

March 31, 1942.

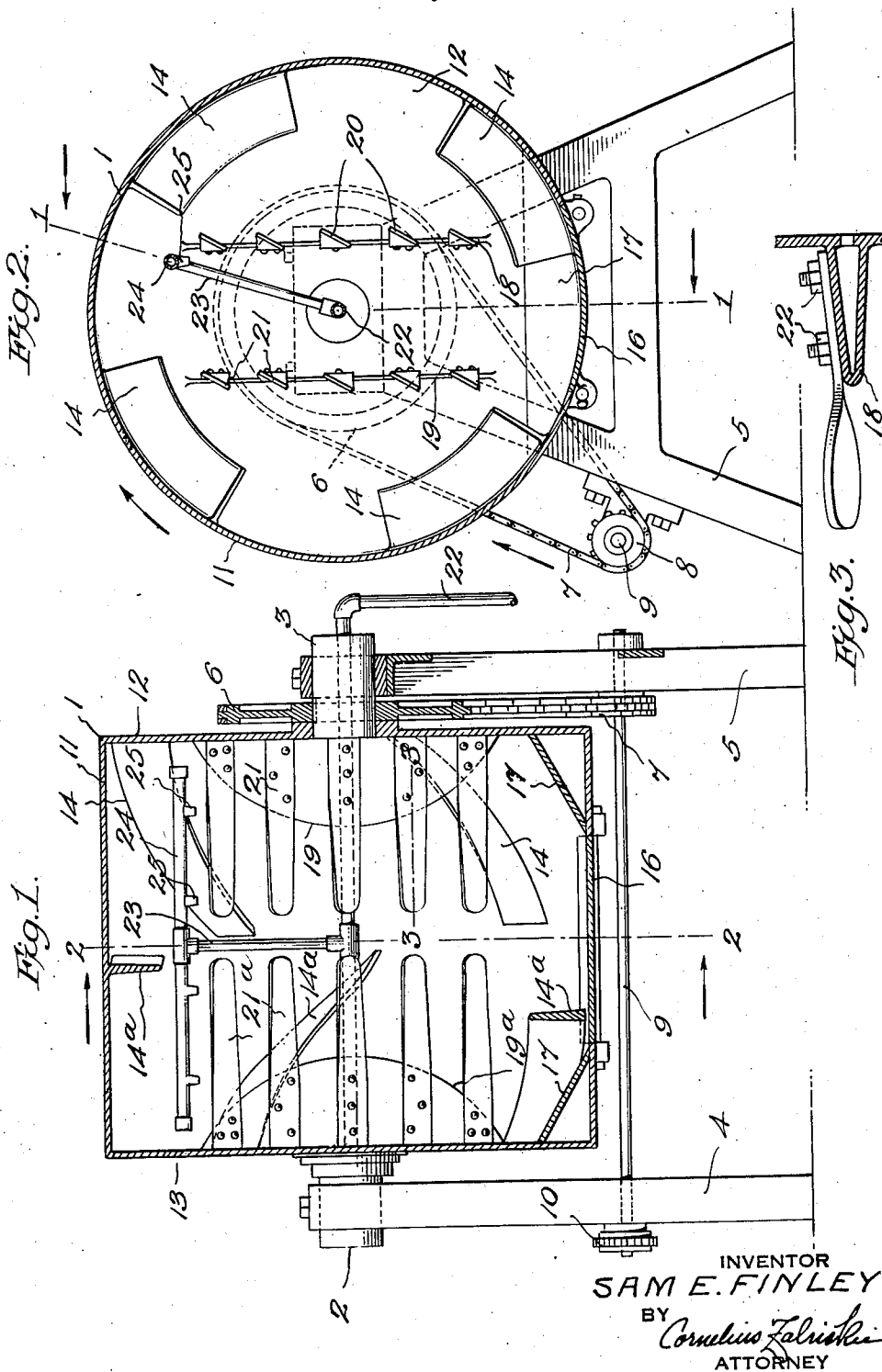
S. E. FINLEY

2,278,069

APPARATUS FOR MIXING MINERAL AGGREGATE

Filed May 22, 1941

2 Sheets-Sheet 1



March 31, 1942.

