85	143	Ground line 7 in. below 4 in. below	20.1c	Mixture broke on two and wires broke on one.

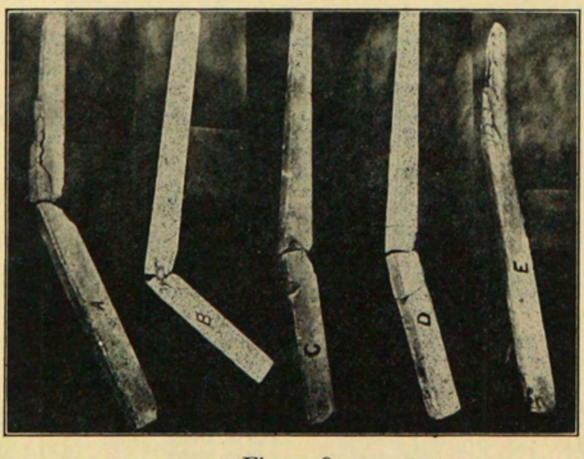

Figure 8.

A few types of broken posts showing: (A) The splitting off of the tamped post. (B) The bursting due to the buckling of the tube of a commercial truss. (C) A post in which mixture and reinforcement were about equal. (D) A post in which smooth wire reinforcement was used, the wires slipped, thus allowing the post to bend. (E) Post removed from mold too soon.

TABLE NO. 10—Poured Posts.

Made in sheet iron mold, which makes a post round on one side and flat on the other. Size 5x5 inches at base, tapering to 3x3 inches at top. Length, 7 feet. Cured weight, 75 to 80 pounds. Mixture, 1 part cement and 3 parts sand by measure. Cost for cement per post, 18 pounds, 10.8 cents. Sand, ⅔ cubic foot, 2.5 cents. For cost of reinforcement, see table below. The reinforcements in this post are supposed to be placed in three places, two next to the flat side and one on the oval side of the post. This makes the flat side stronger. In the test, one post of the three was pulled away from the flat side toward the round side, and two from the round side toward the flat side.

Those marked (a) were pulled away from flat side, and (b) towards it.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
3 long No. 19 ⅝ in. band iron	2¼	9.0c	135 (a) 120(b)	190(a) 125(b)	Ground line Ground line	22.3c	Posts from manufacturer, band iron broke.
3 long strands of 2 wires twisted No.10	1⅞	7.5c	85(b) 95(b) 125(a)	125(b) 135(b) 180(a)	Ground line 3 in. below Ground line	21.8c	Wires broke
3 long strands old barbed wire	1¼	2.5c	70(b) 65(b) 70(a)	70(b) 80(b) 105(a)	Ground line Ground line Ground line	15.8c	Wires broke
3 long and 3 short old barbed wire	2	4.0c	100(b) 120(a) 100(b)	115(b) 155(a) 110(b)	18 in. above 12 in. above 20 in. above	17.3c	Wires broke above extras
4 long strands old barbed wire	1⅔	3.3c	crack'd 85(a) 125(b)	120(b) 125(a) 155(b)	2 in. above 1 in. below Ground line	16.6c	Wires broke
4 long and 4 short old barbed wire	2¾	5.5c	120(b) 115(a) 120(b)	165(b) 120(a) 160(b)	15 in. above 14 in. above 7 in. above	18.8c	Mixture broke
4 long strands, 2 each, twisted No. 10	2½	10.0c	130(b) 180(b) 150(a)	175(b) 230(b) 200(a)	Ground line Ground line Ground line	23.3c	Mixture broke

The last 3 sets of posts contained 4 reinforcements instead of 3. It will be noticed that the one extra wire made a great difference in the strength of these posts; they are more nearly equal strength from both directions.

AMOUNT OF LABOR REQUIRED FOR MAKING POSTS.

