Nov. 10, 1936. C. F. BALL 2,060,409

MULTIPLE UNIT CONCRETE PUMPING APPARATUS

Filed Sept. 8, 1933 2 Sheets-Sheet 1

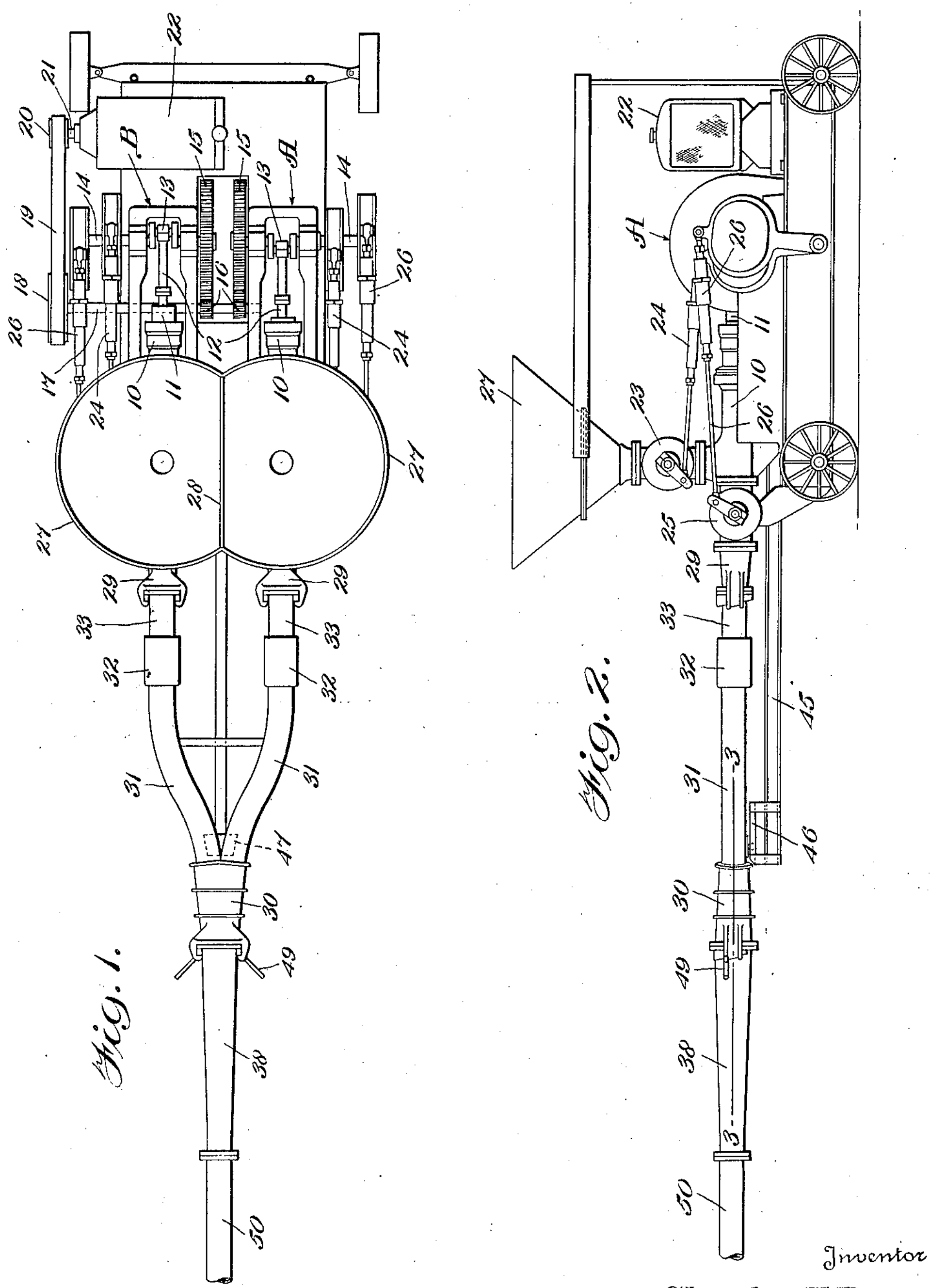

Fig. 1. Fig. 2.

