Feb. 13, 1934. W. W. LILLARD 1,947,345

CONCRETE MIXING METHOD

Filed April 3, 1930

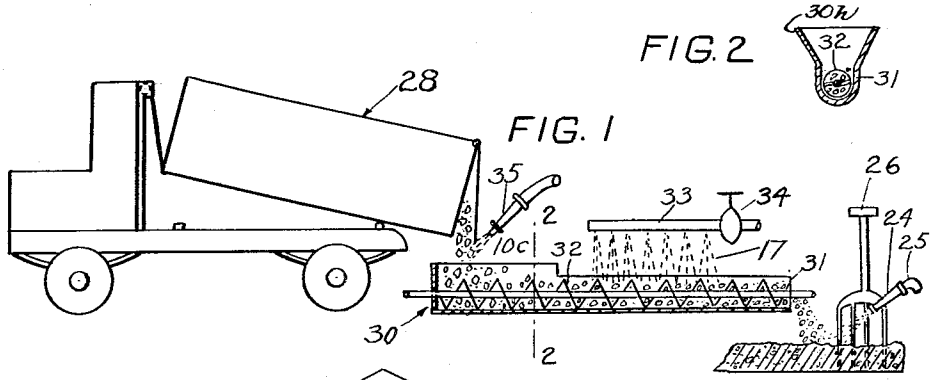



FIG. 1




FIG. 2

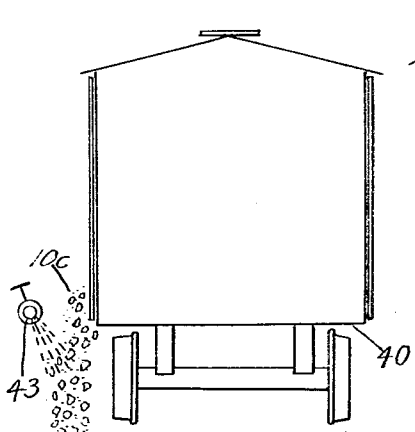



FIG. 3

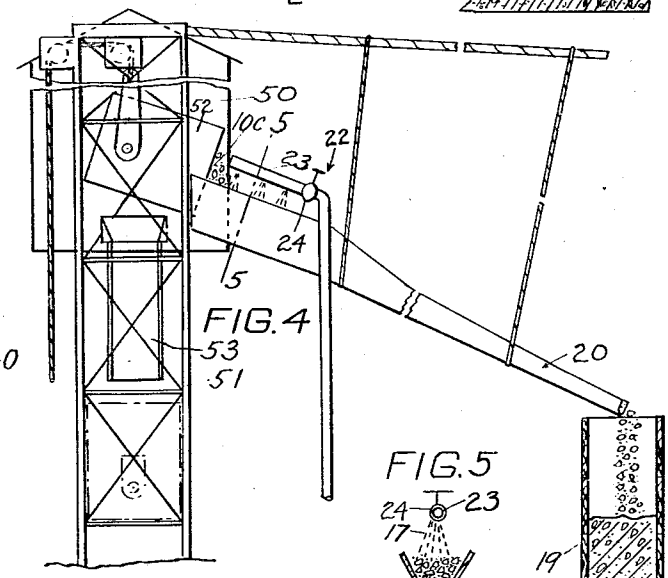
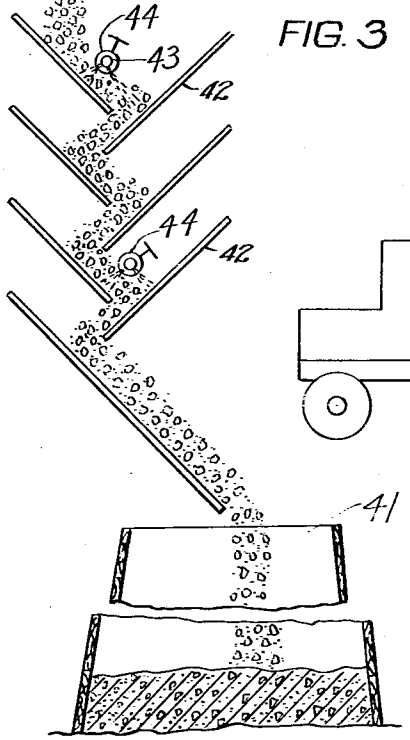
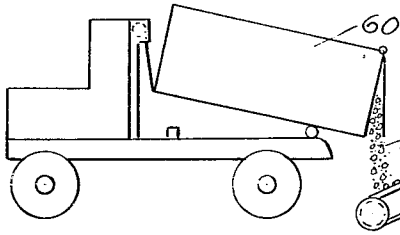