No definite statements can be made as to the amount of time required to make a cement or concrete fence post. The amount of time will vary with conditions, handiness of materials, methods of mixing, etc. According to data obtained in the experiment, two men mixing by hand, with everything reasonably handy, can make from three to five 5-inch poured line posts per hour. Figuring labor at $2.00 per day, ten hours for each man, the cost for making a post would amount to about 10 cents each. Three men with a small home made mixer and a two-horse-power gasoline engine for driving it would be able to make at least twice as many posts as two men working by hand and the cost for making would be very much less.

TABLE NO. 11—Poured Posts (Triangular).

These are triangular posts made in triangular sheet iron molds. Size, 7 inches on each side at the bottom, tapering to 5 inches on each side at the top. Length, 6 feet 6 inches. Cured weight, 85 pounds. Mixture, 1 part cement and 3 parts sand, by measure. Cost for cement per post, 19 pounds, 11.4 cents. Sand, ⅔ cubic feet, 2.5 cents. For cost of reinforcement, see table below. In the test, one post of the three was pulled away from the flat side towards the opposite corner and is marked (a); the other two were pulled from one corner towards the opposite flat side and are marked (b).

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Materials in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
3 long strands new barbed wire	1¼	5.0c	65(b) 90(a) 70(a)	100(b) 90(a) 105(a)	2 in. below 2 in. above 2 in. below	18.9c	Wire broke Mixture crushed Mixture crushed
3 long and 3 short old barbed wire	1¾	3.5c	45(b) 35(b) 30(a)	50(b) 55(b) 100(a)	15 in. above 15 in. above 15 in. above	14.9c	Wires broke Wires broke Mixture crushed
6 long old barbed wires 2 in each corner	2¼	4.5c	80(b) 110(b) 130(a)	120(b) 190(b) 130(a)	2 in. above 2 in. below 2 in. below	15.9c	Wires broke Wires broke Mixture crushed
3 long No. 14 3 strands twisted	1¼	2.5c	70(b) 85 a)	90(b) 145(a)	4 in. above 4 in. below	13.9c	Wires broke Mixture crushed
4 long new barbed wires*	1⅔	6.6c	110(b) 75(a)	135(b) 85(a)	Ground line 6 in. above	18.0c	Mixture split Mixture crushed
4 long No. 14 3 strands twisted	1⅔	6.6c	165(b) 160(b) 115(a)	175(b) 180(b) 140(a)	Ground line Ground line Ground line	18.0c	Mixture crushed Wires broke Mixture crushed
4 long No. 15 3 strands twisted	1⅛	4.5c	130(b) 130(b) 105(a)	150(b) 175(b) 105(a)	Ground line Ground line 1 in. above	15.9c	Wires broke Wires broke Mixture crushed

THE EFFECT OF ALKALI ON CEMENT AND CONCRETE POSTS.

It has been found that some soils contain an excessive amount of alkali, which has a tendency to destroy concrete work. While no experimental work has been done to test the effect of such soils upon cement or concrete posts, it has been conclusively proven that cement drain and sewer tiles which come in contact with water which has percolated through these alkali soils are soon destroyed.

While it might be possible that the action on cement or concrte posts would be slower than in case of the tiles, it is probable that the posts would eventually be destroyed.

For further information in regard to the effect of alkali on cement construction see Bulletin No. 69 of the Montana Agricultural College Experiment Station, and Bulletin No. 132, Agricultural Experiment Station of the Colorado Agricultural College.

*Where 4 wires are used for reinforcement, the extra wire is placed in the corner opposite to the side on which the fence wires are fastened.

TABLE NO. 12—Poured Posts.

These posts were made in special sheet iron lined wood molds put out by a certain manufacturer. The reinforcement recommended for these posts is a special trussed tube, which is sold by the manufacturer at 15 cents each at the factory. The results of the test on three posts in which this truss was used is shown below in connection with other similar posts with wire reinforcement. Size of post, 3½x4½ inches at base, tapering to 3½x3½ inches at the top. Length, 6 feet 6 inches. Cured weight, 80 pounds. Mixture, 1 part cement and 3 parts sand, by measure. Cost of cement per post, 18 pounds, 10.8 cents. Sand, ⅔ cubic foot, 2.5 cents. For cost of reinforcement, see table below.

