March 27, 1956 M. F. KEMPER 2,739,797

METHOD OF AND APPARATUS FOR MIXING CONCRETE

Filed July 24, 1952 7 Sheets-Sheet 1

Fig. 1.

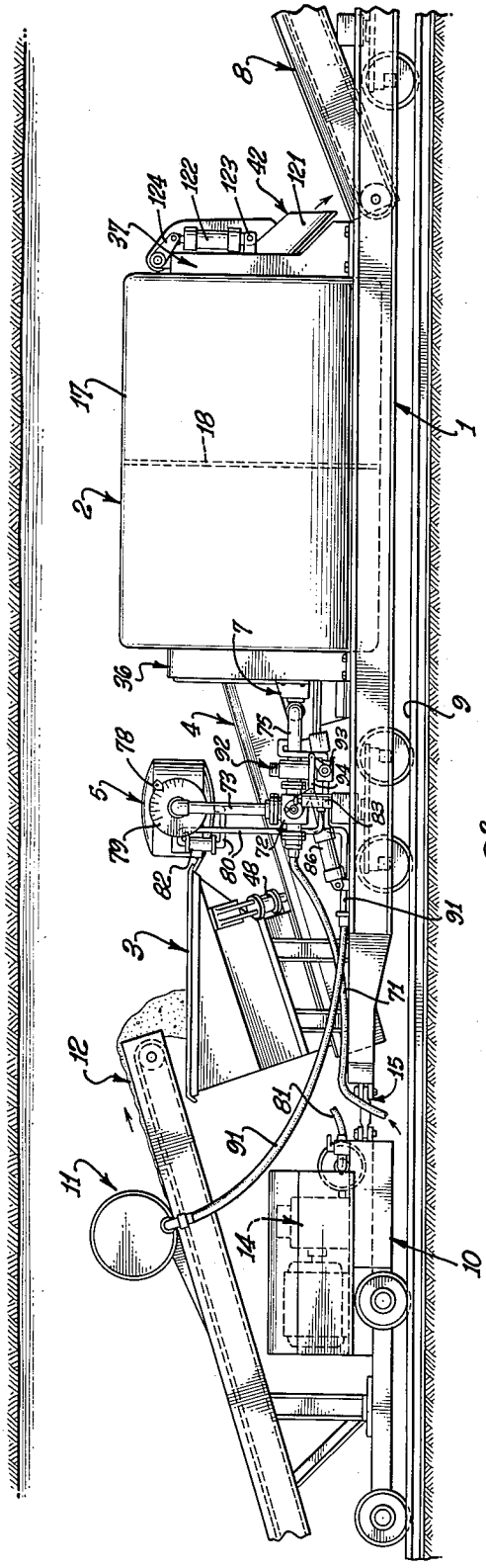


Fig. 9.

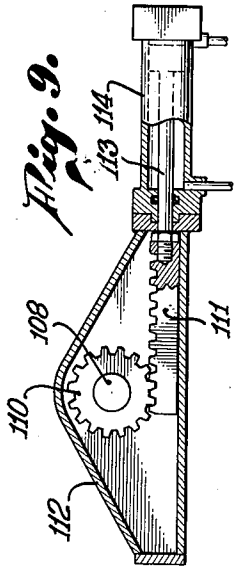
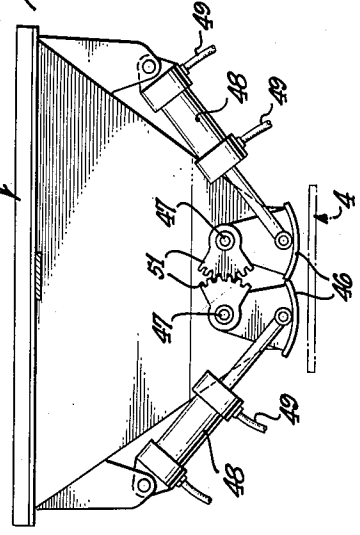


Fig. 8.



INVENTOR.
MAXWELL F. KEMPER,
BY
Paul A. Weilein
ATTORNEY.

March 27, 1956 M. F. KEMPER 2,739,797

METHOD OF AND APPARATUS FOR MIXING CONCRETE

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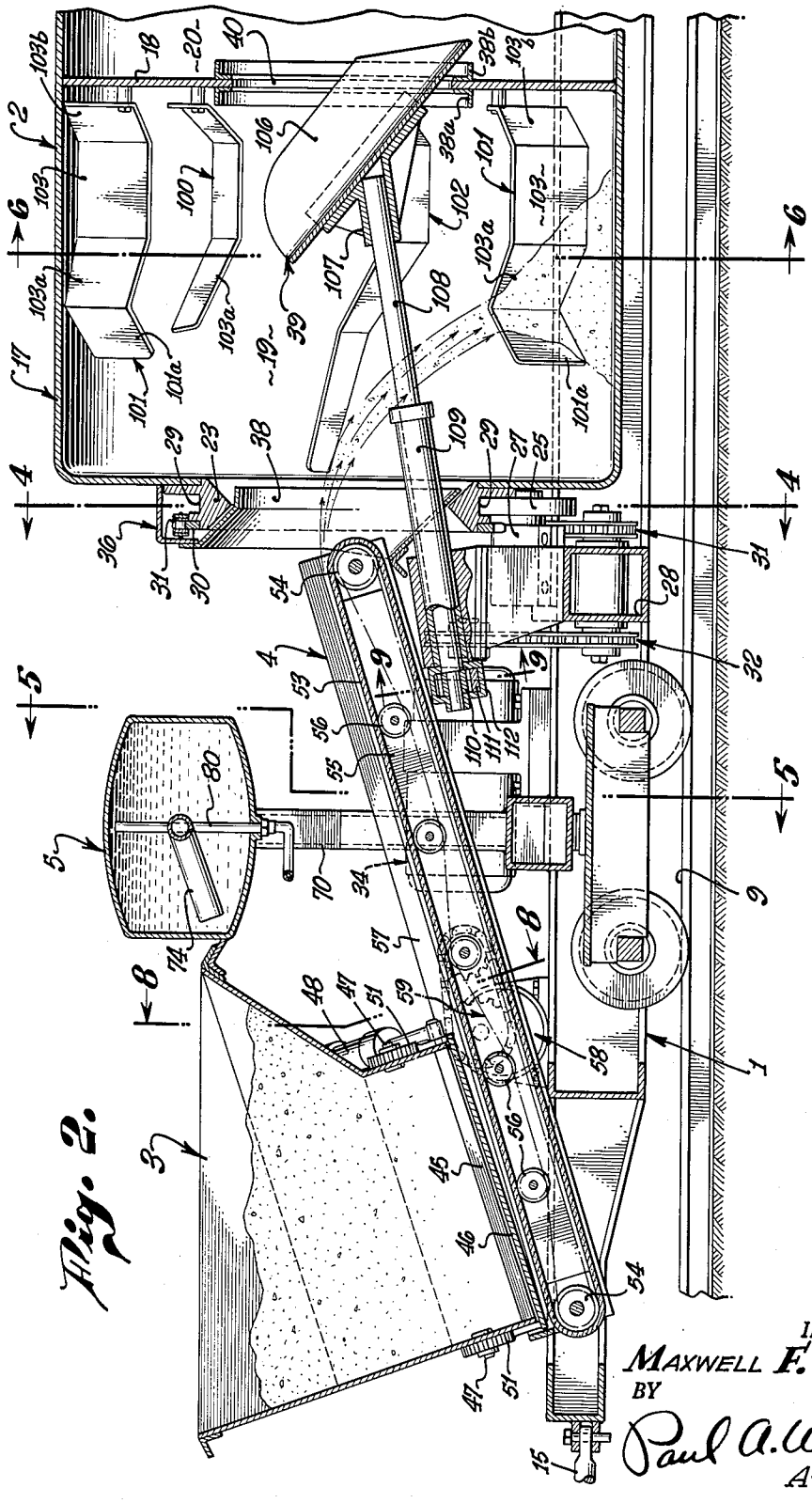


Fig. 2.

INVENTOR.
MAXWELL F. KEMPER,
BY
Paul A. Weilein
ATTORNEY.

