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Silos

Questions and Answers

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Questions and Answers

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1. Why do I need a silo? Because it will pay; it supplies the cheapest winter feed, and keeps up the milk flow when prices are highest.

Because your dairy cows, cattle, and sheep will relish the preserved succulence from these big "Mason jars." Cows like silage for the same reason that you like canned fruit better than dried apples. Your corn crop is worth from 25 to 30 per cent more when put in a silo than when fed in the form of fodder. Cows waste fodder, but eat all the silage.

When early frosts threaten, the silo saves the soft corn and prevents a feed shortage.

About 60,000 of your Wisconsin farm neighbors know that a silo is a profitable investment. If it pays them, it will pay you.

2. What kind of a silo shall I build? It all depends on what materials are most available where you live, and the relative costs of keeping it up. No one silo type can be called the best type, but every silo must have certain features to successfully preserve stock feed.

3. What is the cheapest silo? That, too, depends on the availability of the materials. If there is a sand and gravel pit in your neighborhood, a concrete silo will probably be the cheapest. In other places, wood, brick, cement block, or tile may be the cheapest form of silo for you.

4. How much will it cost? Maybe $100, or $500. It all depends on the amount of stock on your place, the size you need, and on your foresight in putting up buildings that will last.

5. Why should my silo be round? Round silos are more easily reenforced to withstand the bursting pressure. The round shape has no corners for air pockets, making it possible to pack the green succulent feed as tightly as preserves in a Mason jar.

Smooth walls, plumb from top to bottom, decrease the possibility of air pockets.

6. How strong should the walls be? The silo wall must be reenforced to withstand the bursting pressure of silage, which is outward in all directions, but of course much greater at the bottom than at the top.

7. Should I try to build a frost-proof silo? In this climate it is difficult and expensive to construct a silo absolutely frost-proof. Yet much freezing will be prevented by locating the silo on the protected side of the barn. During extreme cold weather all doors and windows should be closed and the silage kept covered.

8. What is the warmest silo? The double-wall silo which has little, or no, material connecting the outside and the inside wall, will be warmest. There is very little difference in temperature between a so-called hollow block wall, as they are generally made, and a solid wall of the same material.

9. Why is a good roof a necessity? Most of the freezing in a silo comes from the top. If the doors are kept closed, and the silage is covered during the coldest weather, freezing will not be serious.

10. Should a silo be wide or high? The tower type is better than the short, squatty type. Build the silo not less than 30 feet high. In a well-proportioned silo the height is 2½ to 3 times the diameter.

Some silage spoils at the top of any silo, showing that weight and exclusion of air are necessary to the making of good silage. As silage is very heavy, the greater its depth, the more silage can be packed into a given space.

It is not safe to build certain types of silos too high, on account of the wind pressure, the walls not having the strength to resist crumpling. Masonry silos of almost any height can be built.

11. How far below the barn floor level should the silo go? From four to six feet. If the silo goes lower than this, it takes too much labor to remove the silage. From 4 to 6 feet is below the frost line and the soil then affords a good footing for the structure.

12. How can I keep the silage from molding? Construct the silo so that it has ample capacity but so that at least two inches can be fed off each day. The exact size depends on the

amount of stock. Some cows will eat 25, others 40 pounds, the average ration being about 30 pounds a day.

TABLE I.—RELATION OF SIZE OF SILO TO AMOUNT OF SILAGE TO BE USED DAILY

Number of cows	Silage for 180 days at 30 lbs. per day	Acres of corn at 15 tons per acre	SIZE OF SILO		Silage for 240 days at 30 lbs. per day	Acres of corn at 15 tons per acre	SIZE OF SILO	
			Inside diameter	Depth of silage			Inside diameter	Depth of silage
	Tons	Acres	Feet	Feet	Tons	Acres	Feet	Feet
10	27	½ to 2	10	20	36	2 to 3	10	25
15	40	3 to 3½	10	28	54	3½ to 4	10	33
20	54	3½ to 4	10	34	72	4½ to 5	12	32
23	68	4 to 5	12	30	90	6	12	36
30	81	5 to 6	12	34	108	7 to 8	14	34
35	95	6 to 7	14	31	126	8 to 9	14	38
40	108	7 to 8	14	34	144	9 to 10	14	41
45	122	8 to 9	14	37	162	10 to 11	16	37
50	136	9 to 10	14	40	180	11 to 12	16	40

The depth indicated in the table is the actual depth of the silage after settling and not the depth of the silo wall. To secure a given capacity it is therefore necessary to build the silo about 5 feet higher than the depth given to allow for settling.

TABLE II.—CAPACITY OF SILOS

Depth of silage feet	INSIDE DIAMETER OF SILOS IN FEET						
	10	12	14	16	18	20	22
	Tons	Tons	Tons	Tons	Tons	Tons	Tons
24	34	49	67	86	110	.....	.....
26	38	55	71	97	123	.....	.....
28	42	61	83	108	127	170	205
30	47	68	93	120	150	187	226
32	51	73	101	136	166	205	248
34	55	80	109	147	180	223	269
36	.....	82	112	158	194	230	290
38	.....	89	122	169	208	249	301
40	.....	96	181	180	222	268	324
42	.....	.....	140	191	237	286	346
44	.....	.....	149	202	251	305	369
46	.....	.....	158	213	265	324	391

13. Is it wise to build a silo in the barn? There is no advantage in having the silo in the barn. In most types of construction, as far as the silo itself is concerned, the walls do not need

protection. A silo takes up a lot of very valuable space inside the barn and usually is very unhandy to fill.

If placed next to the barn, the labor required to handle the silage will be very little, if any, more than inside. In round barns only will the silo be most convenient in the center of the barn.

14. What kind of a foundation shall I build? Because of the weight of the material which it contains, a silo must be placed on a good foundation. It should be broad enough to prevent any noticeable settling. In masonry types of construction the foundation is usually a continuation of the wall.

15. What is good way to mark out the silo foundation? The best method is first to mark out on the surface of the ground the exact location as shown in Figure 1.