REINFORCEMENT			TEST			COST	REMARKS
Kind of Wire	Weight Per Post Lbs.	Cost Per Post	First Crack in Lbs.	Final Break in Lbs.	Location of Break Above or Below Ground Line	Cost of Material in Post	New Wire is Figured at 4c per Lb. and Old Wire at 2c per Lb.
Special Commercial Trussed Tube	3, 6-oz.	15.0c	105	150	Ground line Ground line Ground line	28.3c	In every case trussed tube bent caused post to crack.
4 long strands new barbed wire	1⅔	6.6c	130	137	Ground line Ground line Ground line	19.9c	Wires broke. Wires poorly placed in one post.
4 long strands 3 twisted No; 14 wires	1⅔	6.6c	75	107	1 in. below 1 in. below Ground line	19.9c	Wires broke. Wires poorly placed in one post.
4 strands of 2 wires twisted No. 10	2½	10.0c	110	160	3 in. below Ground line 2 in. below	23.3c	One wire broke in each post.

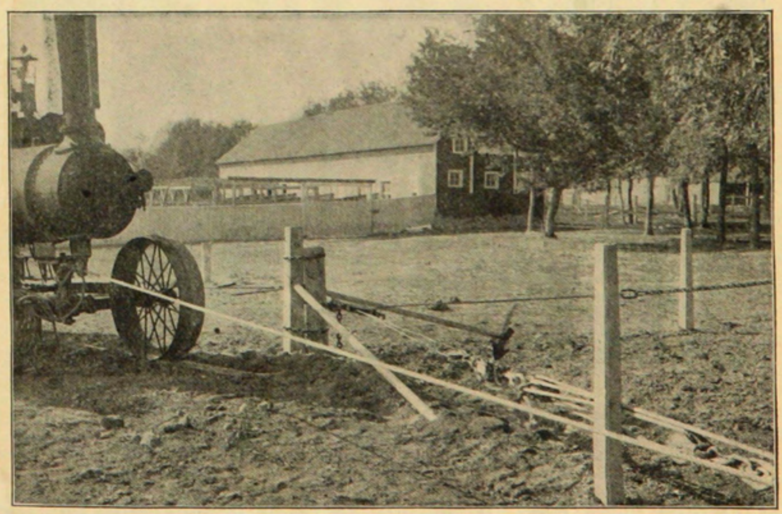

Figure 9.

A 7-inch corner post braced with a 2-inch gas pipe 14 feet long; 5-inch brace post. The exact number of pounds of pull exerted by each of the two fences is recorded by the dynamometer shown under the arrow.

THE THREE-CORNERED POST.

The three-cornered post, which is advocated to some extent, does not have as many points in its favor as it may seem. In the first place an equal amount of reinforcement in each corner of the post cannot make a post of equal strength from two opposite directions. If a force is brought to bear against one of the flat sides of the post towards the opposite corner, the material in the corner will crush long before the wires will break on the side from which