March 27, 1956 M. F. KEMPER 2,739,797

METHOD OF AND APPARATUS FOR MIXING CONCRETE

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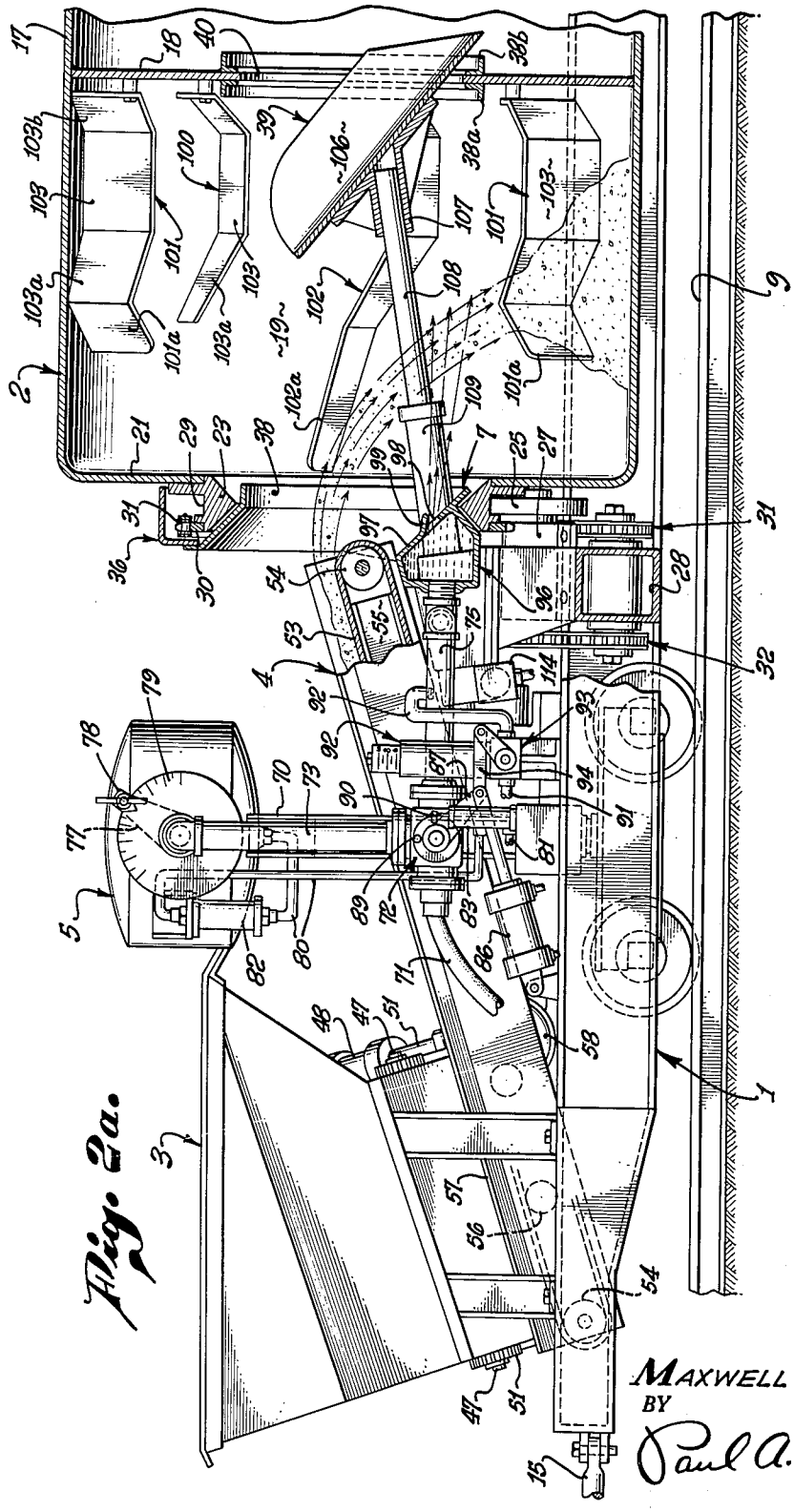


Fig. 2a.

INVENTOR.
MAXWELL F. KEMPER,
BY
Paul A. Weilcin
ATTORNEY

March 27, 1956 M. F. KEMPER 2,739,797

METHOD OF AND APPARATUS FOR MIXING CONCRETE

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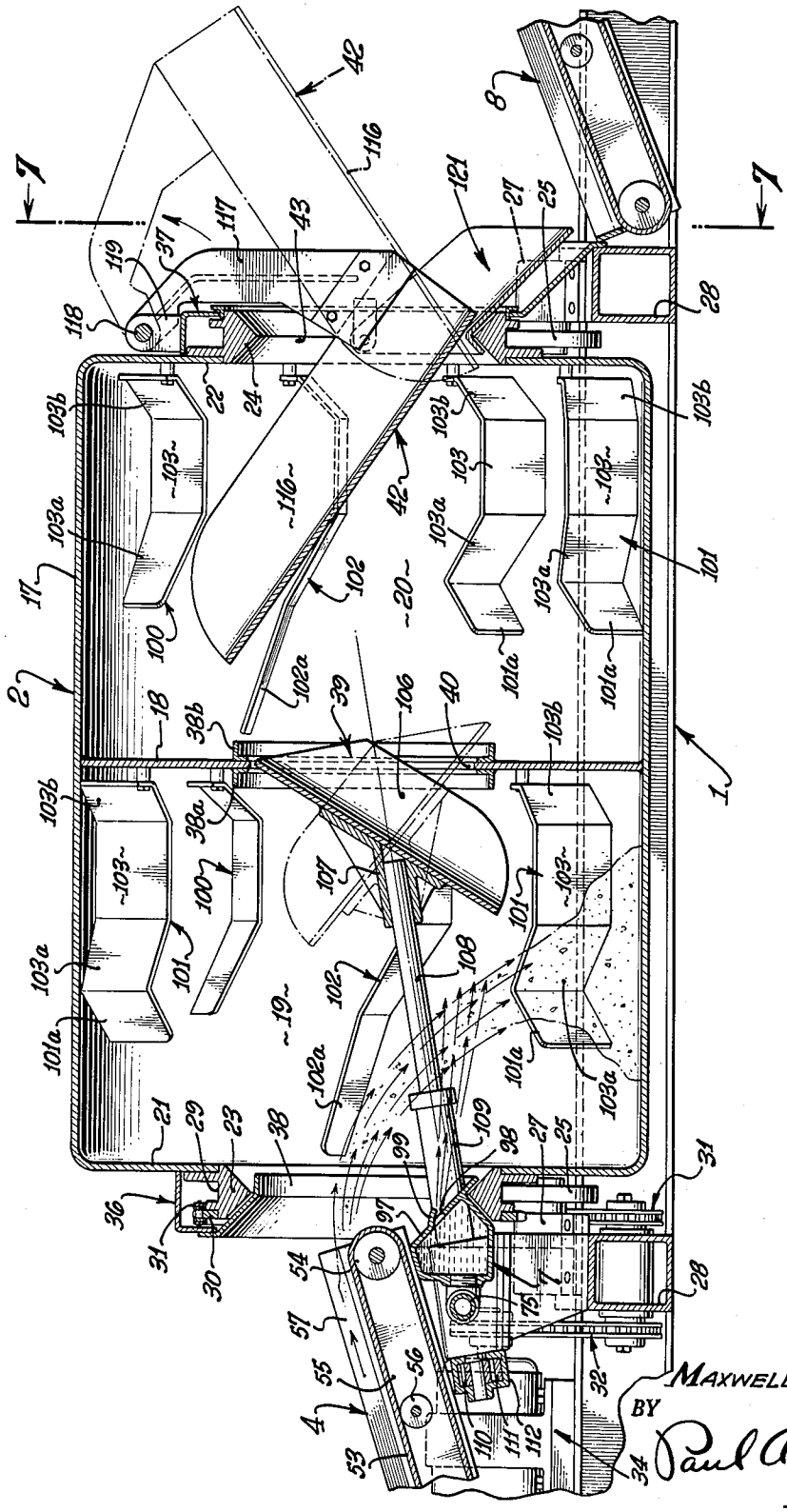


Fig. 3.

INVENTOR.
MAXWELL F. KEMPER,
BY
Paul A. Weilein
ATTORNEY.

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Fig. 4.