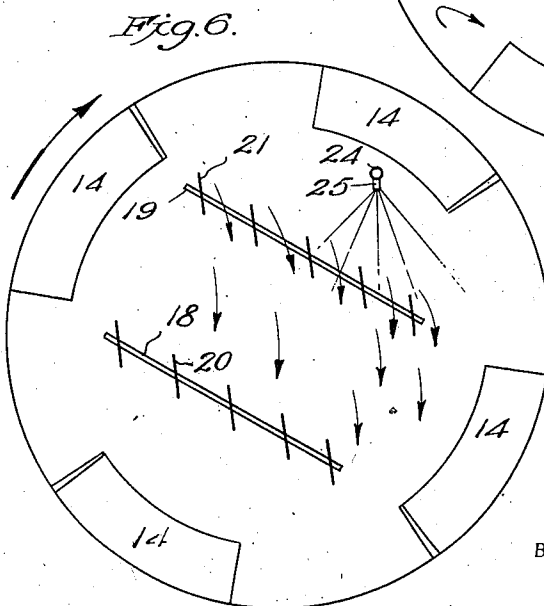
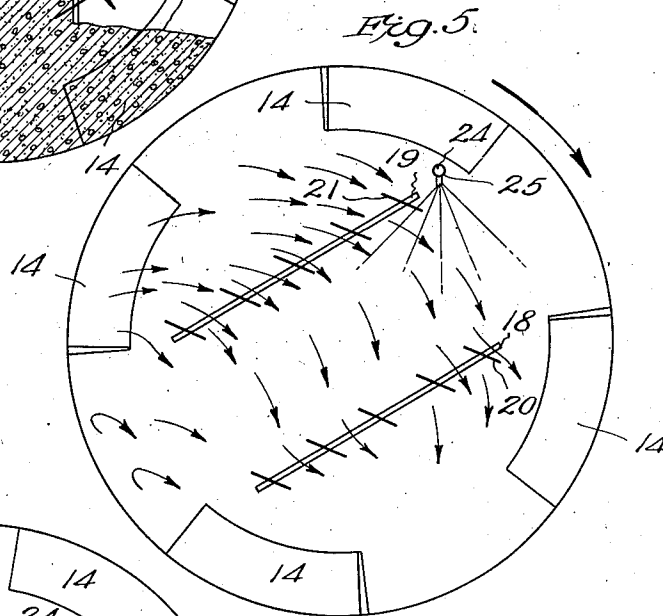
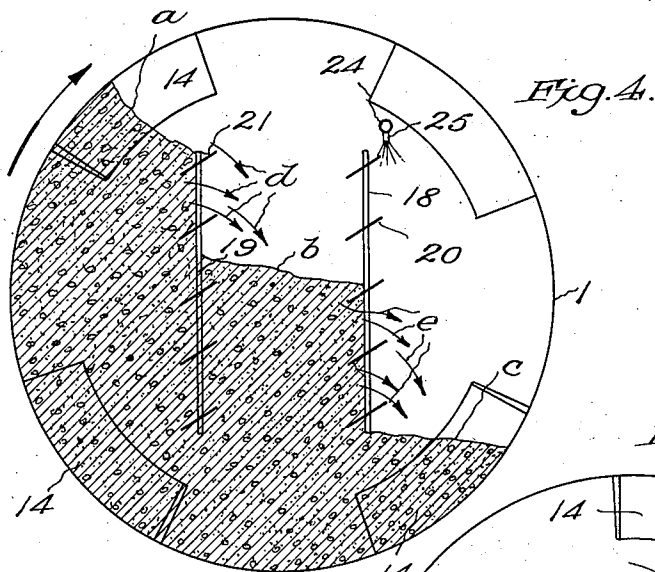
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APPARATUS FOR MIXING MINERAL AGGREGATE

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2 Sheets-Sheet 2



BY

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APPARATUS FOR MIXING MINERAL
AGGREGATE

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Application May 22, 1941, Serial No. 394,630

12 Claims. (Cl. 259—175)

The primary purpose of the invention is to provide an apparatus by which uniform concrete can be produced more quickly and economically than heretofore.