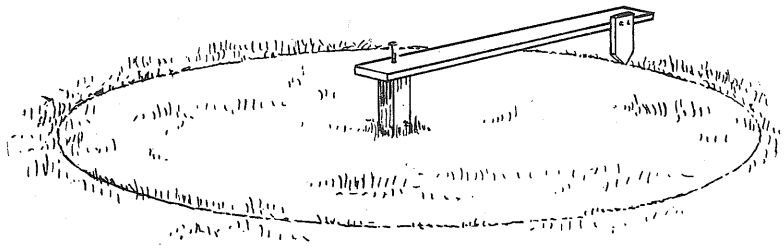

FIG. 1.—METHOD OF LAYING OUT FOUNDATION

This simple device enables one to lay out quickly and accurately the excavation for the footings.

16. Is it all right to dig a trench and pour in concrete? This is not a good practice unless the soil is firm. If a form is not available, the trench can be lined with building paper to prevent the concrete from coming in contact with the dirt. Where the concrete comes in contact with the soil, it becomes hard to plaster. If the soil is to be excavated afterwards, it is much better not to attempt to use the soil for the inner form.

17. What other materials can be used for the foundation? Well burned brick or clay blocks if laid in cement mortar. If clay blocks are used, either good drainage should be provided to prevent the blocks from filling with water, else they can be set on end, and filled with concrete.

18. How wide should a concrete foundation be? The width of the bottom of the foundation wall for a concrete silo should be from 10 to 12 inches on silos from 30 to 50 feet in height on

any kind of soil, except very soft clay or quick sand when a 16 to 24 inch base is needed.

19. Why have a concrete floor? It saves silage because it makes the part below ground more nearly waterproof. The very bottom layer of silage on a good concrete floor is usually perfect. In non-porous soils like heavy clay where the silo foundation extends far enough below the surface of the ground so that the danger of rats undermining the floor is avoided, it is not so essential.

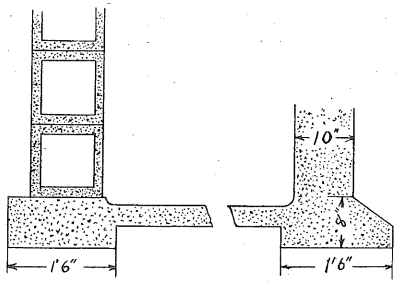

FIG. 2.—TYPICAL FOOTINGS FOR MASONRY SILOS

A good concrete footing insures even settlement of the silo, thus preventing cracks.

20. Does a silo need a ventilator? For a few days following filling a door or window at the top needs to be left open for ventilation. It is true that carbon dioxide gas does collect in a silo, but it is not dangerous in silos built above ground. As this gas is heavier than air and as it only collects directly after filling, this is the only time there is any danger. To be absolutely safe, however, it is advisable to run the ensilage cutter for a few minutes before entering the silo.

21. Where is a King type of Wisconsin silo advisable? In the northern part of the state where short lengths of lumber can be secured at reasonable rates direct from the lumber mills.

22. How is the King silo built? It originally consisted of a sill made by cutting 2 x 4's into two-foot lengths and placing them on the foundation as a double thickness. The sill may be made also by cutting them out of 6 or 8-inch plank, sawing them to the curvature of the silo. Studding made of 2 x 4″ are placed one foot apart on this circular sill. The lining on the inside, as shown in Figure 3, consists of three layers of ⅜″ boards bent and nailed to the studding with a layer of water-proof building paper between each layer. On the outside is nailed ⅜″ sheeting, a layer of paper, and then any form of siding which can be bent to a circle. This type of silo can be a homemade product.

23. What lining is preferable for King silos? From the experience of owners it has been found that the wood lining soon

rots, out. Cement, plaster on metal or wood lath are very satisfactory. Lath and cement plaster on the outside are also more satisfactory than siding.

24. What materials are needed for King type silos? For a 14 x 26′ silo it will require 44 pieces of 2 x 4 studding, and 88 board feet of 2 x 6 for sill plate; for inside and outside lath, 2,400 square feet; for plastering, it will require 28 barrels of cement, and 8 cubic yards of sand, and 6,000 board feet of sheeting.

25. What about the wood stave-silo? It is unquestionably the most common silo in use. A wood silo can be easily and

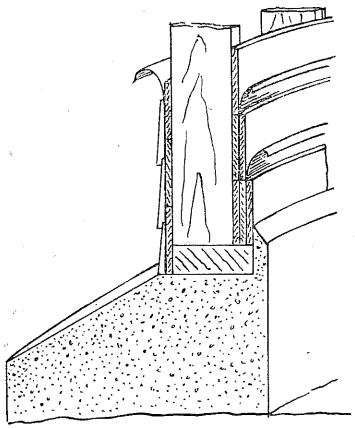

FIG. 3.—ORIGINAL KING SILO

A satisfactory home-made silo, materials for which can be secured anywhere.

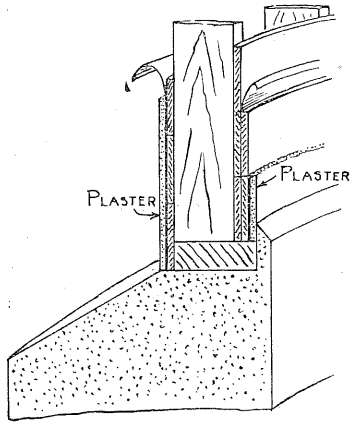

FIG. 4.—KING SILO

A coat of plaster inside and outside will usually be found cheaper and more satisfactory than sheeting.

quickly erected, and the first cost is usually less than for masonry construction. The life of a stave silo varies from 5 to 25 years. A stave silo made of cypress erected in 1907 on the University farm shows but few signs of decay, except around the bottom and in the tongue and grooves of the staves. It has perhaps been given better care than most silos. It has been painted on an average of once in 3 or 4 years. This silo is located in a very sheltered spot which prevents winds causing any damage.

26. What care is necessary in selecting the lumber? If a patented silo is to be built, do not accept lumber having loose knots, any sapwood, or pieces with bark. Sapwood, as a rule, is less durable than heartwood and will nearly always decay first. The best wood which can be selected for silo construction

is known as edge grain. Shrinkage in edge-grain lumber is approximately 60 per cent as great as in flat-grain. Figure 5 shows what is meant by flat and edge grain.

