

June 4, 1957

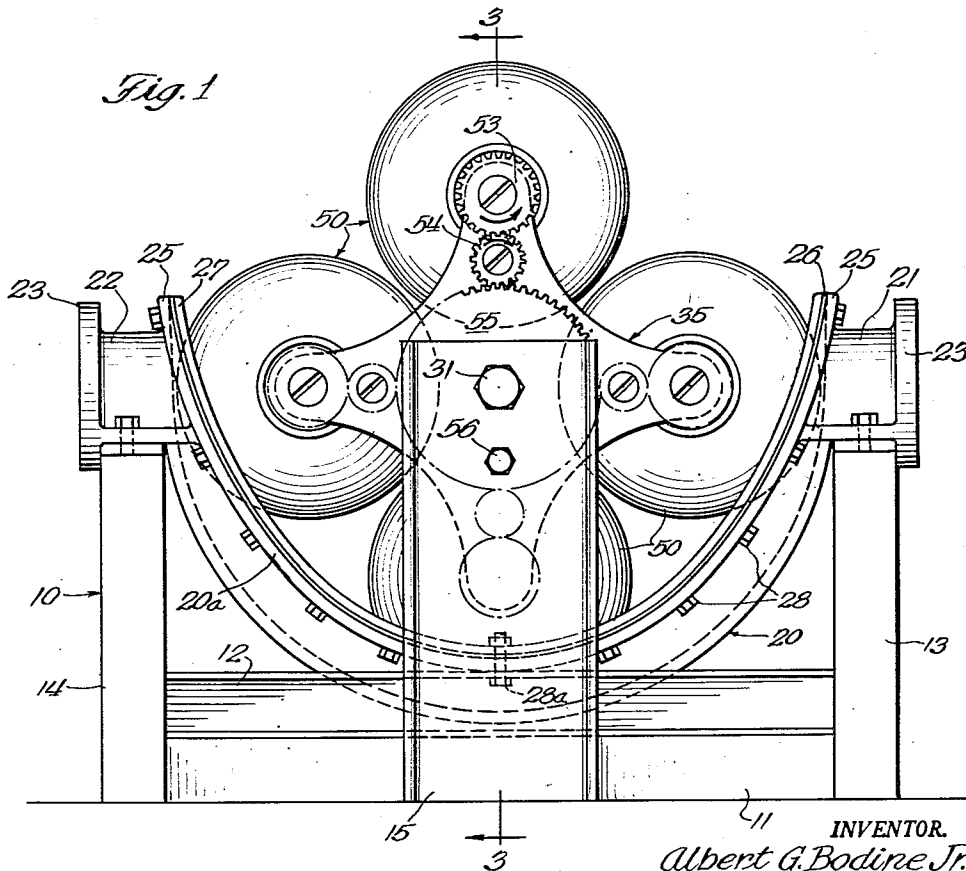
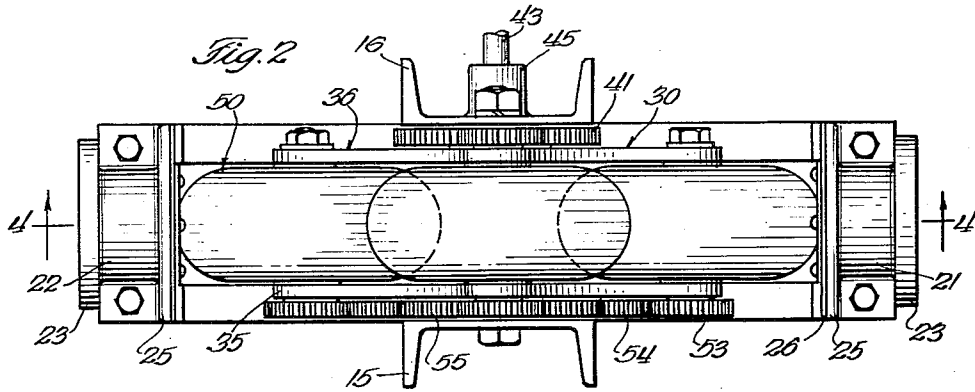
A. G. BODINE, JR

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PUMP FOR FLUID AND SEMI-FLUID MATERIALS