More specifically, one object of the invention is to provide an apparatus for preparing bituminous cement-aggregate compositions in which the bituminous cement, in liquid form, is caused to thoroughly coat and impregnate the aggregate and agglomerates of such aggregate while thoroughly broken up and separated into individual particles.

A further object of the invention is to provide an apparatus of preparing bituminous cement-aggregate compositions through conjoint cascading and cutting operations.

Speaking generally, the apparatus of this invention is adapted for the tumbling and cascading of aggregate and a liquid through a series of cutting fingers set edgewise in the path of travel of the aggregate mass, so that said fingers exert a cutting and separating action upon the mass so that the mass is broken up by passage between said fingers. By this apparatus, I obtain results somewhat similar to those which are accomplished by cutting the aggregate mass with a spade or shovel.

It has long been recognized that one of the most efficient methods of producing a good concrete is to cut it with the blade of a shovel. This operation has a smoothing effect on the concrete and operates with a high degree of efficiency in bringing about a thorough mixture of the constituents. It opens up the mass for the entrance of the liquid constituent and it smooths out the mass and produces uniform consistency. By the present invention this so-called cutting action is effectually accomplished in a far more expeditious manner than it could ever be accomplished by a shovel blade and at the same time insures a presentation of all portions of the mass to the cutting action, in order to produce a uniform blend of all of the constituents.

The apparatus of the present invention constitutes one means of carrying out the method thereof in a manner to insure the highest efficiency and expedition of operation.

Features of the invention, other than those adverted to, will be apparent from the herein-after detailed description and claims, when read in conjunction with the accompanying drawings.

In the accompanying drawings I have shown one form of apparatus for carrying out the present invention but the showing therein made is to

be understood as illustrative only and not as defining the limits of the invention.

Figure 1 is a vertical longitudinal section of apparatus embodying the invention, this section being taken on the broken line 1—1 of Figure 2.

Figure 2 is a transverse section taken in the plane of the line 2—2 of Figure 1.

Figure 3 is a fragmental section through one of the cutting fingers taken in the plane of the line 3—3 of Figure 1.

Figures 4, 5 and 6 are schematic views showing consecutive steps in the method of this invention.

In the apparatus shown in Figures 1, 2 and 3, 1 indicates a cylindrical drum mounted to rotate on trunnions 2 and 3 supported in end frames 4 and 5. Secured to one end of the drum is a sprocket wheel 6 embraced by a sprocket chain 7 in mesh with a drive sprocket 8 fixed on the drive shaft 9. The shaft 9 is driven from any suitable prime mover, as through a sprocket 10, and serves to impart rotation to the drum 1. The peripheral shell 11 of the drum, as well as the heads 12 and 13 thereof, are shown in the drawings as of single thickness, although in practice these may be double walled or jacketed for the passage of steam therethrough in order that the drum may be kept hot. This is particularly important when mixing bituminous material, although for other materials, where heat is not required, the jacketing may be omitted.

Mounted on the inner periphery of the shell 11 of the drum are two sets of lifting blades, hereinafter referred to as the shell blades. They are indicated by the reference characters 14 and 14a and are of substantially helical form. The blades 14 extend from the right hand end of the drum and terminate substantially midway of the length thereof and are of right hand pitch, whereas the blades 14a extend from the left hand end of the drum and terminate substantially midway of the length thereof and are of left hand pitch. Moreover, these blades are staggered with respect to one another about the inner periphery of the shell, as shown in Figure 1, and they are made sufficiently wide to efficiently lift the material contained in the drum when the drum is rotated in a clockwise direction, as viewed in Figure 2.