FIG. 4




FIG. 5



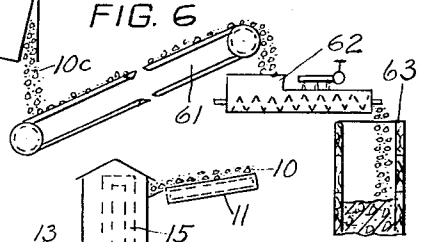




FIG. 6

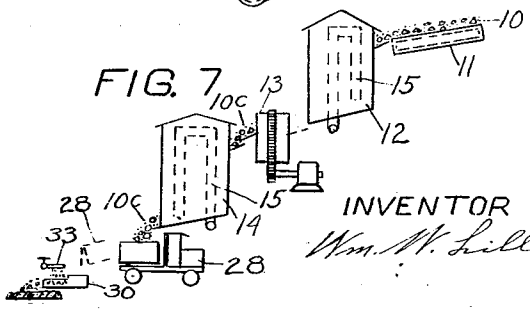



FIG. 7

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## CONCRETE MIXING METHOD

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4 Claims. (Cl. 83—73)

The present invention relates generally to concrete which is usually made by mixing aggregate such as crushed stone and sand with cement and water; and more particularly to methods of preparing and mixing the ingredients of concrete.

According to one widely used way of preparing concrete for building a structure, the aggregate such as crushed stone and sand is brought to the site of the structure in a more or less moist condition and is mixed with the cement and water in some kind of concrete mixer. When concrete is mixed this way for a large remote structure it is usual to transport a large supply of aggregate to the site of the structure and store it; and then move it again as needed from the storage bin or piles to the mixer. This way of mixing concrete calls for moving the heavy concrete aggregate, unloading it, loading it again, moving it the second time and unloading it in the mixer. This way usually requires a concrete mixer for each job.

With the end in view of eliminating the above and other well known objections to the preparation of concrete at the site of the structure it has been proposed to mix all the concrete ingredients (including water) in a central plant usually some distance from the site of the structure where the concrete is to be used. Freshly mixed concrete is then carried as rapidly as is practicable from the mixer to the site of the structure and poured into the forms.

Concrete mixed in a distant central plant or in transit is open to this objection: certification by an inspector stationed at the plant that the concrete ingredients were properly proportioned and mixed cannot be so fully accepted as a guaranty of the quality of the concrete delivered at the job as a similar certification of concrete mixed and inspected at the job.

There are other objections to the above-described method of preparing concrete at a point quite distant from the structure where it is to be used. For one thing, the freshly mixed concrete cannot be safely and satisfactorily moved distances from the central mixing plant that will require considerable time for its transportation. Any considerable delay in transporting a batch or quantity of concrete from the distant mixer to the forms means the loss of that much concrete. Also, as a result of unforeseen delays in transporting the freshly mixed concrete, structurally weak places are sometimes made in structures because certain members of the structures cannot be molded as monoliths without joints. Moreover, the joints sometimes come at places where they are quite objectionable, and such joints cannot be avoided since a reserve supply of the freshly mixed concrete cannot be kept on hand for such emergencies.

An objection common to all of the above-described methods of preparing concrete resides in the fact that when a large number of loads of concrete aggregate such as crushed stone and sand are brought to a mixer at the job or at a central mixing plant at different times and during different kinds of weather, the amount of moisture in them will vary considerably at times. This greatly increases the difficulty of securing uniformity of the water-cement ratios of the several batches of concrete turned out by the mixer, which uniformity is very desirable for reasons well known to those skilled in the art of concrete construction.

An object of the present invention is the provision of a practicable and economical method of preparing at different times, several quantities or batches of concrete, the water-cement ratios of which are substantially the same.