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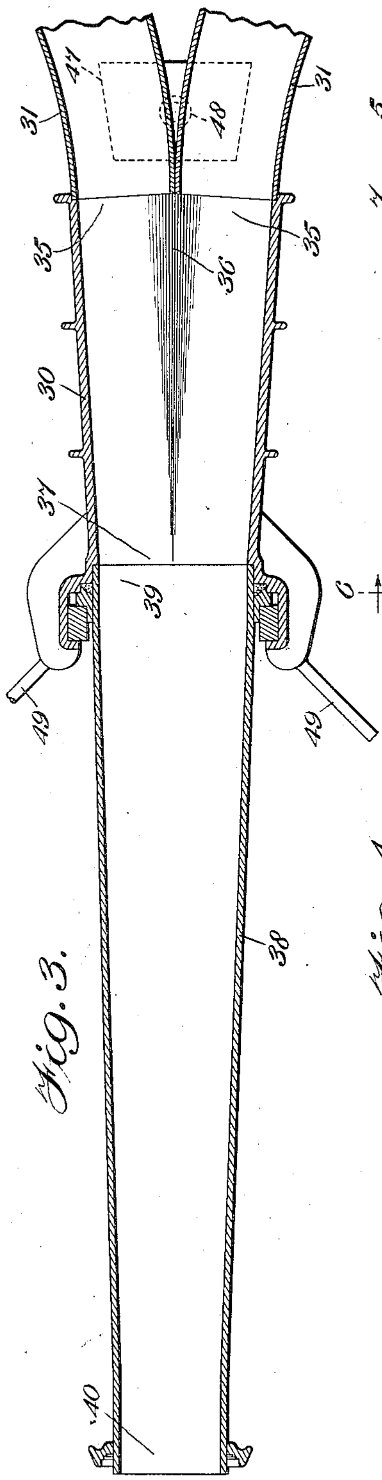

Fig. 3.

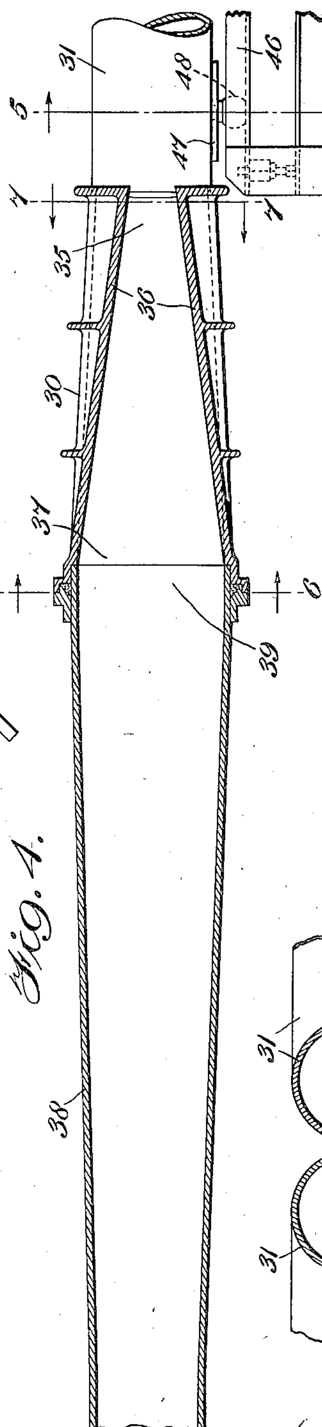

Fig. 4.

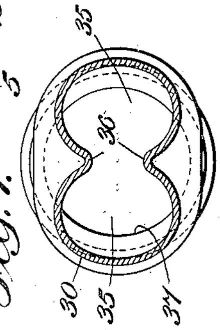

Fig. 7.

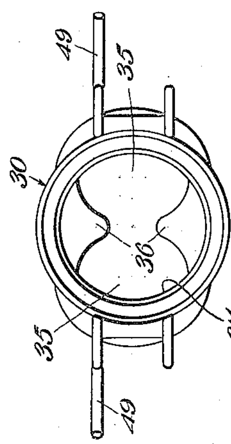

Fig. 6.