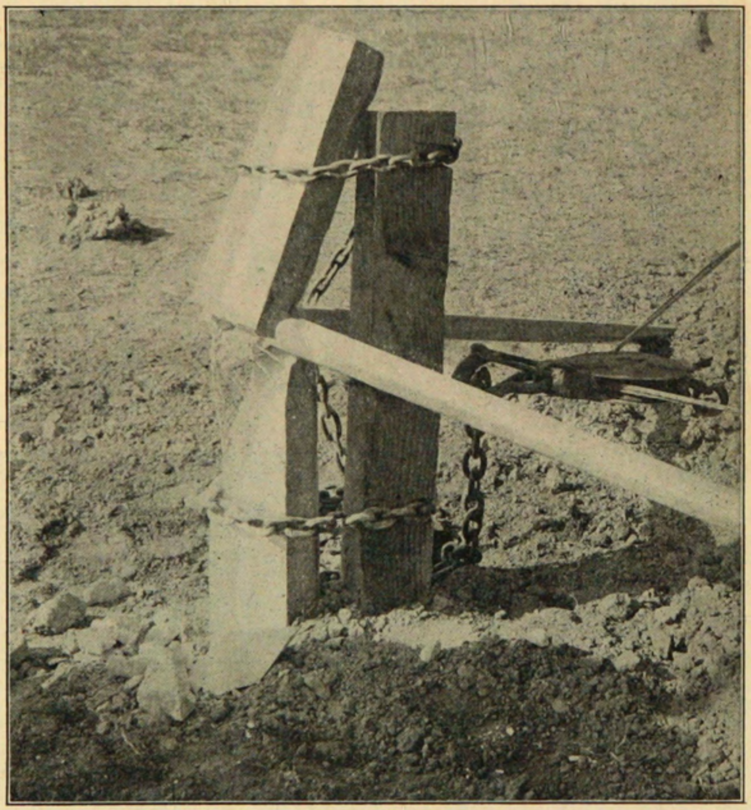

Figure 10.
The post shown in Fig. 9 after the test. Two-fifths of the pressure is exterted above the brace and three-fifths below.

the force is exerted. On the other hand, if a force is brought to bear against one corner of the post towards the opposite flat side, the single reinforcement in the corner will break before the mixture has begun to crush on the flat side.

An extra reinforcement in the corner on which the force is exerted towards the opposite flat side will make it practically as strong as the flat side. But when the force is again applied to the flat side towards the single corner which is doubly reinforced, the mixture in the corner gives way too soon and it is no better than with but a single reinforcement.

TABLE NO. 13—Corner Posts.

Size, 8x8 inches from base to ground line, tapering to 5x5 inches at top. Length, 8 feet. Cured weight, 360 pounds. Mixture, 1 part cement, 2 parts sand, and 3 parts of gravel, by measure. Cured 90 days. Cost for cement per post, 51 pounds, 30.6 cents; sand and gravel, 3 cubic feet, 11.1 cents. For cost of reinforcement, see table below. Test shows pull exerted in pounds as by each of two fences pulling at right angles.

REINFORCEMENT			TYPE	TEST			COST	REMARKS
Kind of Reinforcement	Weight Per Post Lbs.	Cost Per Post	Poured or tamped	First Crack in Lbs.	Final Break in Lbs.	Location of Break	Cost of Material per Post	All reinforcements figured at 4c Lb. excepting old barbed wire at 2c.
2-8 ft. and 2-5 ft. pieces ½ in. rod on tension side	16	64c	poured	7200	8500	at brace	$1.057	Short wires extended from below ground line to above brace line
Same as above	16	64c	tamped	5050	5600	at brace	1.057	Short wires extended from below ground line to above brace line
14 strands old barbed wire on tension side.	8	16c	tamped	6300	7300	at brace	.577	Mixture broke
Same as above	8	16c	poured	5900	7400	at brace	.577	Mixture broke
10 twisted strands No.10 on tension side	8	32c	tamped	5400	7300	4 in. below brace	.737	Mixture broke
Same as above	8	32c	poured	6300	6650	4 in. above brace	.737	Mixture broke

Size, 7x7 inches at base, tapering to 5x5 inches at top. Length, 8 feet. Cured weight, 250 pounds. Mixture, 1 part cement, 2 parts sand and three parts gravel, by measure. Cured 90 days. Cost of cement per post, 36 pounds, 21.6 cents; sand and gravel, 2 cubic feet, 7.4 cents. Fort cost of reinforcement, see table below.

REINFORCEMENT			TYPE	TEST			COST	REMARKS
Kind of Reinforcement	Weight Per Post Lbs.	Cost Per Post	Poured or tamped	First Crack in Lbs.	Final Break in Lbs.	Location of Break	Cost of Material Per Post	All reinforcements figured at 4c Lb. excepting old barbed wire at 2c.
8 strands old barbed wire 2 in each corner	4½	9c 2c lb.	poured	2700	3600	at braces	$ .38	Mixture broke
8 strands new barbed wire 2 in each corner	4½	18c 4c lb.	poured	3225	4050	at braces	.47	Mixture broke

HOLLOW POSTS.