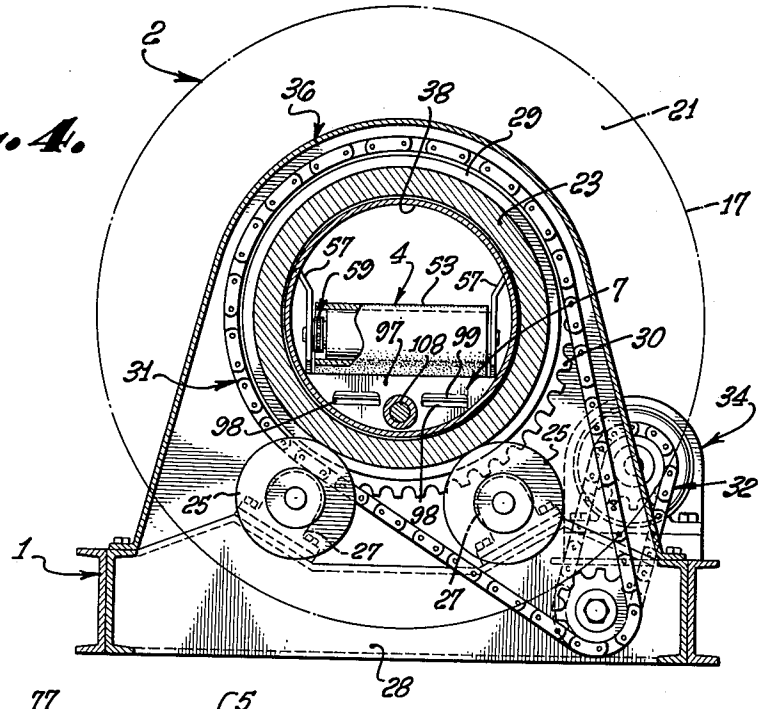
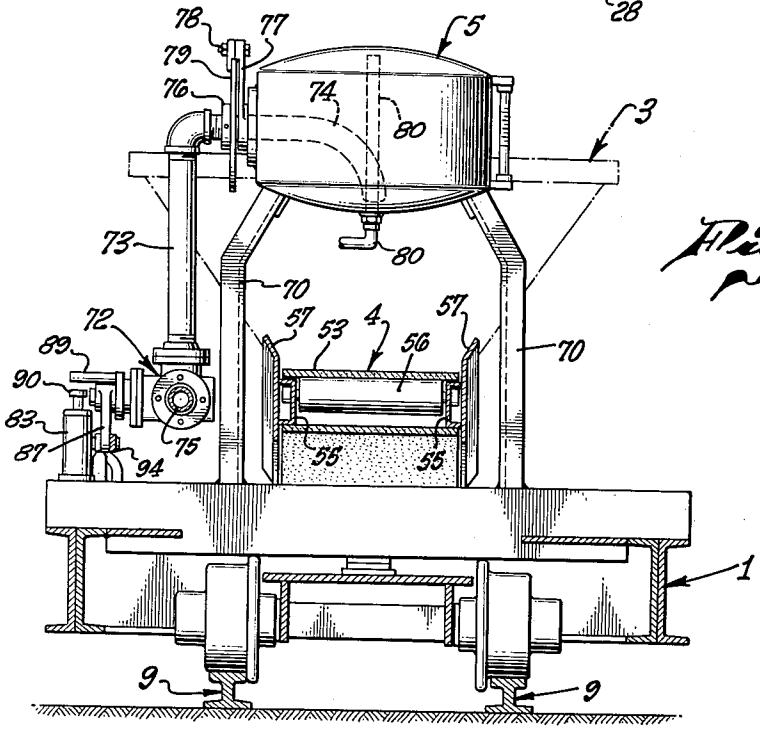


Fig. 5.



INVENTOR.
MAXWELL F. KEMPER,
BY
Paul A. Weilein
ATTORNEY.

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Fig. 6.

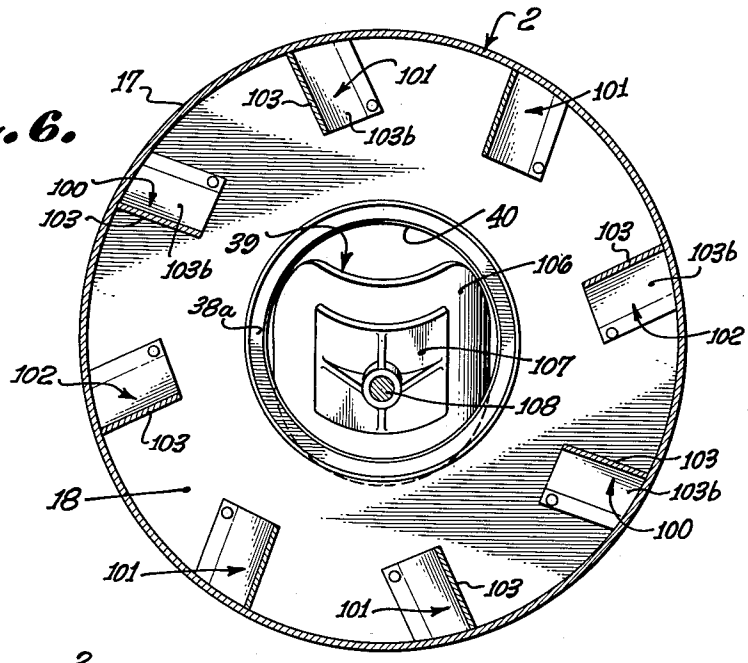
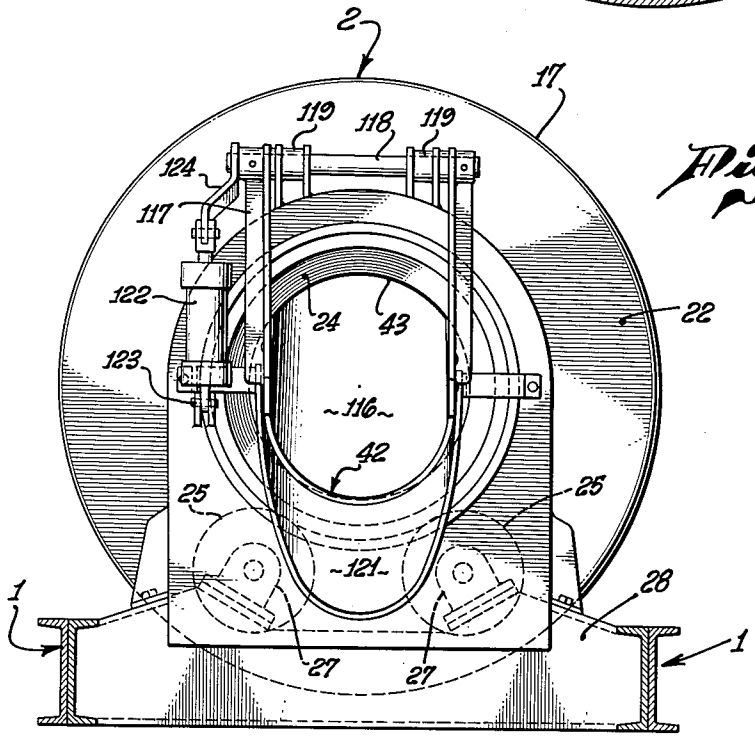


Fig. 7.