A feature of my invention resides in preparing plastic concrete by drying and mixing solid ingredients of concrete in a distant plant, transporting the prepared solid ingredients in bulk to the site of a structure to be erected irrespective of the time required, and mixing water with the solid ingredients at the site of the structure while the ingredients are being expeditiously moved from the transporting means to the forms of the structure.

Referring to the accompanying drawing which forms a part of the specification:

Figure 1 is a diagrammatic view in elevation illustrating a means suitable for conveying a dry mixture of concrete ingredients from a vehicular container in the form of an automobile truck to a concrete structure such as a pavement, and mixing water with the dry ingredients as they are moved along toward the pavement. Means are also illustrated for incorporating additional water in the concrete ingredients after it is on the ground. Figure 2 is a cross-section along the line 2—2 of Figure 1. Figure 3 is a diagrammatic view illustrating a means suitable for expeditiously conveying a dry mixture of concrete ingredients downward from a transporting container in the form of a box car, and for incorporating water with the ingredients as they are moving toward the forms. Figure 4 is a diagrammatic view, in elevation, illustrating a means suitable for carrying out certain steps of the present invention when employed in connection with the erection of high structures especially in congested sections of large cities. Figure 5

is a cross-section along the line 5—5 of Figure 4. Figure 6 is a diagrammatic view illustrating means suitable for carrying out certain steps of the present invention when employed in erecting such structures as long high walls. Figure 7 is a diagrammatic view illustrating a succession of steps employed in my invention.

The quantity of water to be added to a fixed quantity of solid ingredients of concrete should vary in accordance with the amount of moisture already in the aggregate. The amount of moisture in several unit quantities of concrete aggregate taken from the same pile or supply will vary considerably. For example, the amount of moisture in a pile of sand is usually greater near the bottom than near the top.

Since it has been well established that the use of too much water mixed with solid concrete ingredients results in a much weaker concrete, a serious objection has become more evident to the practice of preparing concrete wherein measured quantities of moist aggregate are mixed with an estimated quantity of water. Especially since the quantity of water needed is often estimated under conditions which are a hindrance to accuracy. According to methods heretofore commonly used, the quantity of water that should be added to a certain quantity of solid ingredients of concrete has been estimated by observation of rapidly tumbling materials in a concrete mixer in which the light is usually poor and the view is often greatly obstructed.

According to present invention, the amount of water needed to be mixed with the solid ingredients of a batch of concrete can be accurately known at all times because all of the moisture is first removed from the aggregate. This may be done by the application of natural heat such as sunshine, artificial heat, or movement of dry air over or through the aggregate designated by the reference numeral 10. It can be readily seen that the aggregate may be dried out by suitable combinations of the above named agencies.

In Figure 7, is illustrated one means of drying the aggregate 10 which is shown spread over the top of a metal oven or stove 11 which may be heated interiorly by steam or hot air. In this view, the aggregate 10 is shown as if it were socalled concrete gravel, i. e. a natural mixture of sand and rocks. Where the aggregate consists of crushed stone and sand, the stone and sand will be dried separately.

The dryness of gravel aggregate for concrete may be tested by burying thoroughly dry pieces of ordinary unglazed newsprint in different portions of the aggregate for an hour or more. If the aggregate is thoroughly dry, the pieces of paper will retain their usual crispness and dryness. If the aggregate has any moisture remaining in it, the pieces of newsprint paper will absorb enough moisture to cause them to loose their crispness and dryness to an appreciable extent. Crushed stone, and sand may be tested separately in the above described way, or in any other suitable way.

After the aggregate has been dried out and tested, it may be stored in a closed dry bin 12. If the aggregate consists of two materials like crushed stone and sand, the bin 12 will have two compartments, one for the stone and one for the sand.

When the concrete masonry of a structure is nearly ready to be started, a predetermined amount of the dry aggregate 10 is drawn from the bin 12 and poured into a suitable dry concrete mixer 13 which may be of any well known make. A proportionate amount of dry cement (not shown) is also put in the mixer and the latter will be operated until the aggregate and the cement are thoroughly mixed, which can usually be determined by the mixture or batch having a uniform color. Such a mixture is designated as 10c.

In most cases, it will be preferable to mix a plurality of dry batches of solid ingredients of concrete as described above and store them in a tightly closed dry bin 14 until the time the pouring of the concrete in the structure is to start.