It has been suggested that the cement and concrete posts should be made hollow. The hollow post would require less mixture and it would also be lighter. As the material in the center of the post does not have a good opportunity to act to the best advantage in compression, it is argued that the strength of the hollow post would be nearly as great as that of the solid post.

In case time is of little value it would probably prove more economical to build hollow posts. As the amount of reinforcement is not affected by the change from the solid to the hollow post, only the saving in cement, sand and gravel need be considered. It is an easy matter to compute the saving accomplished by the making of hollow posts, and then by knowing the cost of labor, the economy of building them may soon be calculated. With cement at 55 cents per sack and sand at $1.00 per yard, one cubic foot of 1 to 4 mixture costs 18 cents. If a 1½ inch hole were to be left in the center of a post 7 feet long about 1½ cents' worth of material would be saved. With labor at 15 cents per hour, 6 minutes might be given to the extra work of making the post with the hollow core.

In case of alkali soils the hollow center gives additional exposed surface upon which the alkali may act. In a 4-inch square post with a 1½ inch core, the extra surface amounts to about 28 per cent. of the original lateral surface.

Finally there is a serious question as to the relative strength and durability of the hollow post as compared with the solid one.

CORNER POSTS AND GATE POSTS.

In the building of a fence with cement or concrete posts, the corner and gate posts must be especially strong, so as to prevent the pull of the wires coming upon the line posts. All the pull of the wires should be borne by the corner or gate posts. With this in mind the designer should aim not only to build a very strong post, but the system of bracing should receive special attention.

As the cement posts are not as strong as wood posts, we cannot use the same bracing systems, which are so commonly in use in wood post fence construction. It has been found advisable to place the brace so that it supports the post at a point very little, if any, above the middle of the post. For the reason that the posts are strong in compression, but do not stand as much pull as wood posts, it proves advisable to place the brace against the brace post at least one foot below the ground line; thus the post distributes the pressure at the end of the brace against an area of ground equal to the surface covered on the opposite side of the post.

There should be several wires connecting the brace post and the corner or gate post together. These wires should be placed under the ground at a depth of about one foot. By having these wires tight the corner post cannot move unless the brace post moves, and as this is securely fastened to it, the whole becomes a unit, offering a rigid resistance to the pull of the fence.

In case of a corner post, the wires may be fastened by wrapping them around it, but the most satisfactory way is to cast wire staples in the post. These staples should extend into the post far enough to be wrapped around one or more of the reinforcement wires.

The hinges for gates may also be cast in the posts when it is desired to do so.

Corner and gate posts are usually reinforced in the same way as line posts. It is unnecessary, however, to place reinforcement wires on the inner sides of the corner posts, as the outer sides bear almost all of the tension.

With the tapered posts, it is desirable to construct the face sides straight; this brings all of the taper on the other two sides. Small lugs or shoulders should be cast on each brace side of the post, against which the brace is placed.

The ordinary five-inch line post proves to be strong enough to act as a brace post for an eight-inch corner post.

The following table gives a summary of breaking strength and cost of materials of some of the best poured posts, which were made and tested in this experiment.