Filed May 28, 1956

4 Sheets-Sheet 1



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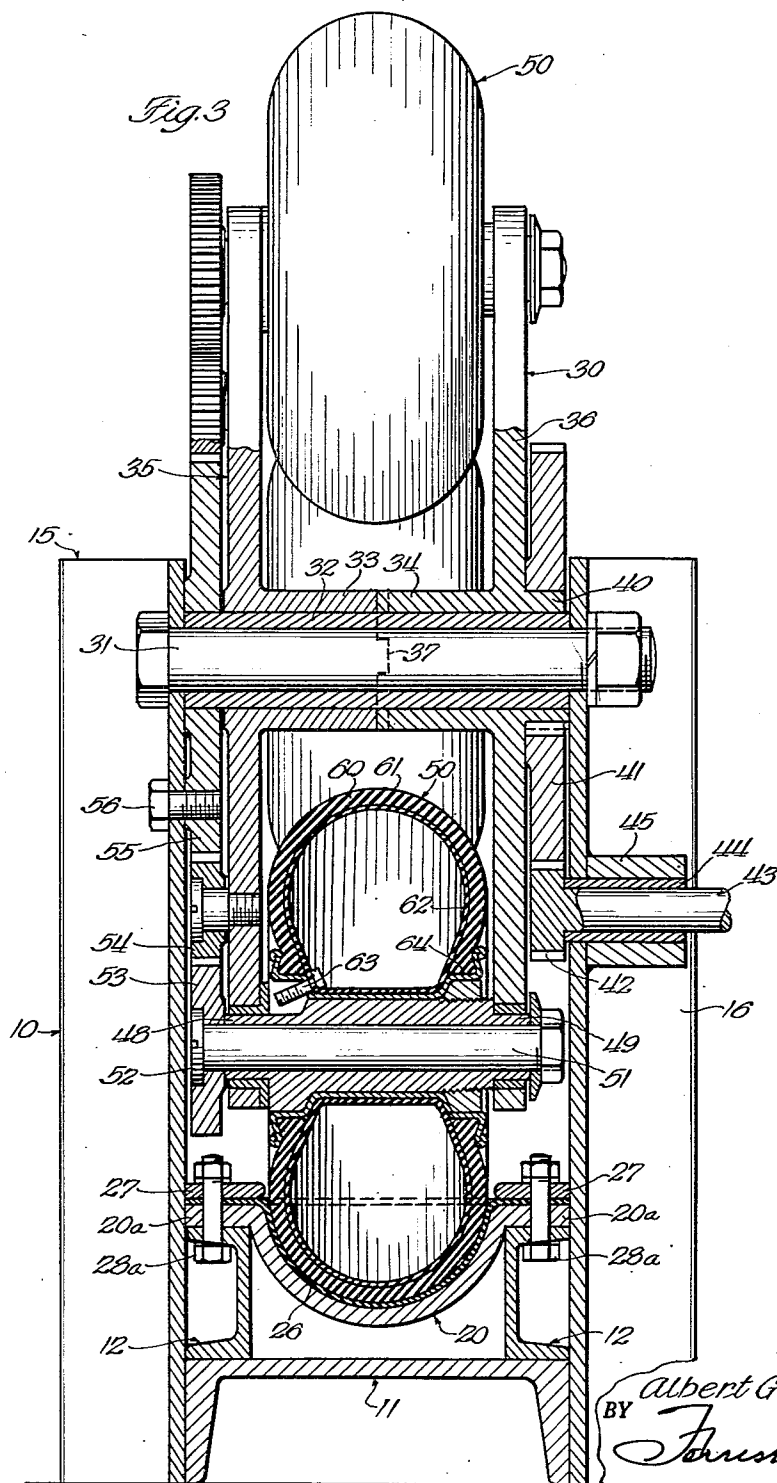
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PUMP FOR FLUID AND SEMI-FLUID MATERIALS