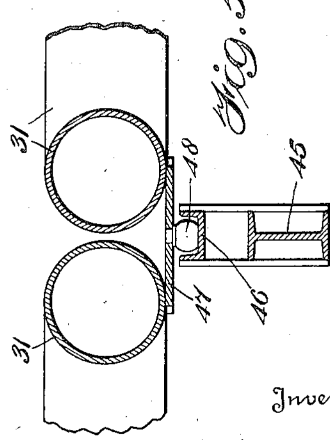

Fig. 5.

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MULTIPLE UNIT CONCRETE PUMPING APPARATUS

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Application September 8, 1933, Serial No. 688,650

15 Claims. (Cl. 137—78)

This invention relates to multiple unit concrete pumping apparatus, and has for one of its objects to provide apparatus of this character capable of forcing a plastic concrete mixture embodying substantial proportions of coarse aggregates which give to such mixture a strong tendency to "stow", over relatively great distances in a continuous confined stream, without detrimental change in the character of the mixture.

The recently developed Kooyman mechanical concrete pump, disclosed in U. S. Patent No. 2,017,975, granted October 22, 1935, which employs a power driven piston reciprocating within a working cylinder, delivers a continuous stream of plastic concrete mixture, and such pumps, having a single cylinder 7 inches in diameter, and a piston stroke of 10 inches, when working at from 44 to 55 strokes per minute, will handle up to 20 cubic yards of concrete per hour. In many instances, however, an increased capacity is desirable, and since it is not commercially practical to materially increase either the piston diameter or stroke, the most feasible way of accomplishing such increased capacity is through the use of additional cylinders. While the single cylinder pumps maintain the pipe line filled, they do not secure the maximum efficiency therefrom, since of necessity on the back stroke of the piston the concrete is not moving forwardly except through its own momentum, and this, because of the sticky nature of the mixture, is relatively small. It is therefore quite practical to employ additional working cylinders and pistons, preferably although not necessarily synchronized in their action, to force additional concrete through the line without increasing the diameter thereof, and such multiple cylinder pumps will discharge greatly increased quantities of the mixture thereby approaching the theoretical maximum capacity of the line.

It is of course old in all sorts of expansible chamber pumps to employ multiple working chambers, and to combine the discharges of the several chambers into a single stream. However, in attempting to combine two or more confined streams of plastic concrete moving under pressure, certain problems are met, which so far as applicant is aware, are not encountered in the handling of other substances.

As is now well known to those skilled in this art, the presence in the concrete mixture of the relatively large proportion of coarse aggregates, e. g. the gravel, crushed stone, and the like, in sizes which may range up to 3 inches or more in greatest dimension, imparts to the mixture a property known as "stowing". That is to say, such a mixture traveling through a closed conduit under pressure, upon meeting an obstruction in said conduit, or a sudden constriction therein, whereby in either case, a relatively abrupt reduction in the cross sectional area of the passageway is produced, will not increase its velocity as will a liquid or gas, to pass such restriction, but on the other hand, due to the resistance of the pieces of coarse aggregate to sudden changes in their relative positions in the mixture, will "stow" or pack at the restriction, and the flow will completely stop. When "stowing" once occurs, no amount of pressure, within the structural limits of the apparatus, will again start the flow. "Stowing" may also occur if there be too abrupt a change in the direction of travel of the stream, as at a bend in the passage, the radius of which is too small.

Practical considerations, including those having to do with the handling of the concrete pipe line sections, make it extremely desirable that the diameter of the pipe be not in excess of that of the pump cylinder, say 7 inches; but with two or more continuous 7 inch streams of concrete coming from a multiple unit pump, there is quite a problem to combine them into a single 7 inch stream without "stowing". If the constituents of the concrete mixture would freely change their relative positions, as do the particles of a liquid or gas, the combining would present no serious difficulties; but as above pointed out, the pieces of coarse aggregate resist to a marked degree any sudden change in their relative positions, and considerable experimenting has been necessary to determine a practical way of effecting the combination.

Under some conditions when operating with a multiple unit concrete pump, it may also be desirable instead of combining the separate streams, to pipe each stream to its own point of discharge, which points may be widely separated. Or, it may be desirable to operate with only one, or less than the maximum number of units, of the pump. This, together with the fact that the combining of the individual streams within the pump structure is not practical without increasing the dimensions of the pump beyond reasonable limits, makes it desirable that each unit have its own individual discharge, and that the combining of the streams, if done, be accomplished exteriorly of the pump.