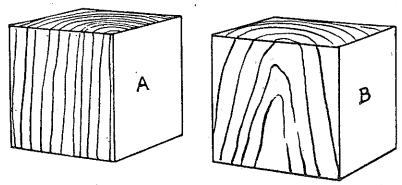

FIG. 5.—DIFFERENCE BEWEEN EDGE AND FLAT GRAIN

Stone silos of edge grain lumber shrink less and require less adjusting of hoops than those made from flat grain material.

27. What are the best woods for silo construction? Redwood, cypress, Oregon or Douglas fir, southern yellow pine, tamarack, white pine, hemlock, and Norway pine, in the order named.

28. Are home-made silos worth while? In districts where silos are new and ready cash scarce, many have build home-made silos out of a good quality of 2″ x 4″ or 2″ x 6″ material selected at the local lumber yard. This material is not tongued and grooved but can and should be beveled. The lumber should be straight and uniform and of good quality. The first cost is very much less than for a manufactured stave silo. Unless care is used in building and selecting the lumber for these silos, they seldom last for more than three or four years. Special attention must be given to tightening the hoops at least during the first summer and loosening them again when filling the silo.

Good home-made silos have been built 30 feet high out of two-piece material; that is, 14 and 10 foot lengths of lumber. The total cost of materials for a 56-ton, 12 x 30 foot silo was: cement, $10.50; 2 x 4's at $20.00 a thousand, $48.00; 11 hoops ⅛″ x 2″ of No. 12 band iron, $22.00; tank lugs, $5.50; creosote, $1.50; paint, $5.00; roof, $3.00; nails, $.50; window, $.65; making a total cost of $96.65 for the silo complete, not counting labor. The staves used were clear Oregon fir 2 x 4's beveled about ⅛ of an inch.

29. How is the Buff Jersey silo built? A Buff Jersey silo uses regular material from the lumber yard, and is in some ways an improvement over the home-made silo. For the regular staves 2 x 4's are set edge to edge on end around the circle. Every 12 to 16 feet around the circle, a 4 x 6 is used instead of 2 x 4, making one 4-inch face of the 4 x 6 flush with the inner wall of the silo and allowing 4 inches of the 4 x 6 to project on the outside. The 2 x 4 staves are beveled but not tongued and grooved. In setting up the silo, spikes at least 5 inches long are driven

edgewise through each 2 x 4, and into the next adjoining stave so that the staves are all nailed together. Place the spikes 4 feet apart. Staves are also nailed to a plate which is made of two layers of one inch lumber cut to conform to a circle and nailed together, breaking joints. The hoops are in sections placed 30 inches apart, extending through each 4 x 6. The doors are sawed out after the silo is complete. A higher silo can be built by fastening two staves together as explained on page 13.

This is a cheap silo, but if labor and the trouble necessary to erect such a silo is considered, it would seem more advisable to buy good staves with the hoops, lugs, and doors necessary to make a complete job.

30. What is the Minneapolis silo? It is a patented panel silo and consists of steel posts set two feet apart upon a circular foundation, with short plank, tongued and grooved on the sides and beveled on the end, to fit into the groove in the studding. Hoops of ⅝ inch rods bind the silo together. The advantages of this silo are: better material at less cost can be used because short length lumber is more easily secured; and there is little shrinkage in wood used lengthwise, therefore, there is no necessity for tightening hoops; in case a board rots, it can be taken out and a new piece inserted at the top; the hoops not being placed directly against the wall can be used as ladder rods.

31. What is the Arctic silo? The Arctic silo is also a patent double-walled silo. The wall is made somewhat similar to that of the Minneapolis silo; that is, short lengths of 2 inch plank are set in between vertical wood studding. The outer wall is made of dressed and matched 1-inch lumber. Between the outer and inner wall is a 3½ inch air space. A layer of insulating material ⅛ inch thick is placed as a lining for the outer wall before the 1 inch facing lumber is put on.

32. What are the essentials to consider in buying a "ready-made," "knocked-down" silo? Although the silo manufacturers always make strong talking points of their particular doors and door frames, roofs, anchoring devices, foundation fastenings, and methods of splicing staves in two-piece silos; the essentials to consider are the quality and kind of wood used in the silo and the reliability of the company manufacturing it.

33. Why is a good door frame necessary? Because the door frames are set up first, and the remaining staves are fastened to the door frame. A good door frame is also necessary be-

cause continuous close fitting doors can be made. There is usually some means of hinging the doors or else a locking device may be used which also acts as a ladder and holds the doors rigidly in place. The doors and door frames should be beveled so that a very tight-fitting door can be made. The doors should fit smoothly on the inside with the rest of the silo wall.

The better constructed silos now are made with a metal or wooden hoop placed on the inside of the silo near the top which prevents buckling during dry weather when the silo is empty. Figure 6 shows how this iron hoop holds the staves in position.

34. How do good hoops and anchors protect the silo? When a wood silo is empty it has a tendency to shrink enough so that if the silo is not securely hooped and anchored the structure will fall in during the first wind storm. These hoops should be adjustable, for when the silo is empty they must be tightened, and when full, loosened. Usually more adjusting and care is necessary the first year than afterwards.

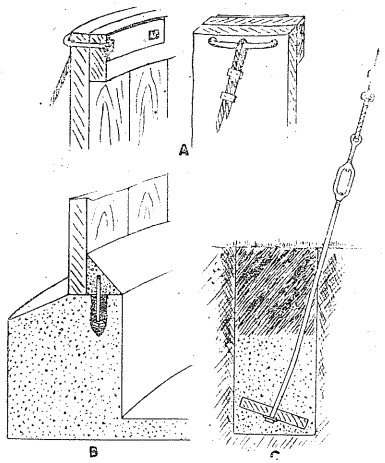

FIG. 6.—METHOD OF ANCHORING A STAVE SILO.

Secure anchoring of a stave silo is cheap tornado insurance.