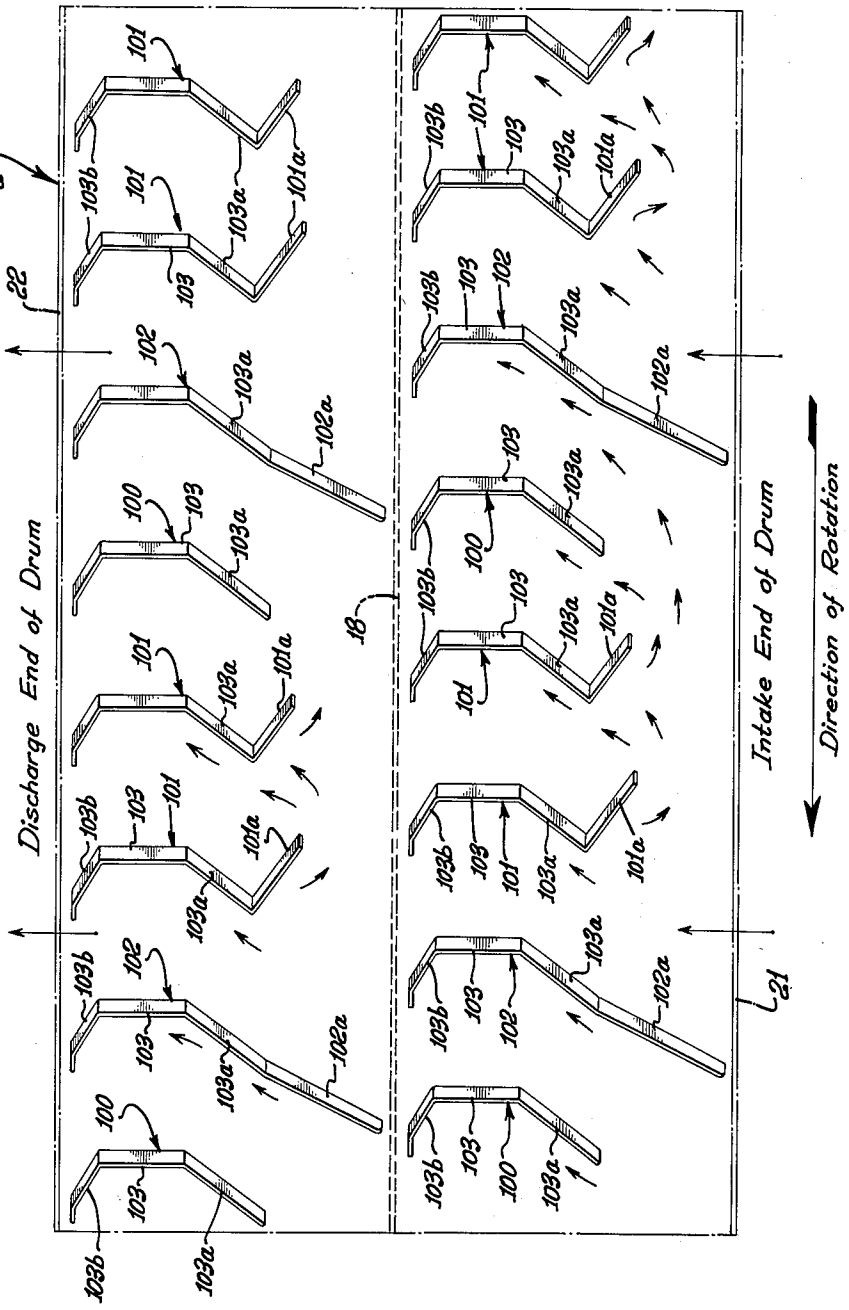
INVENTOR.
MAXWELL F. KEMPER,
BY
Paul A. Weilein
ATTORNEY.

March 27, 1956 M. F. KEMPER 2,739,797

METHOD OF AND APPARATUS FOR MIXING CONCRETE

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Fig. 10.



INVENTOR.
MAXWELL F. KEMPER,
BY
Paul A. Weilein
ATTORNEY.

United States Patent Office 2,739,797 Patented Mar. 27, 1956

2,739,797

METHOD OF AND APPARATUS FOR MIXING CONCRETE

Maxwell F. Kemper, Los Angeles, Calif.

Application July 24, 1952, Serial No. 300,721

29 Claims. (Cl. 259—161)

This invention relates to a method of and apparatus for mixing concrete, particularly for use in lining tunnels.

It is an object of this invention to provide a new method of mixing concrete, by means of which large quantities of concrete exceeding the standards and tests prescribed by building regulations and codes, may be produced in a shorter time per batch, than heretofore.

It is another object of this invention to provide a method which will permit of quick production of a large quantity of high quality concrete, with apparatus of small dimensions particularly adapted for use in tunnels.

It is another object hereof to provide a method of introducing the dry and liquid ingredients into the mixer, so that hydration commences during transit thereof to the mixer.

It is a further object to provide for forcibly and simultaneously cascading the cement, aggregate and liquid ingredients into a mixer in a manner causing hydration and premixing while these components are "in the air" within the mixer, whereby a more thorough mixing of a large batch of concrete may be effected in less time than is usually required.

It is an object of this invention to provide a compact concrete mixer of minimum height, which is especially designed to produce a large quantity of properly mixed concrete in a comparatively short time in a tunnel to be lined with concrete, the size of the unit facilitating the desired movement and operation thereof in small bore tunnels as well as providing greater working space around the mixer.

It is another object of this invention to provide a concrete mixer such as described, which readily lends itself to use in various methods of lining tunnels, for example in accordance with the method disclosed in my copending application, Serial No. 749,402, filed May 21, 1947, now Patent No. 2,660,034 granted Nov. 24, 1953, entitled Method and Apparatus for Placing Fluent Material.

It is another object to provide apparatus for introducing liquid under pressure, into a mixture of cement and aggregates cascading into the mixer whereby hydration commences during this cascading of the mixture.

It is another object to provide for the introduction of the liquid, cement and an aggregate as a comingled, cascading stream directed toward the center of the mixer, so that the mixing action commences as soon as the stream hits the bottom of the mixer, without requiring feed of the mass from a point of deposit on the bottom, to a zone of mixing, as has heretofore been necessitated in mixers.

It is another object hereof to provide a novel dual-drum mixer of small proportions, which will have a large capacity by reason of the manner of introducing the cement, water and aggregate components, and of the particular construction and arrangement of the mixing blades which produce a mixing action throughout the length of the mixing drum.

It is a further object to provide in a dual drum mixer, a novel combined transfer chute and closure means movable between a position serving as a closure between the

drums, and a position serving as a transfer chute for conveying concrete from one drum to the other.

It is an additional object of this invention to provide apparatus for lining tunnels with concrete, which includes the aforesaid improved mixer, and associated means for introducing the cement, aggregate and liquid components, and for discharging the mixed concrete from the mixer for delivery to the forms.

It is another object to provide a mixer such as described which is driven from an end thereof so as to maintain a low height and a small diameter of the mixer.

It is another object of this invention to provide a mixer such as described wherein the cement, aggregate and liquid ingredients are introduced through an end of the mixing drum, with the apparatus for effecting such introduction having no greater upright extent than that of the drum, whereby the unit as a whole is kept to small dimensions particularly as to height and width, for efficient use in tunnels.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of one embodiment of this invention. For this purpose there is shown one form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Fig. 1 is a side elevation of apparatus embodying the present invention;

Fig. 2 is an enlarged fragmentary longitudinal sectional view, showing a portion of the mixing drum as well as the means for introducing the dry and liquid components into the drum;

Fig. 2*a* is a sectional view similar to Fig. 2, showing more in detail, the means for supplying metered amounts of the liquid components to the mixer;

Fig. 3 is a view similar to Fig. 2, showing the complete mixing drum;

Fig. 4 is a cross sectional view taken on the line 4—4 of Fig. 2, to show the mounting means and the drive means for the mixer;

Fig. 5 is a cross sectional view taken on the line 5—5 of Fig. 2;

Fig. 6 is a cross sectional view taken on the line 6—6 of Fig. 2;

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 3;

Fig. 8 is an elevational view looking toward the aggregate and cement hopper from the line 8—8 of Fig. 2, to show the operating means for the releasing of the contents of the hopper.

Fig. 9 is a sectional view taken on the line 9—9 of Fig. 2, and

Fig. 10 is a schematic view of the arrangement of mixer blades between the ends of the dual drum unit.

One form of apparatus embodying the present invention, which the method of this invention may be carried out, is especially constructed for mixing concrete in tunnels.

Accordingly, this apparatus generally includes a wheeled frame or car 1, supporting a concrete mixer 2, a hopper 3, for the dry cement and aggregates, conveyor means 4 for introducing the mixed dry components into the mixer, a tank 5 for metering the water to be supplied to the mixer, and a nozzle structure 7 connected with the tank 5 for introducing the water into the mixer under pressure. The car 1 also may be employed to support a conveyor 8 for delivering the concrete from

the mixer to apparatus, not shown, for placing the concrete as desired in the forms, also not shown.

The car 1 with the aforesaid elements, parts and mechanisms thereon, including the necessary actuating means, is adapted to be run into and out of the tunnel on a track 9, as a part of a train of cars usually employed to form a complete unit for lining a tunnel with concrete. For example, a car 10 mounting a tank 11 for a supply of an air-entraining agent, a conveyor 12, a supply hopper (not shown), for the cement and aggregates, also a source of power such as the air compressor unit 14 may be coupled as at 15 to one end of the car 1 for supplying the dry ingredients and the air entraining agent, respectively, as well as for supplying compressed air for operation of certain of the units on the car 1.