In practice, the shell blades may be solid, but are preferably made hollow for the circulation of steam therethrough when dealing with bituminous material. Aggregate may be introduced into and removed from the drum through a charging and discharging door 16 adapted to be opened and closed as desired and discharge plates

17 are located within the drum at the opposite ends of the door to facilitate the complete discharge of the material.

Rigidly supported on each of the heads 12 and 13 of the drum are a pair of head blades. The blades on the head 12 are designated 18 and 19, while the corresponding blades on the head 13 are designated 18a and 19a. The blades 18 and 18a occupy the same plane which is parallel to a plane of both the blades 19 and 19a and both sets of head blades are located at the same distances from the axis of rotation of the drum and may be radially spaced apart approximately one-half the radius of the drum. These blades may be made solid, although in practice I preferably make them hollow as indicated in Figure 3, for the circulation of steam therethrough when bituminous material is to be operated upon.

Rigidly mounted on each head blade are a series of cutting fingers. The fingers on the head blades 18 and 19 are designated 20 and 21 and the corresponding fingers on the head blades 18a and 19a are designated 20a and 21a. The fingers are secured to their respective head blades by studs or bolts 22 (see Figure 3) or in any other suitable manner, so that they can be replaced from time to time as they may be worn out.

The fingers are spaced apart from one another with substantially equal spacing on each blade, the fingers being preferably about the same width as the spacing between them. Furthermore all the fingers are preferably of the same length and consequently some of them project greater distances beyond the free edge of the end blades than others. Note, for example, in Figure 1 the center fingers project only about half their length, while the successive upper and lower fingers project for increasingly greater distances, so that each head blade with its cutting fingers collectively constitute, in effect, combs with teeth of varying lengths.

Those portions of the fingers which extend beyond the edges of the head blades are all twisted in the same direction, so that these projecting portions of the fingers are substantially helical, as shown best in Figures 2 and 3 and the twisting of these fingers is in the direction of rotation of the drum for reasons hereinafter more fully explained.

The trunnions 2 and 3 of the drum are hollow and through these trunnions extends a pipe 22 provided, about midway of the length of the drum, with a branch 23 leading to a header 24 having thereon a series of spray nozzles 25.

A single liquid feed pipe 22 and a single header 24 are shown in the drawings for feeding liquid to the mix, but, if desired, an additional header with an additional feed pipe may be provided for, in the mixing of certain bituminous concretes, it is desired to spray a liquefier as well as a binder and the two headers will provide for this technique.

The apparatus which I have thus far described is adapted to carry out the method of this invention which is disclosed schematically in Figures 4, 5 and 6 and which will now be described in detail.

To facilitate this description the drum elements previously described will be referred to and the same reference characters will be used where possible.

The drum 1 is charged with aggregate, such, for example, as a graded aggregate of either or both stone and gravel of different sizes with or without sand, as may be desired for the particular

mix. The mass of the charge may vary without departing from the invention, but the drum is preferably charged to about half full. The prime mover is operated to rotate the drum in a clockwise direction, as viewed in Figures 4-6, and the mixing is thus initiated. Simultaneously a liquid bituminous binder or a liquefier or both may be admitted through the sprayer or sprayers or, if desired, liquid bituminous material may be introduced in bulk at the time of introducing the aggregate. We will assume for the present description that the liquid or liquids are sprayed. In this description, the heating of the drum will be omitted, but it will be understood that steam may be circulated through the jacketed cylinder and the shell and head blades.

As the drum revolves the aggregate therein is tumbled, cascaded and cut and the aggregate particles are separated to bring them into intimate contact with the liquid bitumen and all constituents of the mass are thoroughly intermingled and blended into a finished bituminous concrete mixture. In the mixing operation a number of very distinct manipulations occur and while it is not considered necessary here to describe every movement of the material and the way in which it is acted upon, I shall now set forth what I consider to be the main steps of the method and from these the intermediate steps will be understood.