The hoops are usually made of 5/8 inch mild steel rods. One hoop is placed always at the bottom and top. Between the top and bottom they are placed every 2 feet.

If round rods are used for hoops, they should be rolled to fit the curve of the silo. Flat hoops 2 inches wide made of No. 12 band iron, which is about 1/8 inch thick, are satisfactory for reenforcing a home-made stave silo. They are held together by tank lugs which can be purchased at almost any hardware store. Flat hoops will not slip down if there is any shrinkage of the staves. There is more exposed surface for rusting in the flat hoop than for the same weight of round rod. Some means should be provided so that the hoops can be tightened and loosened.

Anchoring a stave silo securely is as important as any other point in the construction of the silo. Adjustable anchors as shown in Figure 6 prevent the silo from being blown over when empty. A good method is to cut about 6 inches of thread on a 5/8" rod 5 feet long. The rod ought to be at least 3 feet in the ground set in concrete. In order to prevent the rod from turning in the cement when the turn buckle is tightened it should be bent slightly and a block of wood fastened on the end so that the rod cannot pull out. The upper part of the anchor is made from a half inch wire cable of four No. 9 wires twisted together. The turn buckle is fastened to the wire cable by an eye in the bolt threading into the cable.

35. How is a stave silo built? The foundation should first be marked out (see Fig. 1). In order to provide a permanent fastening for anchoring the silo before the concrete has hardened, make holes with a wooden peg at least 6 inches deep and 1½ to 2 inches in diameter and 3 feet apart around the silo, these holes to be about 3 inches inside of the completed silo. When the silo is placed on the foundation and the hoops are drawn as tight as possible, bolts should be placed in the holes of such length that they will extend about 2 inches above the foundation. After the silo is complete and all hoops tightened, a triangle of concrete is placed, as shown at B, Figure 6. This ring of concrete prevents the silo from slipping into the pit or being moved on the foundation, and also makes an airtight joint between the silo staves and the foundation. By making this joint slanting from the stave to the edge of the concrete foundation, it permits the silage to settle evenly without leaving an air space where the staves meet the foundation which is the cause of spoiled silage. There are many instances in which this ring of concrete has failed, so that especial care must be taken in casting it to the foundation.

36. How shall the scaffolding be built? In Figure 7 the uprights are made of 2 x 4's set 3 feet outside the foundation wall. Each pair of uprights is fastened together by two diagonal braces. About 7 feet from the ground nail 1 x 4 inch boards, 8 feet long, on each pair of uprights. These horizontal boards should be kept as nearly level as possible. Planks are now laid on these horizontal boards so that they can be used to walk around on. New braces and horizontal boards can then be added to the scaffold as they are needed.

37. Is it possible to build without scaffolding? Stave silos can be constructed without building a scaffold, but this method

is not nearly so convenient, and is dangerous. In building without the scaffold, the door frame is erected and securely braced, then three staves are set up together. They are nailed together on the ground and fastened in place by nailing boards at the top, which are attached to the door frame. This method can be used to the best advantage in erecting a one-piece stave silo.

38. How can I build a home-made door frame and set it plumb? Make it out of 2 x 6 material fastened together with 2 x 6's mortised in the uprights every two feet, of one-piece material. In placing it remove one pair of diagonal braces opposite the point where the door is to be located. Now raise the frame to place, and by means of a carpenter's level make sure that it is plumb both ways. Brace securely to the barn or scaffold.

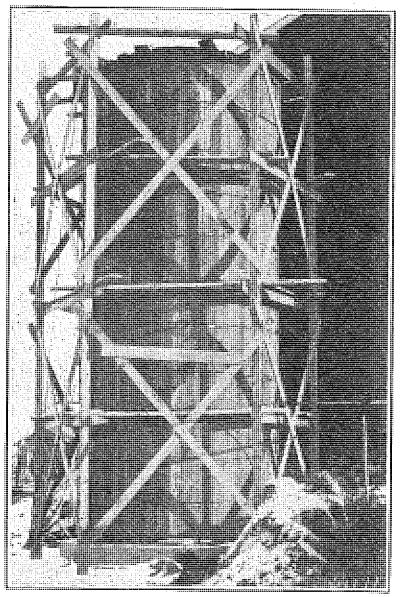

FIG. 7.—COMPLETE SCAFFOLDING FOR A STAVE SILO

A good scaffold lends speed and safety to the work.

39. What is the best way to set the staves. In either a home-made silo or manufactured one, the staves should be beveled slightly and should always be set up with the widest dimension to the outside. Two or three men work to best advantage in placing the staves, one at the bottom, one at the top, and one in the middle. There should be provided a number of cracker or salt barrel staves to be used in holding each stave in place as it is set up. The silo staves are set up by beginning at the door frame and working around half way in either direction. The last stave is set opposite the door frame. When placing the staves and before the hoops are put on they should be drawn together just as tightly as possible.

40. How is the two-piece silo erected? One short and one long length is placed alternately around the silo as explained

for the one-piece construction (pages 12–13). The staves are fastened together at the ends either by tongue and groove or steel spline, as shown in Figure 8. Both methods are in common practice. In the tongue and groove method the area of the stave exposed to moisture is much greater than would be the case if the staves were sawed straight across. If this method is used the ends should be thoroughly painted, and the groove filled with paint or else moisture will be drawn into the tongue and groove by capillary attraction. This moderate amount of moisture is sufficient to permit decay. If the spline method is used it should be tightly inserted. The practice of sawing a wide opening in the ends of the staves so that the spline is easily inserted is poor practice because it exposes a large area of wood to the action of moisture. After the bottom part has been completed, it is best to put on the two bottom hoops. When the top or next set of both long and short staves are set in place the two ends must be hammered so that the top row of staves will settle into place and not leave a loose joint between the staves.

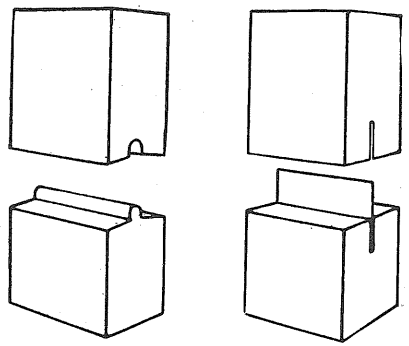

FIG. 8.—TWO METHODS OF SPLICING STAVES

This makes possible the building of silos 30 or more feet in height from stock lengths of lumber.