The other end of the car 1, not shown, may be connected with car-supported apparatus, also not shown, for receiving the concrete from the conveyor 8 and placing it in the forms, for example apparatus employed for this purpose, as shown in the aforementioned copending application.

The mixer 2 and associated means for feeding the cement, aggregate and liquid components thereto, are constructed and arranged as a compact unit of small dimensions, but with provision for an optimum output of properly mixed concrete in a shorter time per batch than usually required.

Accordingly, the mixer 2 is of the dual drum type, consisting of a rotary cylindrical drum 17 divided by a partition 18 forming mixing chambers 19 and 20, having therein mixing blades which will be hereinafter fully described.

As a means for rotatably supporting and driving the drum 17 at the ends thereof, rather than supporting and driving the drum about its periphery, to avoid increasing the height and bulk of the mixer, the end walls 21 and 22 of the drum, as shown in Figs. 2, 3 and 4, have annular bearing members 23 and 24 welded or otherwise fixed exteriorly thereto, These bearing members are supported on pairs of rollers 25 (see Fig. 4), journalled in bearings 27 fixed on cross members 28 on the car 1. Peripheral grooves 29 in the bearing members 23 and 24 receive the rollers 25 and prevent axial movement of the drum relative thereto.

The means for rotating the mixing drum 17 comprises a sprocket ring 30 fixed on the bearing member 23 and driven by a sprocket chain 31, in turn driven by a chain drive 32, means operated by an electric motor 34 mounted on the car 1.

Shield structures 36 and 37 embrace the bearing members 23 and 24 and associated drive means to prevent foreign matter from getting into the bearing and drive means, these structures being suitably secured to the car 1 as shown in Figs. 2, 3 and 7.

The cement, aggregate and the liquid components are fed into the chamber 19 of the drum 17 through an intake opening 38 in the end wall 21 of the drum. As the conveyor 4 has a width which is but slightly less than the diameter of the intake opening 38, the dry ingredients will be introduced as a wide stream subject to quick hydration as it is encountered "in the air" by the liquid directed under pressure from the nozzle structure 7. The concrete mixed in the chamber 19 is conducted by the aid of a combined closure and transfer means 39 through a transfer opening 40 in the partition 18, into the mixing chamber 20. From the chamber 20, the concrete is conveyed by a combined closure and discharge chute means 42 through a discharge opening 43 in the end wall 22 of the drum, onto the conveyor 8.

In carrying out the method of this invention, the dry components, consisting of a dry mixture of cement and a suitable aggregate, are forcibly directed through an end of the mixing drum in a continuous free-falling stream so as to drop onto the bottom of the drum at a point intermediate the drum ends. Simultaneously with

this cascading feed of the dry components, a continuous stream of water under pressure is sprayed or jetted into the drum, so as to intercept the dry stream in a manner causing hydration to commence before the stream hits the bottom of the drum. When an air-entraining agent is specified, it is carried into the drum with the stream or jets of water.

In causing the pre-hydrated mix to fall adjacent the center of the drum, the mechanical mixing will commence immediately, it being unnecessary to cause the feed of the materials from the zone of deposit thereof in the drum, to the mixing zone as heretofore required in mixers.

As a result of this method of introducing the dry and liquid concrete-forming ingredients, the mixing time is appreciably reduced and a concrete exceeding the building regulation requirements as to slump test and other qualifications may be produced in large quantities with a comparatively small mixer.

It is to be understood that the method of this invention may be carried out with various means of which the apparatus here shown is an example. Thus, the hopper 3 and conveyor 4 provide for the introduction of the dry components according to the method, while the tank 5 and associated elements, including the nozzle structure 7, provide for the introduction of the liquid components under pressure according to the method.

Referring now to the hopper 3, it will be seen that it is mounted adjacent one end of the car 1 with its discharge opening 45 over the lower portion of the conveyor 4. A pair of closures 46 normally close the opening 45, being pivoted as at 47 on the hopper 3 so as to swing into and out of closing position responsive to a pair of two-way pneumatically operated rams 48. These rams are connected by flexible conduits 49 with the air compressor 14 and are simultaneously operated, the corresponding simultaneous movement of the closures being assured by means of intermeshed crank-arm quadrants 51 fixed to the closures as shown in Fig. 8.

When the closures 46 are opened, the dry components gravitate onto the conveyor 4 which is upwardly inclined, with its upper end terminating adjacent and opposite to the intake opening 38 of the mixing drum.

The conveyor 4 comprises an endless belt 53 mounted on drive rollers 54 supported by side frame members 55 suitably mounted on the car 1. A series of rollers 56 mounted on the frame members 55, support the upper run of the belt 53. Side plates 57 are fastened to the members 55 and extend above the upper run of the conveyor as shown in Fig. 5, to confine the dry ingredients on the belt in the operation of the conveyor.

An electric motor 58, mounted on the car 1 as shown in Fig. 2, drives the conveyor 4 through suitable drive means designated 59. In this connection, it should be noted that the conveyor is driven at a speed such that the dry ingredients are forcibly projected from the upper end thereof through the intake opening 38, in order to fall toward the center of the mixing chamber in a long arcuate path, thereby making it possible to cause an effective hydration as the liquid jet under pressure intercepts the stream of dry ingredients.

The water metering tank 5, as shown in Fig. 5, is supported on the car 1 over the conveyor 4 by means of standards 70. The water is supplied from any suitable source, not shown, through a flexible conduit 71 leading to a three-way valve 72 on the car 1. From this valve the water passes through an upright pipe 73 and an adjustable pipe member 74 into the tank 5.

The adjustable pipe member 74 is constructed and arranged to introduce water into the tank 5, as well as to provide for discharging metered quantities of water from this tank, back through the pipe 73, the valve 72, thence through a pipe line 75 leading to the nozzle structure 7 for introducing jets of water under pressure into the mixing chamber 19 according to the size of the batch of concrete to be mixed. The adjustment of the pipe member 74

is effected by means of a crank arm 77 operatively connected therewith and having a combined clamp and pointer member 78 thereon, movable over an indicator disk 79 suitably graduated to indicate the amount of water which will be discharged from the tank 5 according to setting of the pipe member 74.

The water is forced from the tank 5 by compressed air introduced into the top of the tank as shown in Fig. 2, through a pipe line 80 connected with a flexible hose 81 leading from the air compressor 14. The introduction of air from the compressor 14 into the top of the water tank 5 is controlled by a float operated valve 82 operating in cooperation with a mechanically operated control valve 83. The valves 82 and 83 are mounted in the air line 81 and are constructed and operated as shown and described in detail in my application for U. S. Letters Patent, Serial No. 306,226 filed August 25, 1952 and relating specifically to the metering tank for the water, the metering tank for the liquid air-entraining agent, and the means for controlling the flow of these liquids in metered quantities to the mixer of the present invention.

Accordingly, in the present application, it is deemed sufficient to point out that the float valve 82 and the valve 83 cooperate to permit air to be vented from the tank 5 through valve 83 to the atmosphere during the filling of the tank, with the float valve 82 closing when the tank is filled, to prevent flow of water past the valve. The valve 83 is spring loaded to occupy a position preventing flow of air past it to the tank 5, and to vent to the atmosphere that portion of the line between it and the tank during the filling operation. When moved to its air line-opening position, the valve 83 permits compressed air to flow through valve 82 and into the top of the tank, thereby putting the contents of the tank under pressure and forcing the water out through the adjustable pipe member 74, pipe 73, valve 72, pipe 75 and the nozzle structure 7 into the mixing chamber 19.

Means also forming a part of the invention embodied in the aforesaid companion application, is provided in the present apparatus for actuating the three-way valve 72 to shut off the flow to the tank 6 and at the same time move the valve 83 into position to open the air line 81 to the tank 5 for forcing the water under pressure into the mixer. This means, as shown in Fig. 2*a*, includes a two-way pneumatic ram 86, operatively connected with the compressor 14 and connected by suitable linkage means 87 for operating the valve 72. The ram moves the valve 72 between a position causing the water to flow into the tank 5 while the air line 81 is shut off by the spring loaded valve 83, and a position shutting off flow of water into the tank and connecting the pipe 73 with the pipe 75 leading to the nozzle structure 8. This operating means also moves the air valve 83 into position opening the air line 81 to the tank simultaneously with the movement of the valve 82 to the position connecting the pipes 73 and 75. For this purpose, the linkage means 87 includes an element 89 for engaging the stem 90 and opening the valve 83.