Assuming, for example, that the drum is rotating in clockwise direction at a speed of approximately 14-16 R. P. M. and has reached the position shown in Fig. 4. The rotation of the drum has shifted the mass in the drum, so that the surface of such mass, instead of being substantially horizontal as is the case when the parts are initially at rest, partakes of a position somewhat like that indicated by the lines *a*, *b*, *c*, in this figure. The relatively high level *a* is due to the fact that, during the rotation of the drum, the upper left hand shell blade 14 coacting with the lower left hand shell blade 14 has lifted the material level, while the head blade 19 and fingers 21 act as baffles to retard a tendency of the thus lifted material to cascade toward the center of the drum. Some of this material will of course squeeze between the uppermost fingers 21, as indicated by the arrows *d*, and simultaneously the two left hand shell blades will tend to move this material toward a medial plane of the length of the drum. Nevertheless the rotation of the drum is sufficiently rapid to raise the material to approximately the elevation *a* notwithstanding the lowering tendencies to which I have referred.

While the material at the left of the head blade 19 and fingers 21 is being lifted to the elevation *a*, as stated, the material in advance of the head blade 18 and fingers 20 is being lifted by this blade and fingers and by the pushing action of the lower right hand shell blades 14 to the elevation indicated at *b*. In other words, it is banked up in front of the blade 18 and fingers 20, although some of the material will squeeze through between the lowermost fingers 20, as indicated by the arrows *e*. Simultaneously there will be of course a falling away of the material between the tips of the blades 20 and 20a at the opposite ends of the drum, but the speed of the drum is sufficient to bring about the elevation at both *a* and *b* as shown.

Now let us assume that the drum continues its rotation for another 60 degrees into the position of Fig. 5. By the time it has reached this

position, all of the cutting fingers have been tilted perceptibly, as shown in this figure, so that the aggregate masses which have been banked up, in front of the fingers and head blades can more freely pass between the cutting fingers of both pairs of end blades, as indicated by the numerous arrows in Figure 5.

As the material passes through these fingers by gravity, the fingers have a cutting effect upon the material and this is particularly true because the helical formation of the fingers tends to feed the material toward a point medially of the length of the drum. There consequently results a cutting action wherein the fingers slice through the material as the material moves between them and while said material is moving to some extent longitudinally of the drum. This longitudinal movement is also brought about by the tendency of the material which has accumulated upon the head blades to cascade off of these blades and between the fingers. The so-called slicing or cutting action is brought about largely by the action of gravity. It is particularly prevalent in this method and is clearly apparent in the operation of the apparatus shown in Figures 1 and 2.

The cutting action breaks up all lumps and thoroughly separates the material so that it falls in dispersed particles. In fact when the parts are in the position shown in Figure 5, by far the greater portion of the mass in the drum is dispersed in substantial suspension, but rapidly falling under the action of gravity so that an appreciable portion of the lower part of the drum is practically uncovered.

Meanwhile the sprayers 25, which are preferably of the wide angle variety, spray bituminous liquid upon the falling particles, the dispersed or spaced condition of which is admirably suited to proper application of the liquid. The operation described continues while the drum continues its rotation through a further 60 degrees to the position of Figure 6, during which time the remainder of the material which has not already passed through and been subjected to the cutting action of the fingers, passes between them and falls to the bottom of the drum. During this period also the material which was banked upon the head blades is slid off of these blades onto the fingers and is subjected to the action thereof.

By the time the drum is rotated slightly beyond the position of Figure 6, practically all of the material which was elevated, as described in connection with Figures 4 and 5, has passed through the fingers and descended to the bottom of the drum so that from about the position of Figure 6, the head blades 18 and the fingers 20 cooperate with the lowermost shell blades 14 to start to bank up the material again to raise the material to the level *a* in Figure 4 and shortly thereafter the head vane 19 and its blades 21 cooperate with the right hand shell blades 14 to build up the level *b* indicated in Figure 4, so that by the time one-half revolution of the drum is completed, the operations described with reference to Figures 4, 5 and 6 will re-occur but with the end blades in, of course, reversed condition.