41. What are the methods of creosoting the staves and which is most effective? The pressure treatment is the most satisfactory and is preferable to all other methods of treating wood stave silos, as the oil can be forced farther into the wood and distributed more evenly, making a much more thorough job than is possible by other methods. The timber used in silos is quite long, and, therefore, the pressure treatment is usually limited to a manufactured product.

Since decay is fastest at the bottom ends, a combination of the brush and open tank methods of treatment is quite effective in preventing decay and can be used by anyone considering the construction of a wood silo. The treatment consists of placing the staves on end in an iron tank and heating the creosote to

between 200 and 220 degrees F. for from 2 to 3 hours. Both ends of the staves can be treated in this manner and then the part in between can be creosoted by painting with two coats of hot creosote.

There are companies manufacturing and selling silos thoroughly creosoted by the pressure method. Also there are others whose product is merely sprayed with creosote, or dipped in it. There has been advertised quite widely a creosote wood stave silo which has been treated under "atmospheric pressure." Whether this means that the wood has been given an open tank treatment or has been piled out in the open and a spray of creosote scattered in a "hit or miss" fashion over the wood, it is impossible to say. From the advertisements this would be all that is necessary to fulfill the claims made. From reports made by farmers purchasing such silos, it is quite evident that nothing more than the equivalent of a brush treatment has been used. Such statements as treated under "atmospheric pressure" mean absolutely nothing. The purchaser should learn beforehand the method of treatment he is paying for, and should keep in mind that the method of treatment is of greater importance than the quality of the creosote.

42. Does creosote contaminate silage? The odor is not serious after the first year if the wood is thoroughly seasoned before the silo is filled. The slight contamination of the silage does not seem to affect the health of the cattle.

43. What woods are best to creosote for silos? Of the woods in use in silo construction, the pines are most easily treated. With the pressure treatment, the Forest Products Laboratory of the United States Department of Agriculture states that the greatest saving can generally be effected by using cheaper woods because the difference in the durability of the various species is less after treatment than before it is forced into the wood in sufficient quantity. Besides increasing the life of wood creosote reduces the shrinkage and swelling. It is questionable whether it will pay to treat such durable woods as redwood and heart cypress.

44. Why should I build a concrete silo? It will be permanent, because of its strength to resist the pressure of the silage, and its action on the concrete, as well as any action of the weather, such as wetting, drying, freezing, and thawing. It will be fireproof. It needs no attention on account of swelling and shrinking. If there is good sand and gravel on your place or within a team's hauling distance, it will be the cheapest form of silo.

45. Does silage hurt concrete? No; the silage juice is less than one-tenth as strong as ordinary cider vinegar. Examine concrete silos which have stood for years.

46. Does concrete spoil silage? Silage may spoil sometimes in concrete silos, because the wall is porous, and therefore neither airtight nor waterproof. The best way to render it nonporous, is to puddle the concrete during construction next to the inside wall with a flat spade, and then after taking down the forms to soak the wall, and paint it with cream cement from the top down, using a stiff whitewash brush. The spoiled silage at the juncture of the stave silo with its concrete foundation is due neither to the concrete nor to the wood, but either to a poor ledge, or the fact that the joint is not air-tight.

47. Does more silage freeze in concrete than in stave? It is true that wood is a better non-conductor of heat than concrete, but the concrete is much thicker, so that it takes longer for heat to pass through the concrete wall. Most of the freezing in silos comes from the top rather than through the wall. If more care is taken to keep windows, doors, and ventilators closed, on all types of silos, there will be less trouble from freezing.

43. How are single and double-walled concrete silos built? Single-wall concrete silos predominate, commonly six inches thick. Four inch walls are strong enough, but it is hard to place reenforcement and keep an even thickness. It is true that walls can be made lighter at the top, but it is impractical to use two or three different sized forms to make one silo.

The double-wall concrete silo can be built only with patented forms, impracticable except in the hands of a contractor. The inner wall is 5½ inches thick and the outer wall 3½ inches thick, both tied together with steel rods. All the extra effort and expense to form an air space to prevent freezing would seem to be unnecessary as the freezing is not serious in the single wall, and would certainly only be practical in very cold climates.

49. When should concrete blocks be used? Only when they are made by a manufacturing concern in your neighborhood, as it is not practicable to ship blocks any distance. If the concern

manufactures the blocks in quantities, it ought to reduce the cost of construction over the solid wall type. They can be hauled to the silo site and easily constructed without a form.

50. How is the concrete block silo made? It is built of circular blocks set in cement mortar, reenforced with steel rods placed near the outside wall between every three or four courses.

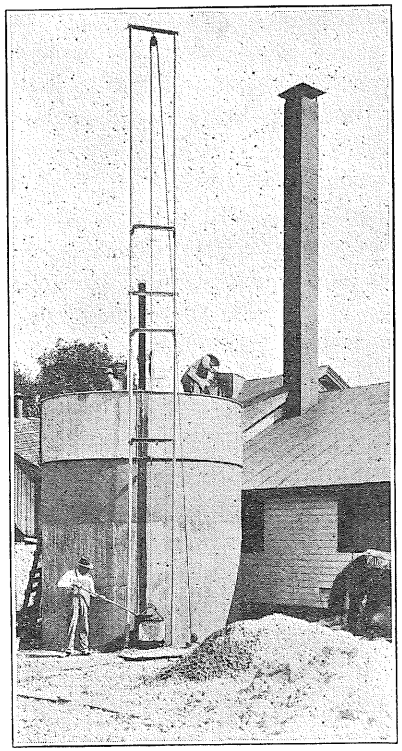

FIG. 9.—MONOLITHIC CONCRETE SILO UNDER CONSTRUCTION

The home-made form with this simple hoist is a cheap and effective outfit.