The invention therefore resides principally in the provision of a plurality of separate pumping units, each having its own discharge conduit, operated to produce a plurality of continuous confined streams of the mixture, which may be discharged independently as such, but which are preferably combined without stowing into a single confined stream.

The invention further particularly includes the means whereby the several independent streams are combined without stowing into a single stream, the cross sectional area of which is substantially equal to the mean of the cross sectional area of the original streams.

With the above and other objects in view, which will appear as the description proceeds, the invention consists in the novel details of construction and combinations of parts more fully hereinafter described and particularly pointed out in the appended claims.

Referring to the accompanying drawings, forming a part of this specification in which like reference characters designate like parts in all the views:—

Figure 1 is a top plan view of one form of multiple unit concrete pumping apparatus constructed and arranged in accordance with the present invention, including the means for combining the separate streams into a single stream;

Figure 2 is a side elevational view of the parts shown in Figure 1;

Figure 3 is an enlarged horizontal sectional view through the stream-combining and reducing elements, taken approximately on the plane indicated by the line **3—3** of Fig. 2;

Figure 4 is a central vertical sectional view of the parts illustrated in Figure 3;

Figure 5 is a cross sectional view, taken approximately on the plane indicated by the line **5—5** of Fig. 4;

Figure 6 is an end elevational view of the outflow end of the combining chamber, as viewed on the plane indicated by the line **6—6** of Figure 4; and

Figure 7 is a cross sectional view, taken approximately on the plane indicated by the line **7—7** of Fig. 4.

In the said drawings there is illustrated more or less diagrammatically in Figures 1 and 2 a concrete pump of the Kooyman type, comprising two units, A and B, although obviously a greater number may be employed if desired. The said units are substantial duplicates of one another except that one is right hand and the other left hand as regards the valves, valve actuating mechanism and driving gears, and each comprises a cylinder **10**, piston **11** working therein, and reciprocated by means of piston rod **12** and crank mechanism **13** from a crank shaft **14** which carries a gear **15** meshing with a pinion **16** mounted upon the counter-shaft **17**, which carries a pulley or sprocket **18** driven by a belt or chain **19** which passes around a pulley or sprocket **20** carried by the driving shaft **21** of a suitable motor enclosed within the housing **22**. Each unit is provided with an inlet valve **23** having a suitable valve actuating mechanism **24**, and an outlet valve **25** actuated by suitable mechanism **26**. Each unit is further provided with a supply hopper **27** communicating with its inlet valve **23**, and as here shown, the two hoppers are joined together and provided with a dividing plate or wall **28**. Each unit is provided with its own individual discharge **29** leading from the outlet valve **25**. The driving gears **15** of the respective units are preferably so meshed with their pinions **16** that the pistons **11** of the two units are working in synchronism at 180° apart so that when one piston is making its working stroke the other is making its suction stroke. Of course if three or four units are employed the strokes of the pistons preferably will be operated at 120° or 90° apart as will be readily understood.

In case it is desired to conduct the concrete from the respective units in the form of two separate streams, separate pipe lines may be connected to the outlet members **29** of each unit and each line carried to its own discharge point. If, however, as is usually the case it is desired to combine the separate streams of the two units into a single stream, the apparatus shown at the left of Figures 1 and 2, and in detail in Figures 3 to 7 inclusive is employed.

This apparatus comprises a combining chamber **30**, which may conveniently take the form of a casting, to the inlet end of which is welded or otherwise rigidly secured a pair of reversely curved pipes or conduits **31**, which may be provided with suitable slip joints diagrammatically indicated at **32** for engagement with the short pipe sections **33** which are connected to the discharge members **29**, preferably by some form of readily detachable pipe coupling.