The operations which I have described with reference to Figures 4, 5 and 6 occur twice for each complete rotation of the drum, and they operate in definite cycles as described with the periodic raising and lowering of the level of the material and with accompanying tumbling and cascading of the material by the blades and fingers as indicated.

There is of course a relatively narrow area at a

point midway of the length of the drum where these operations are modified to a considerable extent by the absence of the fingers, because it will be noted from Figure 1 that the ends of the fingers on the opposite heads of the drum are spaced apart. Through this gap the material is free to cascade along a substantially unbroken incline, but there is very considerable agitation at this point, particularly as the shell blades are helical and tend to feed the material in this direction. Consequently there is here present a very violent tumbling, rolling and cascading action, causing the particles to rub together and assuring distribution of the bituminous material by attrition. Moreover, certain of the sprayers spray directly into this zone which forms, in effect, a void in the operations described with respect to Figs. 4-6. Into this void the particles of the material are constantly descending with the liquid sprayed therein, while in those portions of the length of the drum wherein the fingers and head blades are located, the operation is more in the nature of an intermittent action.

As a result the material within the drum is subjected to a number of different operations. Its particles are rubbed over one another, it is caused to flow and tumble, and it is cascaded, cut and dispersed. During these various operations the bituminous material is sprayed upon the mass to insure a uniform distribution of the graded aggregate throughout the mass and a uniform coating of all of the particles thereof with the bituminous material introduced as stated.

The fingers play a very important roll in the method and apparatus of this invention, for aside from the cutting action which has been described, these fingers also exert a mixing action as the material is squeezed between them. This squeezing action may be likened, in a sense, to the squeezing of mortar, plaster of Paris, or the like, through the fingers of the human hand when the hand is closed upon a mass thereof, or when the fingers of the human hand are used to stir a mass of such materials. Demonstration by the human hand in this connection will show that all lumps and agglomerates are efficiently broken up and an unusually smooth mix results. The fingers in the present invention operate in somewhat the same way during a portion of the rotation of the drum, while at other portions at the rotation of the drum they exert a pronounced cutting action depending upon the angle of approach of the material which impinges upon them or passes between them.

The cutting fingers of the present invention should not be confused with rotary beater rods and arms which have heretofore been used quite extensively in the mixing of mineral aggregates. Beater rods and arms mounted on shafts to rotate within mixing drums have long been used in this art. They have been rotated in the same direction as the drum and in directions opposite to the rotation of the drum and the rotation has usually been at an appreciably higher rate of speed than the speed of rotation of the drum. Their function is to beat the material or whip it during the mixing operation. My cutting fingers operate in an entirely different manner. They are not rotated rapidly through the material to drive it off in a different direction, but, on the contrary, the material as it is being mixed is deposited on or falls upon the four distinct series of fingers, while the fingers of each series with their corresponding head blades form in effect a shelf or platform wherein the fingers are like the

strips of a Venetian blind or the louvers of a food grater. As the material slides over these platforms, the several fingers act like the knives of the food grater to slice off portions of the material which fall through the intervening spaces. These homely illustrations clearly show the vast difference between the present invention and all prior mixing apparatus and methods of which I am aware.

Practical experience has shown that the method of this invention, as well as the apparatus thereof, provide unusually efficient mixing mediums. This is particularly noticeable in the apparatus for it is found that with this apparatus, it is possible to charge the drum with larger batches for efficient operation than is ordinarily true of mixing drums. This in itself shows that the mixing efficiency is high and this high efficiency, together with increased size of batch, makes the daily output of the apparatus much greater than is ordinarily possible in the mixing fields with consequent economies and without sacrifice of quality.

I have described the drum as rotated in a clockwise direction in Figure 2 and in Figures 4-6. It is also possible to operate the drum in a contra direction and still obtain a high grade mixture, particularly if the fingers are inclined in the opposite direction. It is likewise possible in carrying out the method of this invention to rotate the drum in one direction for a time on any particular batch and then complete the mixing of the batch by rotating it for a time in the opposite direction.