51. Is there any insulation value in hollow type blocks? The claim of the concerns manufacturing machinery for building blocks is that there is less freezing in this type, however, as only 1/3 of the total contents of most blocks can be eliminated, the air space has little if any value as insulation.

52. How should blocks for silos be made? Quite wet, although this is impracticable by the ordinary methods of block construction for the mixture is similar in consistency to poured concrete, and therefore the blocks must be left in the molds to harden. There is no question about this method giving a better block, but it is also more expensive.

Dry blocks as ordinarily made for use in buildings are not satisfactory for silo construction. It is practically impossible to make the plaster stick to the dry blocks, and they are so porous that much of the silage next to the wall spoils. In the manufacture of any block for silos, a space for the reenforcement should be provided.

53. How are concrete stave silos made? From slabs of concrete 2 feet long, 2¼″ to 3¼″ thick, and 6″ to 8″ wide, made to

conform to a circle. The staves are a manufactured product and since the high freight cost makes shipment for any distance impracticable, they are generally used locally. This type of silo requires no forms and can be quickly erected by two or three men. If the staves are made wet and out of good material, they seem to give very good results. After the silo is completely set up, it should be washed on the inside with a waterproof wash.

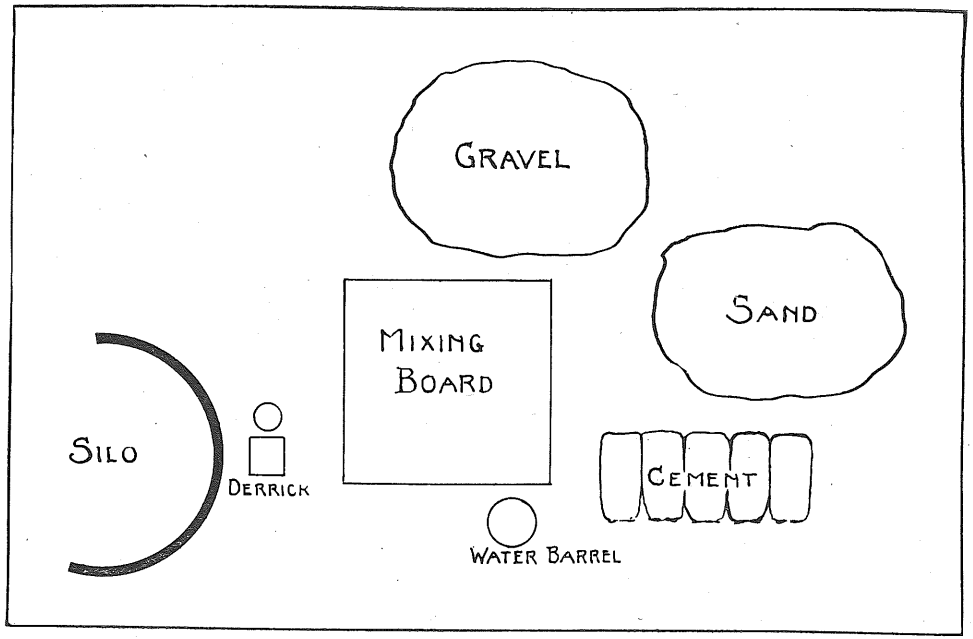

FIG. 10.—ARRANGEMENT OF MATERIALS FOR HAND MIXING

The labor and waste of materials can be reduced to a minimum by a little forethought in planning the most convenient arrangement.

54. What objections are made to the concrete stave silo? The reenforcement is placed on the outside where it is exposed. If the builder is not particular, many poor staves go in to the silo, and it is practically impossible to remove these afterwards to make a tight wall.

55. How can time and labor be saved in mixing concrete? By planning the location of the mixer or mixing board, sand, gravel and cement according to the location of the silo.

56. How shall I mix the concrete? Thoroughly until the mixture is of a uniform color regardless of the method of mixing.

To hand-mix, spread the sand on the board, and cover with cement. Add gravel or crushed stone with enough water to produce the proper consistency. The addition of water before the stone is thoroughly mixed saves at least one turning of the mixture. However, if the sand and gravel are already mixed, it is best to mix the sand, gravel, and cement until the mixture has a uniform color before adding water.

In using power, the materials are all thrown into a batch mixer, water added, and the mixer set in motion for one or two minutes. After a few trials the correct amount of water and the time required will be determined so that each mixture will be uniform and of the proper consistency.

57. What does good concrete require? Clean sand, gravel, and fresh cement properly proportioned and thoroughly mixed. In an ideal mixture the sand should just fill the air or void space in the gravel and the cement should fill the void space in the sand. By properly proportioning the sand and gravel the void space to be filled by the cement can be materially reduced thus decreasing the cost without sacrificing strength. Stone larger than ⅓ the thickness of the wall should not be used.

58. What proportions of materials shall I use for silo work? A mixture of one part of cement, two parts of sand, and four parts of stone or gravel is usually considered ideal. The proper proportion to use would be one part of cement to four parts of the ready mixed or bank-run sand and gravel. In bank run gravel the sand should be in proportion to 1 to 2 to the stone. This mixture will be of approximately the same strength as a 1, 2, 4 mix where sand and gravel are mixed separately.

59. How can sand be easily and accurately tested? Fill a long glass jar of small diameter with water and pour in slowly an average sample of the sand until half full. Shake well, set aside to settle for an hour. Then if much mud or clay appears at the top it is unfit for use. The narrower the jar proportionately, the more accurately the percentage of fine material can be approximated. If 8 to 10 per cent or more of clay or very fine silt is in the sample, the concrete will be weak. Either wash the sand, or else use considerably more cement. Materials can be washed by throwing them on a screen set at an angle of

15 degrees, (Fig. 11) and letting water run over the screen. Clay prevents the binding of the cement and sand to the stone.

60. What precautions must I observe in pouring? Pouring from a height of 4 to 6 feet causes the heavier parts of the mixture to separate from the lighter, and forces the stones to the bottom of the mass. Wet concrete is easier to handle than dry, but for silo work it should be just wet enough so that it can be puddled by a flat spade. Cavities can then be easily prevented, and a smooth wall secured by working some of the lighter mortar next to the forms.