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4 Sheets-Sheet 2



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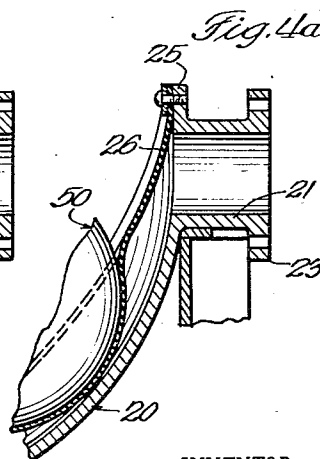
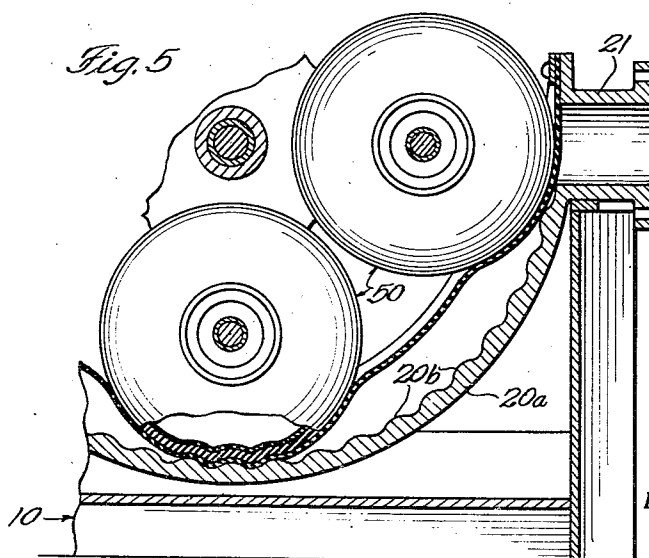
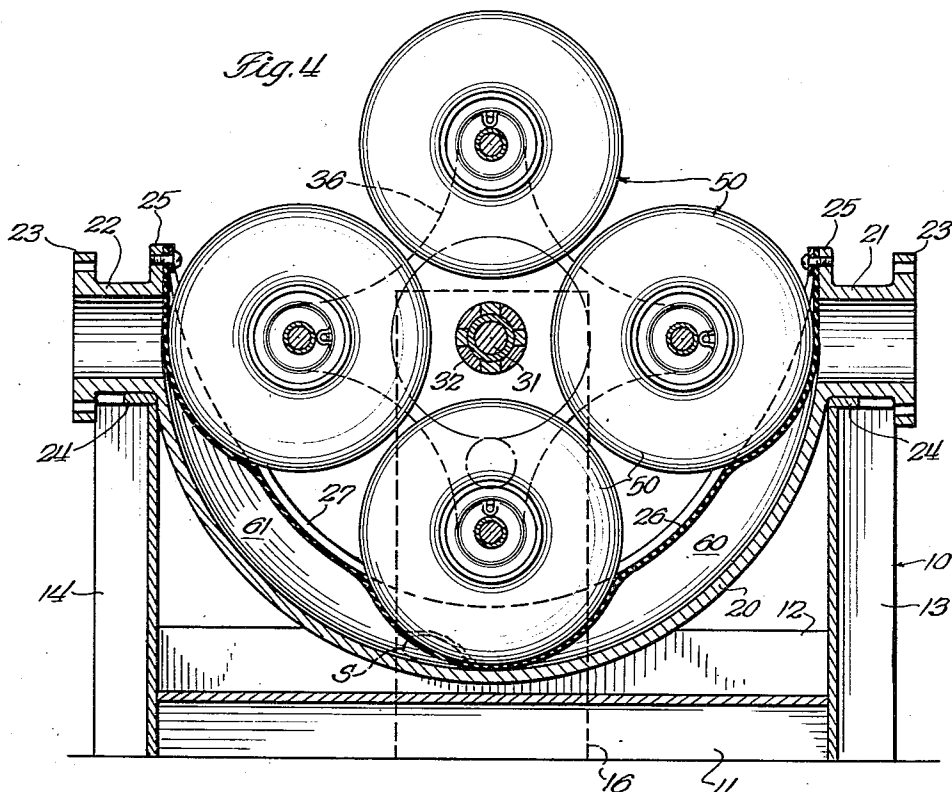
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PUMP FOR FLUID AND SEMI-FLUID MATERIALS