The foregoing description has dealt with the invention, for the purpose of illustration, particularly with respect to the mixing of bituminous concrete. The invention, however, is adapted to different uses and may be used with satisfaction for the mixing of hydraulic cement concretes and other mixtures where mineral aggregate are employed in conjunction with a liquid. The present invention, therefore, is to be understood as fully commensurate with the appended claims.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. An apparatus for mixing mineral aggregate comprising a drum mounted to rotate on a horizontal axis, lifting blades mounted on the interior of the peripheral wall of said drum, and a plurality of fingers mounted on the interior of each of the end walls of said drum at different radial distances from the axis of the drum and projecting longitudinally of the drum within the confines thereof to engage with and divide aggregate masses within the drum.

2. An apparatus for mixing mineral aggregate comprising a drum mounted to rotate on a horizontal axis, lifting blades mounted on the interior of the peripheral wall of said drum, and a plurality of relatively wide and thin fingers mounted on the interior of each of the end walls of said drum at different radial distances from the axis of the drum and projecting longitudinally of the drum within the confines thereof to engage with and divide aggregate masses within the drum.

3. An apparatus for mixing mineral aggregate comprising a drum mounted to rotate on a horizontal axis, lifting blades mounted on the interior of the peripheral wall of said drum, and a plurality of relatively wide and thin helical longitudinally fingers mounted on the interior of each of the end walls of said drum and projecting longitudinally of the drum within the confines

thereof to engage with and divide aggregate masses within the drum.

4. An apparatus for mixing mineral aggregate comprising a substantially cylindrical drum arranged with its axis horizontal and mounted to rotate thereon, a series of lifting blades projecting inwardly from the circumferential wall of the drum, end blades arranged in parallel relation to one another on the interior of the opposite end walls and fingers mounted on said end blades and projecting longitudinally of the interior of the drum with the free ends of the fingers of one end of the drum spaced from the adjacent ends of the fingers at the other end of the drum.

5. An apparatus for mixing mineral aggregate comprising a substantially cylindrical drum positioned with its axis horizontal and mounted to rotate thereon, substantially helical lifting blades on the interior of the periphery of the drum and extending substantially one-half the length of the drum from each end thereof with said helical blades at the opposite ends of the drum staggered with respect to one another, a pair of head blades projecting inwardly from the inner face of each of the heads of said drum and with all of said head blades parallel to one another and to the axis of the drum and spaced equidistantly from said axis, and broad relatively thin spaced apart fingers attached to each head blade and projecting beyond the free edge thereof in a direction parallel to the axis of the drum and terminating in spaced relation to the corresponding fingers at the other end of the drum.

6. An apparatus for mixing mineral aggregate comprising a substantially cylindrical drum positioned with its axis horizontal and mounted to rotate thereon, substantially helical lifting blades on the interior of the periphery of the drum and extending substantially one-half the length of the drum from each end thereof with said helical blades at the opposite ends of the drum staggered with respect to one another, a pair of head blades projecting inwardly from the inner face of each of the heads of said drum and with all of said head blades parallel to one another and to the axis of the drum and spaced equidistantly from said axis, each of said head blades being of substantially segmental shape, and broad relatively thin spaced apart fingers attached to each head blade and projecting beyond the free edge thereof in a direction parallel to the axis of the drum and terminating in spaced relation to the corresponding fingers at the other end of the drum.

7. An apparatus for mixing mineral aggregate comprising a substantially cylindrical drum positioned with its axis horizontal and mounted to rotate thereon, substantially helical lifting blades on the interior of the periphery of the drum and extending substantially one-half the length of the drum from each end thereof with said helical blades at the opposite ends of the drum staggered with respect to one another, a pair of head blades projecting inwardly from the inner face of each of the heads of said drum and with all of said head blades parallel to one another and to the axis of the drum and spaced equidistantly from said axis, and broad relatively thin spaced apart fingers attached to each head blade and projecting beyond the free edge thereof in a direction parallel to the axis of the drum and terminating in spaced relation to the corresponding fingers at the other end of the drum, each of said fingers being transversely inclined with respect to the planes of the head blades the inclination of all of said fingers being in the same direction.