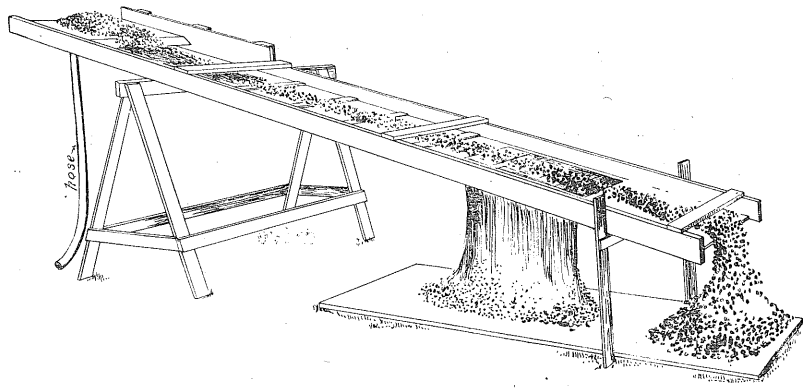

FIG. 11.—SCREEN FOR WASHING GRAVEL CONTAINING A HIGH PER CENT OF CLAY

Time and money spent in this manner will often improve the quality of the concrete as well as reduce the amount of cement required.

61. What about forms for the concrete monolithic solid wall silo? The commercial forms are practicable for contractors, but there have also been developed a number of home-made forms which have proved to be quite successful and most economical if not quite as convenient.

62. How fast can the silo be built? With commercial forms which vary in height from 2½ to 4 feet it is possible to build from 6 to 8 feet a day. In the smaller heights of forms it is the practice to build them in sections so that as soon as one section has been filled another one is set in place, making it possible to fill almost continuously.

63. Can I make a set of home-made forms? Yes. They consist of a wooden frame with the inside forms lined with galvanized or black iron.

The main frame work is made from 2 x 12 plank 12 feet long, sawed into two circular pieces. To make this form a true

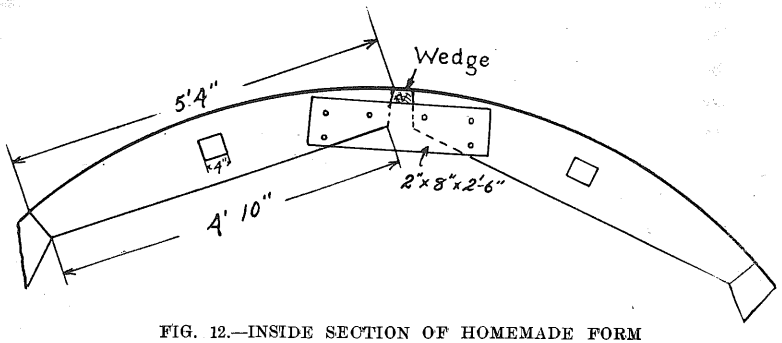

FIG. 12.—INSIDE SECTION OF HOMEMADE FORM

It requires but a small outlay of time and money to build this form.

circle, place on a level place in the shop or barn, a narrow strip of wood 2″ wide and 8 feet long, with a hole bored in one end the size of a lead pencil. Measure from the center of this hole exactly 7 feet along the strip and drive a nail into the floor.

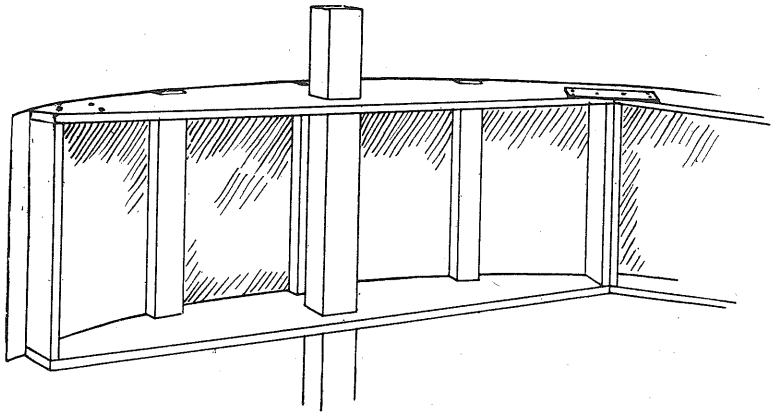

FIG. 13.—INSIDE VIEW OF INSIDE FORM

Forms constructed in this manner are rigid and durable, yet comparatively light.

This nail will be the center of a 14 foot circle. Since this form is made up into eight sections, each section will be cut as shown in Figure 12. Using this as a pattern, it will be necessary to cut 16 such pieces. The bracing to which the galvanized iron is attached is shown in Figure 13. This bracing is mortised

into the inside frame and after constructing the sections they should be set together and bolted in a circle. To do this, make a circle on the floor as explained for cutting out the form. The

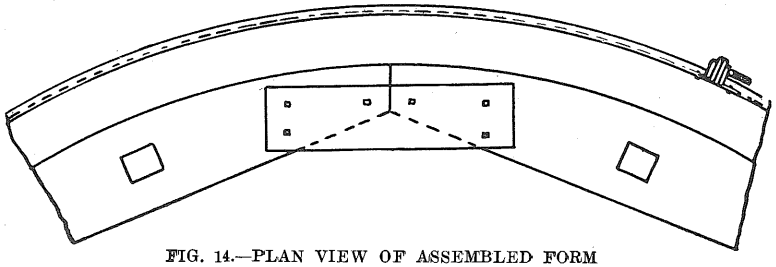

FIG. 14.—PLAN VIEW OF ASSEMBLED FORM

Form should be held apart by spacers, of a length corresponding to thickness of the wall, until the concrete is poured.

sections are bolted together by two pieces of board 2″ x 8″—3 feet long, one at the top and one at the bottom of each form. Alternate sections have wedges cut from 2 x 4's placed between them which are removed when the form is raised.