Sometimes, as in localities having very damp climates it may be desirable to provide means for drying out damp air that may infiltrate into the dry aggregate stored in the bin 12 and into the mixture of solid concrete ingredients stored in the bin 14. These drying means may be vertical metallic pipes 15 interiorly heated by connection with a suitable source of heat such as hot water (not shown). It will be understood that other suitable drying means can be employed in place of the pipes 15. The mixture of solid ingredients of concrete will be preferably transported to the site of the structure in a dry, vehicular container suitably constructed for protecting the ingredients from moisture.

As indicated in Figure 7, the following devices, the oven 11, the bin 12, the mixer 13, and the bin 14 of the plant illustrated for carrying out my invention may be advantageously positioned, one relative to another, so that the concrete aggregate and the mixture of cement and aggregate can be economically advanced by a flowing movement, due partly to gravity, from one of said devices to the next succeeding device of the plant.

According to the present invention, water designated as 17 is added to the previously mixed dry ingredients of concrete after the mixture is at the site of the structure. The water 17 may be added to the mixture 10c of dry ingredients in either of several ways. A batch of the ingredients may be emptied into a usual concrete mixer which will preferably be positioned near the forms of the concrete structure to be built. The correct amount of water required for the size of the batch can be measured and run into the mixer in a usual way and the mixer revolved as long a time as is necessary to thoroughly wet the batch. This time will be much shorter than the time required to turn out a well mixed batch of concrete where the aggregate, cement and water are mixed in the usual way.

In most cases, water will preferably be incorporated with the mixture 10c of dry ingredients while the mixture is being moved toward the forms from the container in which it is brought to the site of the structure, thus saving time by eliminating the division of the mass in the container into batches and stopping each batch for a time en route from the container to the forms. The water may be sprinkled on the moving mixture or applied thereto in any other ways as are hereinafter described. It has been found in practicing my invention, that water sprinkled on a shallow mass of the dry mixture 10c penetrates it quickly and but little motion of the mass is necessary to cause the water to be well incorporated in the mass.

In practicing the present invention to provide concrete to be moved by gravity downward

through a chute 20 to forms 21 of a wall, for example, the water 17 may be sprinkled on the mass of solid concrete ingredients by a well known form of sprinkler device 22 which may consist of a perforated pipe 23 having its outer end closed. It is provided with an ordinary valve 24 for controlling the flow of water through the perforations of the pipe. The pipe 23 will preferably be connected to a source of supply such as a city water main (not shown) having pressure enough to raise the water to the chute 20.

According to one way of employing the present invention for building sidewalks, floors, and the like, the mixture of solid ingredients which may be dry, or slightly moistened while being conveyed from the container into place is spread in layers, each a few inches deep. Water may be sprinkled on each layer from a usual sprinkling nozzle 24 on the end of a section of hose 25 which may be connected to a source of water (not shown). To facilitate wetting the lower portion of each layer, a multi-tooth instrument such as a usual rock fork 26 may be used to pierce deep down into a layer and make numerous, closely spaced, well-like holes in the layer. The water will fall into the holes and subsequent tamping of the layer in a well known way will close up the well-like holes and force the water collected in them into the mass of surrounding solid ingredients, thus causing all portions of a layer to be moistened.

My method of preparing concrete is especially advantageous in connection with the construction of concrete pavements for streets and highways. In building such structures, the dry mixture 10c can be conveniently transported in a large, rear dumping type motor truck 28 to within a short distance of the end of the concrete already in place. From this point, the dry mixture can be conveniently moved to wherever needed on the roadway by a usual screw conveyor device 30 which may be operated by a gasoline engine or electric motor (not shown).

The use of the screw conveyor device affords some important advantages. The mass of solid ingredients being retained in a usual U-shaped chute 31 as it is moved along is fully exposed to falling water 17. A usual revolving screw 32 in the chute not only moves the mixture 10c forward efficiently and rapidly but also serves to incorporate with it the water 17 which may be sprinkled from a plurality of sprinkler openings in a sprinkler pipe 33 above and substantially parallel to the chute.