As in some instances, it is specified that a liquid air-entraining agent be added to the concrete forming ingredients, the tank 11 for such an agent is connected by means of a conduit 91 with a valved metering tank 92 (see Fig. 2*a*) in turn connected by means of a pipe 92' with the water pipe line 75 leading to the nozzle. The flow of this agent into the line 75 is controlled by a valve 93 operated by a linkage 94 connected with the linkage 87 for the valves 82 and 83. Thus, the valve 92 is operated simultaneously with the valves 82 and 83 whereby the air-entraining agent will flow into the water passing to the nozzle structure 7.

It should be noted that any suitable means may be employed for controlling the electric motors and the operation of the pneumatic rams embodied in the apparatus of this invention, whereby these actuating devices may be simultaneously and independently operated, or selectively operated, as required.

The nozzle structure 7 comprises, as shown in Figs. 2*a* and 4, an elongated closed chamber 96 fixed to extend horizontally adjacent the lower side of the intake opening 38 of the mixer 2. This chamber has a front wall 97 which is downwardly and inwardly inclined relative to the intake opening 38 and provided with a pair of laterally spaced horizontal, elongated orifices 98 for directing fan-like jets of the mixture of the water and the air entraining agent under pressure, into the stream of dry ingredients as shown in Figs. 2*a* and 3. These orifices are formed to provide baffle members 99 (Fig. 2*a*) thereabove on the front wall 97, to cause the jets to be directed downwardly and inwardly for encountering the stream of dry ingredients before the stream hits the bottom of the mixing chamber 19.

Referring more in detail to the mixing drum, it is seen, with reference to Figs. 3 and 10, that the mixing chambers 19 and 20 are provided with like mixing elements consisting of bucket forming blades 100, mixing blades 101 and cleaning blades 102 fixedly secured to the interior surface of the cylindrical walls of the chambers in circumferentially spaced relation one to the other. These blades extend in general, axially of the chambers 19 and 20. The bucket-forming blades 100 and the mixing blades 101 extend from the partition 18 and the end wall 22 to points approximately centrally of the ends of the chambers 19 and 20 respectively. The cleaning blades 102 extend approximately the full length of the respective chambers.

As shown in Figs. 3 and 10, each of the several blades consists primarily of a straight center plate 103 extending axially of the drum and disposed between and joined at its ends to ends of substantially straight end plates 103*a* and 103*b* extending angularly and divergently from plate 103 in a manner to form with the plate 103 a bucket having its concave side facing in the direction of rotation of the drum.

The bucket-forming blades 100 consist solely of the plates 103, 103*a*, and 103*b*, whereas the mixing blades 101 are provided with deflecting plates 101*a* joined to the outer ends of the plates 103*a* thereof and extending divergently therefrom in a direction opposite the direction of rotation of the drum. The cleaning blades 102 are provided with extension plates 102*a* projecting from the outer ends of the plates 103*a* thereof, to points adjacent the end wall 21 and the partition 18 respectively, whereby the blades 102 extend substantially the full length of the respective chambers.

These different vane formations provide for a quick and thorough mixing action throughout substantially the full length of the respective chambers 19 and 20. All of the blades serve as buckets to pick up the ingredients, as soon as the ingredients hit the bottom of the chambers 19 and 20 and at that time, commence an agitating, tumbling and mixing action of considerable intensity by reason of the particular construction and arrangement of the blades. The extensions 102*a* of the cleaning blades are so inclined as to guide any of the ingredients not deposited adjacent the center of the chambers 19 and 20, or which may have been deflected toward the end wall 21 and partition 18 respectively, toward the center of the drum, that is, into the zone in which the blades 100 and 101 effect the mixing action. These blades also facilitate the cleaning of the drum chambers throughout the length thereof. The extensions 102*a* also produce an agitating and mixing action.

The combined transfer chute and closure means 39, as shown in Fig. 3, includes an elongated chute 106 of arcuate cross section, provided intermediate the ends of the back thereof with a socket 107 projecting angularly from said back and having fixed thereto, a rotary shaft 108. This shaft projects through the nozzle structure 7 between the jet orifices 98 and is upwardly inclined therefrom to the point of attachment to the chute. This inclination of the shaft 108 and disposition of the socket 107 relative to the back of the chute makes it possible, selectively

to move the chute between a position shown in full lines in Fig. 3, serving as a closure preventing the mix from passing through the transfer opening 40 in either direction, into a position shown in dot-dash lines, in which the chute projects through the opening 40 for gravitationally transferring the mix from the chamber 19 into the chamber 20.

It should be noted that the chute 106, when in position to serve as a closure as shown in full lines in Fig. 3, has its upper edge in the transfer opening 40, substantially in line with the partition 21 to prevent flow of any part of the mix in either direction through the transfer opening 40. This is made possible by the inclination of the shaft 108 and the inclination of the chute 106 relative thereto.

The upper edge of the chute 106, when positioned as a closure, is protected by baffle rings 38*a* and 38*b* extending laterally from opposite sides of the partition 21 around the margin of the transfer opening 40. Thus, the upper end of the chute, when positioned as a closure, is disposed between the baffle rings, whereby water and portions of the mix, are prevented from passing through the opening 40 by the baffle rings and the particular position of the chute relative thereto. This arrangement obviates the necessity of employing flexible rubber sealing rings around the transfer opening 40 as heretofore required in dual-chamber mixers.

The shaft 108 is supported in an elongated bearing member 109 which extends through the center of the nozzle structure 7 in sealed contact with the walls thereof. The lower end of this shaft projects outwardly from the bearing 109 and has a gear 110 fixed thereto. As shown in Fig. 9, the gear 110 is driven by means of a rack bar 111 slidably guided in a housing 112 enclosing the gear and bar. The rack bar 111 is connected to the piston rod 113 of a two-way pneumatic ram 114 secured to one side of the housing 112. This ram is coupled in any suitable manner with the source of compressed air 14 and may be operated as desired by valve means, not shown, for rotating the shaft 108 to position the chute 106 as a closure or for transferring the mix from the chamber 19 to the chamber 20.

It should be noted that in extending the shaft 108 from below the conveyor 4 so as to be upwardly inclined from the intake opening 38 to the transfer opening 40, the opening 38 is unobstructed, whereby the conveyor 4 may be positioned forcibly to direct the dry components into chamber 19 to fall adjacent the center of this chamber.

Referring now to the combined closure and discharge chute means 42 for the chamber 20, it is seen with reference to Fig. 3, that it includes an elongated chute 116 of arcuate cross section, similar to the chute 106, and means for moving the chute between a position closing the discharge opening 43 and a position for conveying the mix from chamber 20 onto the conveyor 8. Accordingly, as shown in Figs. 3 and 7, the chute 116 is supported on the lower ends of a pair of arms 117, the upper ends of which are fixed to a horizontal rotary shaft 118 journalled in the bearings 119 mounted on the upper side of the stationary shield structure 27 on the end wall 22 of the mixing drum.

When the chute 116 is in position to close the opening 43 as shown in dot-dash lines in Fig. 3, the arms extend outwardly substantially axially of the drum, with the lower end of the chute extended within the lower part of the opening 43 and the remainder of the chute inclined upwardly and outwardly from said opening. The transverse curvature of the chute conforms to the curvature of the margins of the opening 43, whereby the chute will prevent the mix from being discharged from this opening.

When in position to serve as a discharge chute as shown in full lines in Fig. 3, the chute 116 is disposed, for the most part, within the chamber 20, the lower end of the chute projecting somewhat outwardly from the lower side of the opening 3. The mix is discharged from this lower end of the chute 116 onto a downwardly inclined, stationary chute 121 fixed to the lower portion of the shield structure 27 so as to direct the mix onto the conveyor 8.

As a means for moving the chute 116 into and out of positions to serve as a closure and as a discharge chute, a pneumatic two-way ram 122 is fixed as shown in Fig. 7, to a bracket 123 on the shield structure 27, and operatively connected with a crank arm 124 on the shaft 118. This ram is connected in any suitable manner with the air compressor 14 and may be selectively actuated by valve means, not shown, for disposing the chute in position to close the opening 43 or to discharge the mix onto the conveyor 8.