The combining chamber **30** when viewed in plan as in Figures 1 and 3, tapers from its right hand end as viewed in the said figures from a dimension which is substantially equal to the sum of the diameters of the pipes **31** to a somewhat lesser dimension at its left hand end. The said pipes **31** where they join the combining chamber **30** are disposed at an acute angle relative to one another, not exceeding say 30°, and preferably approximately only 15°, and the taper of the combining section **30** when viewed in plan is substantially that produced by this angle. On the other hand, said combining section as viewed in side elevation in Figures 2 and 4 tapers outwardly from right to left from substantially the diameter of one of the pipes **31** at the right hand end to a larger diameter at the left hand end. At its right hand end the combining chamber presents two substantially circular or slightly elliptical passages **35** best seen in Figures 6 and 7, disposed side by side and partially divided by the upwardly and downwardly projecting ridges **36**, which ridges, however, diminish in depth as they progress toward the left, as will be clear from Figures 3 and 4. These ridges leave no dead spots in the chamber in which the concrete would become dormant, harden and build up, and they also assist materially in the blending of the two streams and changing their shape into that of a single stream.

The chamber changes its cross-sectional shape as its progresses from right to left from that of the two side-by-side circular or elliptical passages **35** to a single circular passage **37** at the left hand end. The dimensions of the said passages, however, are such that the cross-sectional area of the chamber, regardless of its shape at any particular point, is substantially uniform throughout. In other words, assuming that the diameter of the pipes **31** is 7 inches, as above mentioned, the diameter of the outlet **37** of the combining chamber will be approximately 10 inches, which will give a cross-sectional area substantially equal to the sum of the cross sectional areas of the two inlet passages **35**. Of course, if more than two inlet passages are provided, in the case of a pump having more than two units, the diameter of the circular outlet **37** in most cases should be increased so as to make the cross sectional area of the said outlet more or less equivalent to the sum of the cross sectional areas of all the inlets.

With the pipes **31** both full of plastic concrete mixture in the form of continuous moving streams, these will be first brought into contact in the inlet passages **35** of the combining chamber, and will be gradually transformed by the latter into a single circular stream by the time they reach the outlet **37**, the cross sectional area of which combined stream will be substantially equivalent to that of the two incoming streams. The combining of the separate streams is so effected within the chamber **30**, by reason of the fact that its cross-sectional area does not vary materially notwithstanding the change in shape, that the pieces of large aggregate in the mixture are not called upon to change their relative positions sufficiently suddenly to produce the "stowing" action above described.

Except for the difficulty in handling the larger size pipe, say of 10 inch diameter, the mixture could be taken from the combining chamber at discharge **37** and conducted to the point of use in a stream of such diameter. However, it is preferred to reduce the diameter of the combined stream down to substantially that of each of the original streams, or say 7 inches, but in so doing, it is essential that the reduction be accomplished quite gradually. While the distance within which the reduction may be accomplished is of course somewhat dependent upon the consistency of the mixture—it being possible to reduce the diameter of a stream of a relatively wet mixture somewhat more rapidly than in the case of a comparatively dry mixture without stowing—it has been found that for the range of consistencies and mixtures commonly employed, a reduction from 10 inches to 7 inches in diameter may be accomplished within a distance of approximately 5 feet without producing the "stowing" action. Extremely wet mixes may be reduced in somewhat less than this distance while on the other hand extremely dry mixes may require a somewhat greater distance, but for all average mixtures the reduction above given has been found to be satisfactory.

In order to effect such reduction there is connected to the outlet end of the combining chamber **30** a tapered reducing section **38**, the right hand end **39** of which has a diameter equal to that of the outlet port **37** of the combining chamber, and the outlet end **40** of which has a diameter substantially equal to that of the diameter of the pipes **31**, or say 7 inches. As above stated this change in the diameter from 10 inches to 7 inches is preferably accomplished within a distance of approximately five feet.

In order to properly support the combining chamber and the said pipes **31** thereof a beam **45** may be extended longitudinally from the pump frame and be provided at its outer end with a suitable guide or track **46** here illustrated as comprising a channel section. A plate **47** is welded or otherwise rigidly secured to the under sides of the pipes **31** adjacent their point of entry into the combining chamber **30** and the said plate carries a stud or nubbin **48** extending downwardly and adapted to be received within the channel **46** as shown in Figures 4 and 5. The plate **47** and stud **48** are preferably located at substantially the balancing point of the assembled combining chamber **30** and the supply pipes **31**, so that the whole assembly may be readily handled by one man through the use of suitable grips or handles **49** with which the combining chamber **30** may be provided as shown in Figure 3. The said assembly may of course be slid longitudinally of the channel **46** to disengage the slip joints **32** when it is desired to break the conduit for any purpose, and the assembly may likewise be swung in a horizontal direction upon the stud **48** which acts as a pivot.