In practicing the present invention, it is preferable, in most cases, to add water in the form of a light sprinkle or spray to the mixture 10c of dry concrete ingredients. For this reason, a greater number of sprinkler openings in the sprinkler pipe 33 will be required to furnish the predetermined proportionate amount of water for a certain volume of the mixture 10c than would be necessary if relatively large streams were directed into the mixture for wetting it.

The sprinkler openings in the pipe 33 may be any suitable kind and it is not considered necessary to an understanding of the present invention to show any particular kind or design of sprinkler opening or nozzle. The pipe 33 may be connected to a suitable source of water (not shown). A hand-operated valve 34 of any suitable kind may be used to control the flow of water through the pipe and out of the sprinkler openings therein in predetermined proportion to the volume of solid ingredients passing along in the chute 31 under the pipe 33.

The amount of water to be added to a certain quantity of the dry concrete mixture 10c will vary according to the water-cement ratio specified, and according to the moisture-absorbing qualities of the particular kind of aggregate used. Concrete made with a certain kind of aggregate may require more water than if made with another kind of aggregate. For illustration, some kinds of crushed stones will absorb or soak up relatively much more water than other kinds. The correct amount of water to be used with a particular kind of aggregate, mixed with cement, to secure a strong, hard concrete can be determined by tests of briquettes made from different batches of concrete, each batch having the same amount of aggregate and cement but made with a different quantity of water.

The proper amount of water to be sprinkled on solid ingredients moving in the conveyor chute 31 usually can be satisfactorily estimated by the appearance of the ingredients since a close unobstructed view of them can be had by an operator who will be stationed at the valve 34 while the concrete is being prepared. Also, graduations (not shown) may be arranged in a well known way in connection with the valve 34 so that the operator can open the valve a predetermined amount proportionate to the revolutions per minute of the screw 32.

Portland cement such as is commonly used for making concrete is supplied in the form of a fine powder, and when mixed with thoroughly dry aggregate the mixture still remains more or less powdery. Should the dry mixture 10c be poured from a vehicular container such as the truck 28 in Figure 1 when a strong wind is blowing there may be a tendency for some of the cement in the mixture to be blown about in the wind somewhat like dust which would be more or less objectionable. In the event of such a thing occurring, it can be readily stopped by directing a fine spray of water from a nozzle 35 against the stream of dry ingredients as its pours from the truck. The nozzle may be connected to the same source of water (not shown) to which the sprinkler pipe 33 is connected.

In Figure 3 is illustrated how a large mass of the mixture 10c such as can be carried in a railroad car 40 can have water incorporated with it while the mixture is expeditiously conducted into forms 41 of a structure such as a bridge pier. Means for incorporating the water 17 with the dry mixture 10c may include a plurality of right and left hand downwardly inclined platforms 42 superposed one above another as indicated in Figure 3. The arrangement of the platforms may be substantially the same as in the well known Haines gravity type concrete mixer. The water 17 will preferably be sprinkled on the downwardly flowing mixture from a plurality of sprinkler pipes 43 which may be arranged with numerous small sprinkler outlets of any suitable kind. The flow of water will be controlled by valves 44. One sprinkler pipe 43 will preferably be positioned near the door or other opening of the car 40 through which the mixture 10c is discharged. By this arrangement, the last-named sprinkler can also perform when needed, the same kind of function as that performed by the sprinkler nozzle 35.

In Figure 4, is illustrated how the present invention may be advantageously practiced in the erection of tall structures, especially in sections

of large cities where street traffic is heavy during the daylight hours. In this view, is shown, in elevation, a storage bin 50 for the mixture 10c, which may be brought to the bin in transporting containers such as motor trucks (not shown). The bin 50 is located near a usual elevating tower 51 for a dump bucket 52 of a well known type, and preferably is arranged so that the mixture 10c in it may be discharged by action of gravity through a chute 53 into the bucket when the latter is lowered in a usual way. Water may be incorporated with the dry ingredients as described hereinbefore, or any other suitable way, after each bucket load of the mixture 10c is dumped into the downwardly inclined chute 20. By this arrangement, it is unnecessary for the builder to perform the work of lifting the water in the concrete from the foot of the tower to the chute 20 as would have to be done if the concrete was mixed as has been done heretofore. The pressure of the water will, in most cases, raise it to the chute.