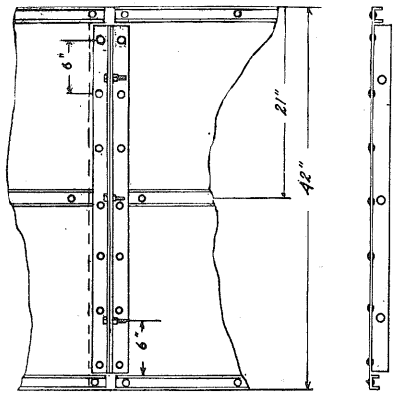

Fig. 15.—OUTSIDE FORM SHOWING ELEVATION AND SECTION THROUGH JOINT

Any first class blacksmith or tinner can make this form in a short time.

A hole 4″ x 4″ is cut in the center of each section as shown at A, Figure 12, through which are attached the upright posts of 4″ x 4 that hold the form in a perpendicular position. The outside form is made of heavy galvanized iron, No. 18 gauge. It can be made in four parts with the ends overlapping and held together by means of angle irons riveted to the sides of the form. The drawing, Figure 13, shows clearly how this form is constructed.

64. How should concrete be reenforced? With round, square or twisted rods, No. 9 wire, or woven wire fencing. Old rusted barb wire should not be used in place of new wire, because it is not strong and is hard to handle. If it is used at all, more of it is needed than if it were new.

65. Where should the most of the reenforcement be placed? At the bottom where the pressure of the silage is greatest. Increase the amount from the top down because the pressure becomes greater. Most reenforcement is placed around the silo. Very little vertical reenforcement is necessary for silos less than 16 feet in diameter. Vertical reenforcement is placed at the sides of the doors and sometimes at intervals around the wall as an aid in holding the horizontal reenforcement in place. The horizontal bands must be continued around the entire silo, but instead of extending them across the door they should be hooked to the vertical rods on both sides of the door as shown in Figure 16. Both the horizontal and vertical rods are placed about one inch from the outside of the wall.

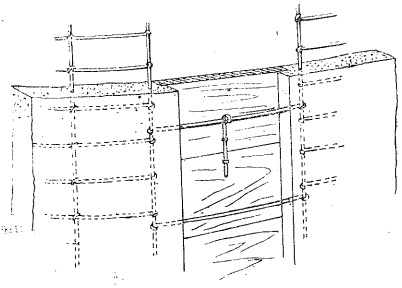

FIG. 16.—REINFORCEMENTS AROUND THE DOORWAY IN A CONCRETE SILO

A concrete silo must be properly reinforced to prevent cracks and ultimate ruin of the structure.

66. What about the steel silo? In cold climates, the silage freezes very quickly, and also thaws out quite rapidly. The metal can be protected from the moisture of the silage by painting with an asphalt or tar paint, once a year. This type of construction seems to be best adapted to arid climates. There is of course less freezing in a double-wall steel silo than in the single wall. However the height of the silo is governed by the strength of the metal in the bottom part of the silo. (At present prices for steel this type of silo is very expensive.)

67. Is brick a good silo material? It is practical where brick can be secured at reasonable prices. It must be well reenforced, otherwise it will not be successful. The quality of brick should be higher than the average soft building brick; paving brick is very good because it is hard-burned, larger than building brick, and rough so that plaster will stick, and an absolutely impervious wall is possible. Vitrified brick is always best.

68. What about the double-wall brick silo? It is as nearly frost-proof (Fig. 17) as a silo need be built. The double wall

is the thickness of the length of the brick. About every six layers a header or brick is placed across the wall to tie the two walls together. Some persons use this flue from the bottom to the roof of the silo as a ventilator for the barn, while others absolutely prevent freezing by building a fire in connection with the flue.

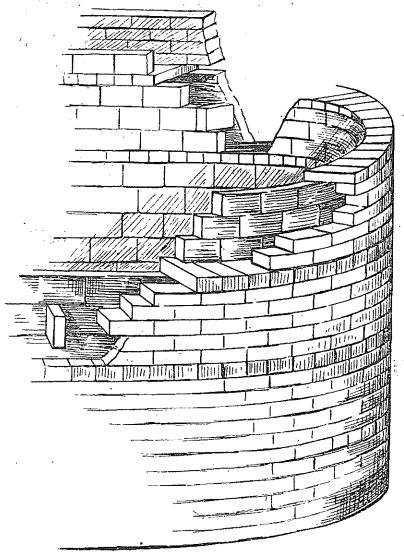

FIG. 17.—SECTION THROUGH A BRICK SILO

A brick silo constructed in this manner will be nearly frost proof and practically indestructible.

69. What about the vitrified tile silo? It is permanent, fire-proof, and does not require a form for its construction. The success of this type depends on the use of hard-burned, not merely glazed, non-porous blocks.

70. How shall I know good tile? Place it in an oven for 48 hours in an atmosphere above the boiling point of water. Remove it then, weigh, and place in water for 48 hours. Remore from the water, wipe off all surface water and weigh. If the difference is more than 5 per cent of the weight when dry, the quality of the block is low, and it should not be used for the silo.

71. Can home labor be used in building a tile silo? No; tile construction requires the services of a good mason to lay the tile so that the silo will be perpendicular, with good, tight joints. The joints of the blocks should be wide enough so that the mortar will have something to stick to. Mortar joints have been known to leak to the extent that would spoil much silage. If the walls are not washed with cement or plastered on the inside, much attention is required to make a perfect joint. On the outside, of course, considerable attention will be required in order to produce a neat-looking structure. Washing the walls should be done either as they are laid or else as the scaffold is taken down. For washing the walls, one part of cement and

one part of sand mixed to the consistency of thick cream is applied with a stiff whitewash brush or old broom.

72. What should be used for plastering the inside of tile silos when necessary? A mixture of one part cement to one and one-half parts of clean, coarse sand, and one-eighth of a bushel of hair or fiber to each barrel of cement. Many plasterers prefer to use lime in the mixture, because it spreads much better. However, because of the danger of getting unslaked material, it should be used with care. If lime is used, the proper proportion is one part of well-slaked lime to 10 parts of cement and sand mortar.

73. With whom can I talk about a silo? Your county agricultural representative for disinterested advice, the dealers for facts about the kind of silo which he sells, your banker if you need financial help. Many banks are very willing to loan money for such productive purposes as constructing a silo.

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