The pipe line **50** which is connected to the discharge end **40** of the reducing section **38** is preferably of the same diameter, say 7 inches, as the pump cylinders and the said line may be extended to any desired point of discharge as is common in these concrete pump lines.

Although in the drawings the two units are illustrated as being directly driven from the motor through the countershaft **17**, it is obvious that suitable clutch means may be provided for disengaging the drive of either or both. Such means, if employed, should be preferably of a type engageable in only one certain position of the parts, to preserve the proper timing of the pistons relative to one another.

While one form of the invention has been illustrated and described, it is obvious that those skilled in the art may vary the details of construction as well as the precise arrangement of parts without departing from the spirit of the invention, and therefore it is not wished to be limited to the above disclosure except as may be required by the claims.

What is claimed is:

1. In apparatus for combining without stowing confined moving streams of plastic concrete mixture embodying substantial proportions of coarse aggregates which give to the mixture a strong tendency to stow, a plurality of closed converging mixture conduits; and a combining chamber at the intersection of said conduits, having an inlet for each thereof, and a common outlet spaced from said inlets, said chamber continuously changing in cross sectional contour throughout its length from approximately that of said plurality of inlets to that of said common outlet while maintaining an approximately uniform cross sectional area.

2. In apparatus for combining without stowing confined moving streams of plastic concrete mixture embodying substantial proportions of coarse aggregates which give to the mixture a strong tendency to stow, a plurality of closed converging mixture conduits; and a combining chamber at the intersection of said conduits, having an inlet for each thereof, and a common outlet spaced from said inlets, said chamber continuously changing in cross sectional contour throughout its length from approximately that of said plurality of inlets to that of said common outlet while maintaining an approximately uniform cross sectional area which is substantially equal to the sum of the cross sectional areas of said converging conduits.

3. In apparatus for combining without stowing confined moving streams of plastic concrete mixture embodying substantial proportions of coarse aggregates which give to the mixture a strong tendency to stow, a plurality of closed converging mixture conduits; and a combining chamber at the intersection of said conduits, having a plurality of adjacent transversely communicating inlet passages connected with the respective conduits, and a common outlet longitudinally spaced from said inlets, each of the latter being of a configuration and cross sectional area substantially the same as its conduit, said chamber gradually changing in cross section throughout its length from the configuration of the plurality

of associated inlets to that of the common outlet while maintaining an approximately uniform cross sectional area.

4. In apparatus for combining without stowing confined moving streams of plastic concrete mixture embodying substantial proportions of coarse aggregates which give to the mixture a strong tendency to stow, a plurality of closed converging mixture conduits; and a combining chamber at the intersection of said conduits, the perimetral walls thereof being shaped at one end to provide a plurality of adjacent transversely communicating inlet passages, each connected to a conduit and of substantially the same cross sectional configuration and area as said conduit, said walls being shaped at the other end of said chamber to provide a single outlet having a cross sectional area substantially equal to the sum of the areas of said inlet passages, and said walls intermediate said ends being shaped to change gradually from the cross sectional configuration of said plurality of inlets to that of said single outlet while maintaining in all transverse planes a cross sectional area which is approximately equal to the sum of the areas of said inlet passages.

5. In apparatus for combining confined moving streams of plastic concrete mixtures, a plurality of closed passages converging at an acute angle, and a combining chamber at the intersection of said passages having a cross sectional area sufficient to prevent stowing of the mixture as the streams meet, said chamber having projecting ridges extending in the direction of flow for facilitating the merging of the streams.

6. In apparatus for combining confined moving streams of plastic concrete mixtures, a plurality of closed passages converging at an acute angle; and a combining chamber at the intersection of said passages having a cross sectional area sufficient to prevent stowing of the mixture as the streams meet, said chamber having tapering projecting ridges extending in the direction of flow for gradually changing the contour and facilitating the merging of the streams.

7. In apparatus for combining without stowing confined moving streams of plastic concrete mixture embodying substantial proportions of coarse aggregates which give to the mixture a strong tendency to stow, a plurality of closed mixture conduits converging at an angle of less than 30°; and a combining chamber at the intersection of said conduits, having an inlet for each thereof, and a common outlet spaced from said inlets, said chamber continuously changing in cross sectional contour throughout its length from approximately that of said plurality of inlets to that of said common outlet while maintaining an approximately uniform cross sectional area.