8. An apparatus for mixing mineral aggregate comprising a drum having a cylindrical shell, the opposite ends of which are closed by heads, means on the heads for mounting the drum for rotation with its axis substantially horizontal, substantially helical shell blades secured to the inner surface of the shell at each end portion of the drum with the blades at one end portion of opposite pitch from the blades at the other end portion and the blades at the opposite ends of the drum being staggered with respect to one another, head blades parallel to one another and secured to the interior of each head of the drum on opposite sides of the axis of the drum with the head blades at one end of the drum in the same planes as the corresponding head blades at the other end of the drum, relatively wide and thin fingers secured to each head blade in spaced apart relation thereon with all of the fingers of all of the blades parallel to one another and with those portions of the fingers which extend beyond the head blades all inclined in the same direction.

9. An apparatus for mixing mineral aggregate comprising a drum having a cylindrical shell, the opposite ends of which are closed by heads, means on the heads for mounting the drum for rotation with its axis substantially horizontal, substantially helical shell blades secured to the inner surface of the shell at each end portion of the drum with the blades at one end portion of opposite pitch from the blades at the other end portion and the blades at the opposite ends of the drum being staggered with respect to one another, head blades parallel to one another and secured to the interior of each head of the drum on opposite sides of the axis of the drum with the head blades at one end of the drum in the same planes as the corresponding head blades at the other end of the drum, relatively wide and thin fingers secured to each head blade in spaced apart relation thereon with all of the fingers of all of the blades parallel to one another and with those portions of the fingers which extend beyond the head blades all inclined in the same direction, each of said head blades being of substantially segmental shape so that the several fingers thereon project varying distances beyond the edge of each blade.

10. An apparatus for mixing mineral aggregate comprising a drum having a cylindrical shell, the opposite ends of which are closed by heads, means on the heads for mounting the drum for rotation with its axis substantially horizontal, substantially helical shell blades secured to the inner surface of the shell at each end portion of the

drum with the blades at one end portion of opposite pitch from the blades at the other end portion and the blades at the opposite ends of the drum being staggered with respect to one another, head blades parallel to one another and secured to the interior of each head of the drum on opposite sides of the axis of the drum with the head blades at one end of the drum in the same planes as the corresponding head blades at the other end of the drum, relatively wide and thin fingers secured to each head blade in spaced apart relation thereon with all of the fingers of all of the blades parallel to one another and with those portions of the fingers which extend beyond the head blades all inclined in the same direction, each of said head blades being of substantially segmental shape so that the several fingers thereon project varying distances beyond the edge of each blade, and means in the upper portion of the interior of the drum to spray a liquid upon the contents of the drum.

11. An apparatus for mixing mineral aggregate comprising a substantially cylindrical drum positioned with its axis horizontal and mounted to rotate thereon, substantially helical lifting blades on the interior of the periphery of the drum and extending substantially one-half the length of the drum from each end thereof with said helical blades at the opposite ends of the drum staggered with respect to one another, and a plurality of broad relatively thin radially spaced apart fingers supported on the interior of each of the opposite ends of the drum and projecting therefrom in a direction parallel to the axis of the drum and terminating in spaced relation to the corresponding fingers at the other end of the drum.

12. An apparatus for mixing mineral aggregate comprising a substantially cylindrical drum positioned with its axis horizontal and mounted to rotate thereon, substantially helical lifting blades on the interior of the periphery of the drum and extending substantially one-half the length of the drum from each end thereof with said helical blades at the opposite ends of the drum staggered with respect to one another, and a plurality of broad relatively thin radially spaced apart fingers supported on the interior of each of the opposite ends of the drum and projecting therefrom in a direction parallel to the axis of the drum and terminating in spaced relation to the corresponding fingers at the other end of the drum, all of the fingers at each end of the drum being transversely inclined in the same direction.

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