Operation

In the operation of the apparatus of this invention, upon opening the gates or closures 46 for the hopper 3 by means of the rams 48, a quantity of cement and aggregate, for example sufficient to make a given quantity of concrete, will gravitate onto the conveyor 4 which, together with the mixer, has been put into operation.

As the conveyor 4 commences to forcibly project the dry ingredients thereon through the intake opening 38 into the mixing chamber 19, the two-way ram 86 is operated to move the valve 72 from the position in which it causes the tank 5 to be filled, into the position for connecting the pipe 73 to the pipe 75 leading to the nozzle structure 7. When the valve 72 is operated to connect pipes 73 and 75, the linkage means 87 through the elements 89 and 90 causes the air valve 83 to open whereby compressed air will be effective in the tank 5 to force the water from the tank through the pipe 74, the pipe 73, valve 72 and the pipe 75 to the nozzle structure 7.

Also at this time, the linkage 94 causes the valve 43 to open and allow a metered quantity of an air-entraining agent to pass from the metering tank 92 through the pipe 92' into the pipe 75, whereby this agent will pass with the water under pressure, into the nozzle structure 7.

The water and air-entraining component build up a head in the nozzle chamber 96 and are forcibly ejected as pressure jets or streams through the elongated orifices 98, into the chamber 19 so as forcibly to strike the stream of dry ingredients in a manner causing hydration of the dry ingredients before they strike the bottom of the mixer.

Due to the width of the conveyor 4, the wide stream of dry ingredients introduced into the drum, when encountered by the fan-like jets of liquid issuing from the nozzle orifices 98 on opposed sides of the shaft 108, will be quickly hydrated. The fan-like jets of liquid will encounter the stream of dry ingredients for the most part at a point below the shaft 108, so that in having the latter inclined upwardly towards the transfer opening 40, it does not interfere with the streams of ingredients introduced into the drum so as to intercept one another, in accordance with this invention.

The hydrated stream will strike the bottom of the chamber 19 at a point adjacent the center of said chamber, and immediately will be agitated and mixed by the action of bucket blades 100, mixing blades 101 and cleaning blades 102.

After an appropriate mixing action in the chamber 19, the ram 114 is operated to rotate the shaft 108 for moving the chute 106 from a position closing the transfer opening 40, into a position to serve as a transfer chute, as shown in full lines in Figs. 2 and 2*a*, and in dot-dash lines in Fig. 3. This will cause the mix to gravitate into the chamber 20 where the mixing operation is completed.

After the transfer of the first mix to the chamber 20, the ram 114 is operated to move the chute 106 into position closing the transfer opening 40 and a new supply of concrete-forming ingredients are introduced into the chamber 19, while the finishing mixing operation of the

first batch is taking place in the chamber **20**. When the first batch has been mixed in the chamber **20** a prescribed length of time, the ram **122** is operated to move the chute **116** from closure position into position to discharge the mix onto the conveyor **8**. When the first batch has been discharged in this manner from the chamber **20**, the ram **122** is again operated to move the chute **116** into position to close the opening **43**. At the same time the ram **114** is operated to move the chute **106** into position to transfer the second mix into the chamber **20**.

Thus it will be apparent that these mixing, transferring and discharging operations may be carried out continuously to produce a large quantity of effectively mixed concrete in a comparatively short time, with compact apparatus of low overall height.

I claim:

1. The method of preparing concrete which comprises: impelling a mixture of cement and aggregate in the form of a sheet into a mixer; directing a spray of liquid under pressure across said impelled mixture and thereinto to initiate hydration before the mixture contacts the mixer; and then subjecting said mixture and liquid to a mixing action within said mixer.

2. The method of preparing concrete which comprises: impelling a mixture of cement and aggregate in the form of a sheet into a mixer; forcing jets of liquid against said impelled mixture from one side thereof to initiate hydration throughout said mixture before it contacts the mixer; and then subjecting said mixture and liquid to a mixing action within said mixer.

3. The method of mixing concrete which consists in: causing a mixture of dry cement and a dry aggregate to be impelled as a sheet into the interior of a concrete mixing drum so that the impelled mixture is directed toward a point between the ends of the drum; directing jets of water under pressure into said mixture from one side thereof so as to impinge against particles of the impelled mixture across the width thereof before the mixture contacts the interior surface of the drum; and subjecting the mixture to a mixing action incident to contact thereof with the interior of the drum.

4. The method of mixing concrete in a revolving drum having an intake opening at one end and a mixing zone interiorly thereof; which consists in impelling through said intake opening a sheet of dry mixed cement and an aggregate; impelling jets of water through said intake opening and against one side of the impelled mixture before the mixture strikes an interior surface of the drum so that the water jets will intercept the impelled particles in the air; and then subjecting said impelled mixture to a mixing action in said zone.

5. The method of mixing concrete which consists in: impelling a dry mixture of cement and an aggregate in the form of a sheet through the intake of a mixing drum; impelling through said intake beneath said impelled mixture and against one side thereof before the mixture strikes the bottom of the drum, jets of water which will impinge against the components of the mixture to initiate hydration thereof; and subjecting said mixture to a mixing action upon said mixture striking the bottom of the drum.

6. The method of mixing concrete which includes: impelling a dry mixture of cement and an aggregate in the form of a sheet into a mixing drum; and impelling jets of water into said drum from a point below the impelled mixture and to one side thereof in a direction such that the jets will intersect said impelled mixture before the latter strikes the bottom of the drum.

7. The method of mixing cement, which includes: causing a batch of dry mixed cement and an aggregate to be impelled as a continuous sheet into a cement mixer; directing from a point remote from said impelled mixture and into one side thereof a predetermined quantity of water as a continuous stream under pressure so as to intercept said impelled mixture while in transit above the bottom of the mixer; and subjecting the mixture to a mixing action when the mixture contacts the interior surface of the mixer.

8. A concrete mixer comprising: a mixing drum including means operable therein for mixing dry and liquid components for forming concrete; means for impelling into said drum a sheet of dry concrete-forming components; and means located to one side of the point of entrance of said components into said drum for injecting the liquid component under pressure in a direction transverse to the path in which said components are impelled so as to intercept said components before they encounter the interior of the drum.

9. A concrete mixer comprising; a mixing drum including means operable for mixing the dry and wet concrete-forming components, and means for simultaneously forcibly injecting through an end of the drum from vertically spaced points outside the drum the dry and wet components as separate, continuous, free falling streams which intercept one another while falling free of contact with the interior surface of the drum.

10. In a concrete mixer, a rotary mixing drum having an intake opening at one end, an outlet opening at the opposite end, and mixing vanes between said ends, means for projecting through said intake opening the dry concrete-forming components so as to fall freely therein at a point intermediate the ends of said drum; and means for introducing through said intake opening below the point of entrance of said stream, jets of liquid under pressure which intercept said falling dry components.

11. In a concrete mixer, a mixing drum having an opening therein, separate vertically spaced means for projecting through said opening, dry and liquid concrete-forming ingredients so that said ingredients will fan out in converging streams which intercept one another while in spaced relation to walls of said drum, and means operable upon said ingredients contacting said bottom, for agitating and mixing said ingredients.

12. In combination: a rotary mixing drum having intake and discharge openings; means for impelling dry concrete forming ingredients through said intake opening toward a point intermediate the ends of the drum; means for impelling water through said intake opening below the point of introduction of said dry ingredients; a member movable for opening and closing said discharge opening; and a shaft extending through said intake opening below said point of introduction of said dry ingredients and being inclined upwardly toward said intake opening; said shaft supporting said member and being operable to move said member to open and close said discharge opening.

13. In combination: a rotary mixing drum having an intake opening and a discharge opening; means for impelling into said drum through said intake opening dry concrete-forming ingredients; means for impelling through said intake opening below the point of introduction of said dry ingredients a stream of water; a chute; a shaft extending through said intake opening below said point of introduction of said dry ingredients; said shaft being inclined upwardly toward said discharge opening and supporting said chute; said chute being movable between a position for discharging concrete from said drum responsive tc rotative movement of said shaft.

14. In a concrete mixer, a rotary mixing drum having an intake opening and a discharge opening, means for introducing into said drum through said intake opening, dry and liquid concrete forming ingredients in the form of separate streams which converge and intercept one another while free from contact with the walls of the drum, a chute, means extending through said intake opening supporting said chute for movement between a position closing said discharge opening and a position for discharging concrete from the drum.