8. In apparatus for combining without stowing confined moving streams of plastic concrete mixture embodying substantial proportions of coarse aggregates which give to the mixture a strong tendency to stow, a plurality of closed mixture conduits converging at an angle of approximately 15°; and a combining chamber at the intersection of said conduits, having an inlet for each thereof, and a common outlet spaced from said inlets, said chamber continuously changing in cross sectional contour throughout its length from approximately that of said plurality of inlets to that of said common outlet while maintaining an approximately uniform cross sectional area.

9. In apparatus for combining confined streams of plastic concrete mixtures moving under pressure, a plurality of closed passages converging at an acute angle; a combining chamber at the intersection of said passages having a substantially uniform cross sectional area which is approximately equal to the sum of the cross sectional areas of said passages, whereby to prevent stowing of the mixture as the streams meet; and a tapering passage leading from said chamber, the taper thereof being such as to prevent stowing of the mixture as it passes therethrough.

10. In apparatus for combining confined streams of plastic concrete mixtures moving under pressure, a plurality of closed passages converging at an acute angle; a combining chamber at the intersection of said passages having a substantially uniform cross sectional area which is approximately equal to the sum of the cross sectional areas of said passages, whereby to prevent stowing of the mixture as the streams meet; and a tapering passage leading from said chamber, diminishing in cross sectional area from that of the chamber to substantially the average of the cross sectional areas of the original streams, the taper being such as to prevent stowing of the mixture as it passes therethrough.

11. A chamber for combining without stowing a plurality of confined moving streams of plastic concrete mixtures embodying substantial proportions of coarse aggregates, said chamber having a plurality of transversely spaced inlet ports and a single outlet port longitudinally spaced therefrom, the transverse dimension of said chamber in one plane diminishing uniformly from said inlet ports to said outlet port, and the transverse dimension in another plane increasing uniformly from said inlet ports to said outlet port.

12. A chamber for combining without stowing a plurality of confined moving streams of a plastic concrete mixture embodying substantial proportions of coarse aggregates, said chamber having a plurality of adjacent transversely communicating inlet ports and a single outlet port longitudinally spaced therefrom, the transverse dimension of said chamber in one longitudinal plane diminishing uniformly from said inlet ports to said outlet port, and the transverse dimension in a longitudinal plane at right angles to said first plane increasing uniformly from said inlet ports to said outlet port.

13. A chamber for combining without stowing a plurality of confined moving streams of a plastic concrete mixture embodying substantial proportions of coarse aggregates, said chamber having a plurality of adjacent transversely communicating inlet ports and a single outlet port longitudinally spaced therefrom, the transverse dimension of said chamber in one longitudinal plane diminishing uniformly from said inlet ports to said outlet port, and the transverse dimension in a longitudinal plane at right angles to said first plane increasing uniformly from said inlet ports to said outlet port, and the cross sectional area of said chamber being approximately uniform from said inlet to said outlet ports.

14. Apparatus for combining a plurality of confined pressurally moved streams of plastic concrete mixture embodying substantial proportions of coarse aggregate, comprising a chamber of approximately uniform cross sectional area from end to end, and of cross sectional configuration varying from approximately that of the plurality of streams at its inlet end to that of a single stream at its other end, arranged to com-

bine said original streams without stowing into a single unbroken stream having a cross sectional area greater than that of any of said original streams; and means for gradually reducing without stowing the cross sectional area of the combined stream to substantially the mean of the cross sectional areas of the original streams.

15. The steps in the method of combining a plurality of confined moving streams of plastic concrete mixtures embodying substantial proportions of coarse aggregates which give to said mixtures a strong tendency to stow, into a single confined unbroken moving stream having a cross sectional area substantially equal to the mean of cross sectional areas of the several original streams, which comprise bringing said original streams together at an acute angle to produce a single stream having a cross sectional area greater than said mean of the cross sectional areas of the said original streams; and then reducing the cross sectional area of the combined stream sufficiently gradually to prevent stowing.

CHARLES F. BALL.