Provision of a bin 50 at the site of the structure large enough to hold a supply of the mixture 10c sufficient for a day's run affords an advantage which is very desirable in many cities. The necessary supply of the mixture 10c for a day's concrete work can be transported to the bin 50 from the bin 14 during the late hours of the night before, when street traffic is very light. This makes for rapidity and economy in transportation of the mixture, and also provides a safeguard against the pouring of the concrete being stopped at a time when it would result in undesirable joints being made in members of the structure.

In the construction of long high concrete walls and like structures, my new method of preparing concrete can be advantageously practiced as is indicated in Figure 6. The mixture 10c is discharged from a rear dumping truck 60 onto a belt conveyor 61 which may be of the well known portable elevating type and which conveys the mixture to a wetting device 62 which may be of the screw conveyor type.

As can be readily seen, the wetting device 62 can be mounted by means (not shown) on the usual frame-work (not shown) of the conveyor 61 so that the discharging end of the device can be readily positioned above forms 63 at various points along their length. The dry mixture can usually be handled more satisfactorily by a belt conveyor than green, plastic concrete since it is not so heavy, and also it does not stick to the belt and cause the latter to need constant cleaning while being used.

It will be understood that any suitable form of wetting or sprinkling means may be used for adding water to the dry mixture of solid concrete ingredients without departing from the broad scope of my invention.

It can be readily seen that according to my invention the quality and proportioning of a quantity of the solid concrete ingredients 10c can be satisfactorily inspected at the central plant and again at the job before water is applied to the mixture. And should a quantity of the mixture 10c which appears unsatisfactory in any particular be brought to a job, plenty of time, even up to several days, can be taken to test and decide on the quality and fitness of the mixture before mixing water with it and depositing the resultant product in the forms.

Variations may be resorted to within the scope of the invention, and portions of the improvement may be used without others.

Having thus described my invention, I claim:

1. The method of preparing concrete for building a structure consisting of thoroughly drying concrete aggregate, mixing dry cement with the dry aggregate in a central mixing plant distant from said structure, storing the mixture of dry cement and dry aggregate in a dry bin, applying heat to said mixture to maintain it in a dry condition, transporting said mixture in bulk in a dry container to a point adjacent said structure, conveying said dry mixture from said adjacent point to said structure by conveying and agitating means, and sprinkling water on said mixture as it is agitated and moved from said adjacent point toward said structure.

2. The method of preparing concrete for building a structure consisting of thoroughly drying the concrete aggregate, mixing dry cement with the dry aggregate in a central mixing plant distant from said structure, storing the mixture of dry aggregate and dry cement in a dry bin, maintaining said mixture in a dry condition, transporting in a dry container the mixture of dry cement and dry aggregate, in bulk, to a point adjacent the site of said structure, moving said dry mixture from said adjacent point to said structure through a screw conveyor device wherein said mixture is exposed to falling water and sprinkling water on said mixture in said conveyor.

3. A plant for producing a dry mixture of cement and concrete aggregate including drying devices for drying said concrete aggregate, a dry storage bin for keeping therein the dried aggregate, said bin having an intake opening in its upper portion and an outlet opening in its lower portion, said bin being positioned relative to said drying devices so that said dried aggregate may be discharged by gravity from said devices through said inlet opening into said bin, a mixing machine having its receiving side positioned adjacent said outlet opening, a second dry storage bin adjacent the delivery side of said mixing machine, said second bin having an outlet and a receiving opening positioned to receive the mixture discharged from said machine, and means for applying heat to the contents of said bins for maintaining the contents in dry condition.

4. The method of preparing concrete for building a structure consisting of thoroughly drying the concrete aggregate, storing said dried aggregate in a dry bin, applying heat to said stored aggregate preparatory to removing the same from said bin, mixing dry cement with said dry aggregate in a central mixing plant distant from said structure, storing the mixture of dry cement and dry aggregate in a dry bin, applying heat to said mixture for maintaining it in dry condition, transporting said mixture in bulk in a dry container to a point adjacent said structure, conveying said dry mixture from said adjacent point to said structure by a conveying and agitating means, and sprinkling water on said mixture as it is agitated and moved from said adjacent point toward said structure.

WILLIAM W. LILLARD.