15. In a concrete mixer, a mixing drum having opposed walls provided respectively with an intake opening

and a discharge opening, means rotatably supporting said drum, means for introducing into the drum through said intake opening dry concrete-forming ingredients in a stream directed to fall intermediate said walls, means below said introducing means for injecting through said intake opening under pressure, a jet of liquid intercepting said stream while spaced from contact with the walls of the drum, a chute, and a shaft extending through said intake opening, supporting said chute and operable for moving said chute between a position closing said discharge opening and a position for discharging the mixture from the drum, said first mentioned means introducing said dry ingredients so as to fall from a point above said shaft.

16. In a concrete mixer, mixing drum having opposed end walls respectively provided with intake and discharge openings, means engaged with said end walls rotatably supporting said drum, means for introducing dry concrete forming ingredients as a continuous stream through said intake opening so as to fall between said end walls, a nozzle structure mounted beneath said introducing means including a chamber having laterally spaced jet orifices for directing jets of liquid through said opening so as to intercept said stream of dry ingredients while said stream and said jets are free from contact with the walls of the drum, a chute, a shaft projecting through said intake opening between said orifices, supporting said chute and operable for moving the chute between a position closing said discharge opening and a position for discharging the concrete mixture therefrom.

17. In a concrete mixer, a rotary mixing drum having a partition dividing the drum into a pair of mixing chambers, said drum having an intake opening through which concrete forming ingredients are introduced into one of the chambers and a discharge opening through which mixed concrete is discharged from the other chamber, said partition having a transfer opening for transferring the concrete mixture from said one chamber into said other chamber, a chute for controlling said transfer opening, and a shaft extended through said intake opening and inclined upwardly therefrom toward said transfer opening, said shaft supporting said chute and being operable for moving said chute between a position closing said transfer opening and a position for transferring the concrete from said one chamber into said other chamber, said chute when in said closing position having the uppermost part of the edge at one end thereof aligned with the partition at the uppermost part of said transfer opening to prevent passage of the ingredients between said partition and said chute from one chamber to the other.

18. In a concrete mixer, a rotary mixing drum having a partition dividing the drum into a pair of mixing chambers, said drum having an intake opening through which concrete-forming ingredients are introduced into one of the chambers and a discharge opening through which mixed concrete is discharged from the other chamber, said partition having a transfer opening for transferring the concrete mixture from said one chamber into said other chamber, a chute for controlling said transfer opening, and a shaft extended through said intake opening, supporting said chute and being operable for moving said chute between a position closing said transfer opening and a position for transferring the concrete from said one chamber into said other chamber, said shaft being inclined upwardly from the lower portion of said intake opening towards said transfer opening, said chute when closing said transfer opening, having the uppermost part of the edge at one end thereof aligned with that part of the partition bounding the uppermost part of said transfer opening.

19. In a concrete mixer, a rotary mixing drum having a partition dividing the drum into a pair of mixing chambers, said drum having an intake opening through which concrete-forming ingredients are introduced into one of the chambers and a discharge opening through which mixed concrete is discharged from the other chamber, said partition having a transfer opening for transferring the concrete mixture from said one chamber into said other chamber, a conveyor inclined upwardly toward said intake opening for introducing concrete-forming ingredients therethrough, a chute for controlling said transfer opening, a shaft extended through said intake opening, supporting said chute and operable for moving said chute between a position closing said transfer opening and a position for transferring the concrete from said one chamber into said other chamber, said shaft being inclined upwardly toward said transfer opening from a point below said conveyor, a discharge chute for controlling said discharge opening, and means mounting said discharge chute for movement between a position preventing discharge of concrete from the discharge opening and a position for discharging concrete through said discharge opening.

20. In a concrete mixer, a rotary mixing drum having an intake opening, a conveyor inclined upwardly toward said intake opening, with its upper end disposed to discharge concrete-forming ingredients through said intake opening, a hopper arranged to deposit said ingredients onto the lower portion of said conveyor, and means adjacent said upper end of said conveyor, operable for injecting liquid through said intake opening into the ingredients discharging from said conveyor.

21. In a concrete mixer, a mixing drum having end walls, one of said end walls having an intake opening, means mounting said drum for rotation about an axis extending through said end walls, an inclined conveyor having its upper end disposed below the top of said intake opening, operable for introducing concrete-forming ingredients through said opening into said drum, and means for introducing a jet of liquid through said opening in a path which intersects the path of the ingredients discharging from said conveyor.

22. In a concrete mixer, a mixing drum having end walls, one of said end walls having an intake opening, means mounting said drum for rotation about an axis extending through said end walls, an inclined conveyor having its upper end disposed below the top of said intake opening, operable for introducing concrete-forming ingredients through said opening into said drum, and means for injecting water through said opening from a point below said conveyor, and so as to intercept the ingredients discharging from said conveyor.

23. In a concrete mixer, a rotary mixing drum having an intake opening and a discharge opening, a conveyor inclined upwardly toward said intake opening with its upper end disposed to discharge concrete-forming ingredients through said intake opening, a shaft extending through said intake opening from a point below said conveyor and being inclined upwardly toward said discharge opening, a chute mounted on said shaft for movement to open and close said discharge opening upon rotation of said shaft, and drive means connected with the lower end of said shaft.

24. In a concrete mixer, a rotary mixing drum having an intake opening and a discharge opening, a conveyor inclined upwardly toward said intake opening, with its upper end disposed to discharge concrete-forming ingredients through said intake opening, a rotary shaft extending through said intake opening and being inclined upwardly toward said discharge opening, and a chute mounted on the shaft to turn therewith into and out of positions closing and opening said discharge opening.

25. In a concrete mixer, a mixing drum having end walls, one of said end walls having an intake opening, means mounting said drum for rotation about a substantially horizontal axis, a conveyor inclined upwardly toward said intake opening, having its upper end disposed to project ingredients through said opening so as to fall freely at a point nearer to the center of the drum than to said

end walls of the drum, means for discharging said ingredients onto the lower end of said conveyor, and means for injecting liquid through said opening so as to intercept said falling ingredients.

26. In a concrete mixer, a rotary mixing drum having opposed end walls provided with intake and discharge openings respectively; means engaged with said end walls for rotatably supporting said drum, a conveyor inclined upwardly toward said intake opening, operable for introducing concrete-forming ingredients through said intake opening into said drum, a chute, and a shaft extended through said opening below the upper end of said conveyor, said shaft being inclined upwardly from said intake opening supporting said chute for movement into positions for opening and closing said discharge opening.

27. In a concrete mixer for operation in a tunnel, a wheeled frame, a mixing drum having opposed end walls provided with an intake opening and a discharge opening, cooperable means on said end walls around said opening and on said frame, respectively, mounting said drum for rotation about an axis extending through said end walls, a conveyor mounted on said frame, inclined upwardly toward said intake opening, with its upper end disposed to introduce ingredients through said intake opening into said drum, a hopper mounted on said frame above the lower end of said conveyor for depositing said ingredients thereon, a rotary shaft supported on said frame beneath said conveyor and extended through said intake opening, said shaft being upwardly inclined within said drum, and a chute mounted on said shaft to open and close said discharge opening upon turning of the shaft.

28. In a concrete mixer for operation in a tunnel, a mobile frame, a mixing drum having opposed end walls provided with an intake opening and a discharge opening, cooperable means on said end walls around said opening and on said frame, respectively, mounting said drum for rotation about an axis extending through said end walls, a conveyor mounted on said frame, inclined upwardly toward said intake opening, with its upper end disposed

to introduce ingredients through said intake opening into said drum, a hopper mounted on said frame above the lower end of said conveyor for depositing said ingredients thereon, a rotary shaft supported on said frame and extended through said intake opening, said shaft being upwardly inclined within said drum, a chute mounted on said shaft to open and close said discharge opening upon turning of the shaft, and means supported on said frame beneath the upper end of said conveyor for injecting jets of liquid through said intake opening into the path of the ingredients discharging from the conveyor into said drum.

29. In a concrete mixer, a mobile frame adapted to be positioned in a tunnel, a mixing drum having an intake opening, means mounting said drum for rotation on said frame, a conveyor mounted on said frame, inclined upwardly toward said intake opening, with its upper end disposed to introduce ingredients through said opening into said drum, and means supported on said frame below the upper end of said conveyor for injecting liquid through said opening into the ingredients discharging into the drum.

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