MIXTURE	DESCRIPTION	REINFORCEMENT								
		4 Long No. 10 Twisted	4 long 2 short No. 10 twisted.	4 long New Barbed Wire	4 long Old Barbed Wire	4 long 2 short new barbed	4 long 2 short Old Barbed	3 long No. 19 $\frac{5}{8}$ in. band iron	4 long 4 short Old Barbed	6 long Old Barbed
1 to 3	Ground line 5x5 top 3x3	307 lbs. 29.9c	290 lbs. 31.9c	188 lbs. 26.5c	158 lbs. 23.2c	none none	200 lbs. 23.9c			
1 to 4	Ground line 5x5 top 3x3	222 lbs. 26.9c	322 lbs. 28.9c	none none	95 lbs. 20.2c	172 lbs. 24.9c	127 lbs. 20.9c			
1 to 5	Ground line 5x5 top 3x3	235 lbs. 23.9c	220 lbs. 25.9c	123 lbs. 20.5c	113 lbs. 17.2c	140 lbs. 21.9c	137 lbs. 17.9c			
1 to 3	Base 4x4 top 3x3	183 lbs. 23.3c	none none	105 lbs. 19.9c	108 lbs. 16.6c					
1 to 4	Base 4x4 top 3x3	168 lbs. 20.6c	none none	88 lbs. 17.2c	65 lbs. 13.9c					
1 to 3-3	Ground line 5x5 top 3x3	218 lbs. 22.1c	230 lbs. 24.1c	143 lbs. 18.7c	110 lbs. 15.4c	123 lbs. 20.1c	118 lbs. 16.1c			
1 to 3	Base 5x5 top 3x3 horse shoe shape	202 lbs. 23.3c			133 lbs. 16.6c			157 lbs. 22.3c	148 lbs. 18.8c	
1 to 3	Triangular Base 7x7 top 5x5			110 lbs. 18.0c						147 lbs. 15.9c

Strength of Cement posts compared to new wood posts tested under like conditions.

KIND OF POST	SIZE OF POST	BREAKING STRENGTH	REMARKS
(1) Best cement post tested	5x5 in. at ground line tapering to 3x3 in. at top	av. of three 322 lbs.	
(2) Cement	Same as above	av. of three 307 lbs.	
(3) Cement	4x4 in. at base tapering to 3x3 in. at top	av. of three 185 lbs.	The post was 3.6x 3.6 in. at ground
(4) Split cedar (new)	3.6x3.6 in. at ground line	av. of three 613 lbs.	Same size at ground as No. 3 above
White pine (new)	4x4 in. at ground line	2000 lbs.	
Red spruce (new)	4½x4½ in. at ground line	2400 lbs.	
Red spruce (new)	5x5 in. at ground line	3350 lbs.	

CONCLUSIONS.

Poured posts are easier to make than tamped ones. They are somewhat more expensive because one mold will make but one poured post per day, while the same mold may be used for making as many tamped posts as the builder can mix and tamp in the same time.

According to the tests made poured posts are a little over 25 per cent stronger than tamped ones of the same size, mixture and reinforcement.

Poured posts are not so porous as the tamped ones and are therefore more nearly water proof, thus making them better able to withstand the action of frost and alkali.

The poured post is enough better in every respect to justify its construction and use in preference to the tamped one.

Most commercial molds make a post which tapers from the base to the top, but the most economical mold is one which casts a post as large at the ground line as at the base, tapering from the ground line to the top. For a description of this form of mold, see Fig. 4.

The best form of post is one which is equally strong from all directions. The square, or round post, fulfills this requirement. The triangular post does not meet the requirements because it cannot be economically constructed so as to be equally strong from all directions.

To be economical, the amount of reinforcement should be in proportion to the size of the post and strength of the mixture. See tables.

The material used for reinforcement should be strong, light and rough enough to permit the mixture to get a firm grip upon it. It should be very rigid, with little or no tendency to spring or stretch.

The smooth reinforcement tends to slip even if hooked at the ends.

Two or more wires twisted together make as satisfactory a reinforcement as can be obtained.

Crimped wire tends to strengthen and thereby breaks pieces out of the post at the point of greatest stress.

The reinforcement should be placed in each corner of the post at a depth of from ⅝ to ¾ of an inch from the surface.

There are several commercial wire fasteners now found on the market, the most of which are either cumbersome or expensive. For a simple and satisfactory fastener, see cut of fasteners. (Fig. 5, A.)

The posts should be cured in the shade for at least 60 days, the first 30 days of which they should be sprinkled daily.