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4 Sheets-Sheet 3



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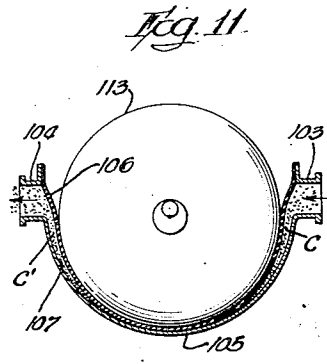
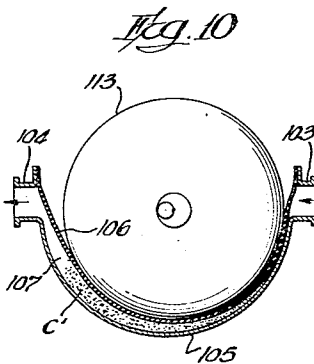
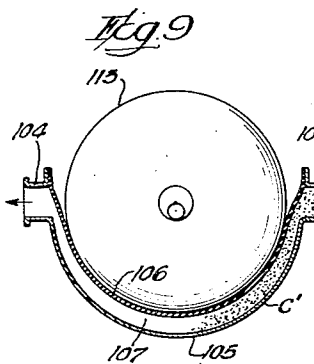
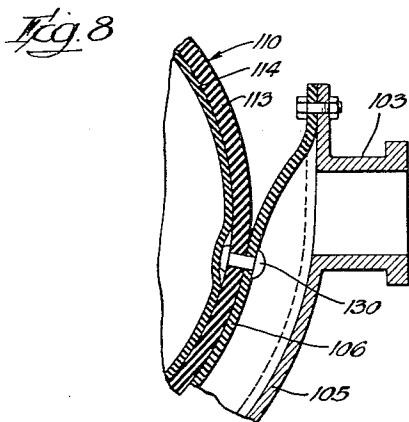
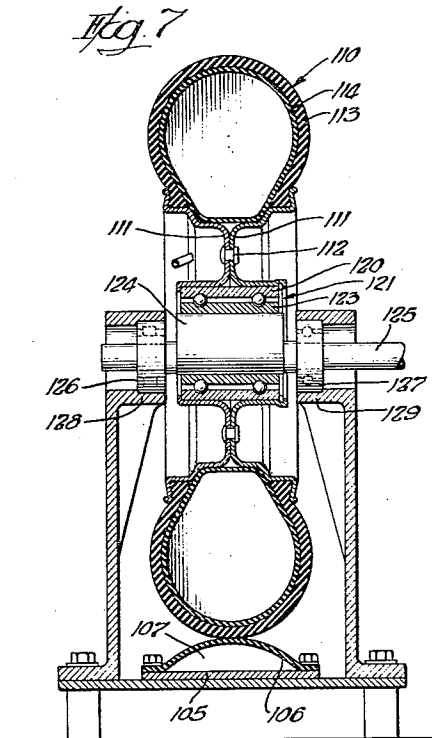
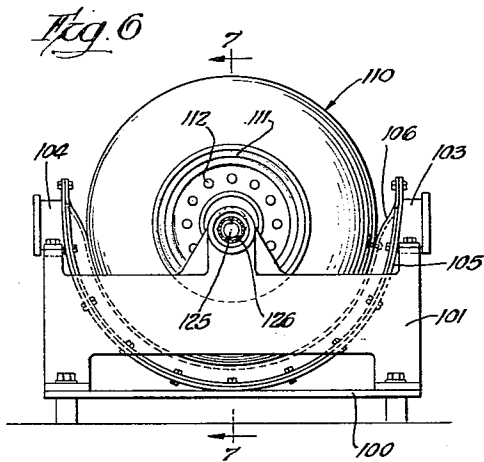
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PUMP FOR FLUID AND SEMI-FLUID MATERIALS

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4 Sheets-Sheet 4



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2,794,400

PUMP FOR FLUID AND SEMI-FLUID MATERIALS

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Application May 28, 1956, Serial No. 587,519

11 Claims. (Cl. 103—149)

This invention relates generally to pumps for pumping fluids or semi-fluid mixtures containing solid materials or aggregates of various sizes, such as plaster, stucco, and mixtures of cement and water with sand, gravel or rock. This application is a continuation-in-part of my application entitled Pump for Fluid and Semi-fluid Materials, Ser. No. 468,769, filed November 15, 1954, and allowed December 1, 1955.

The invention is directed to improvements in a known type of pump comprising an arcuate trough or open conduit for the material to be pumped, and a plurality of wheels or rollers adapted to roll in succession along said trough or conduit, in a manner to force the fluid or semi-fluid substance in a forward direction. Such pumps of this class as have previously been known have employed solid wheels, and have, in consequence, suffered two major disabilities: first, the wheels or rollers could not pass over large solid particles, such as rock, which might temporarily become slowed or jammed in their forward progress, with the consequence that the entire pump mechanism became jammed; and second, closure of the pump outlet, either by closure of a valve, or by becoming obstructed for any other reason, similarly jammed the entire pump mechanism.

A purpose of the present invention is the provision of a pump of the class named having improvements designed to permit the pump mechanism to continue its normal operation notwithstanding blocking of the pump outlet, or temporary stoppage or slowing of large solid particles in the pump conduit.

The characterizing feature of the present invention is the provision of pneumatic tires on the wheels or rollers, such tires being compressible to pass over large temporarily arrested solid particles, and being also compressible to pass over the entire mass of material in the pump conduit in event of stoppage of the pump outlet. This gives the pump an automatic pressure maximizing characteristic.

A further advantage of this pneumatic adaptation is that the roller closest to the outlet in any instance tends to yield and slip part of its load back to the next roller, and so on back, so that the pump gives an automatically distributed pressure in multi-stage division.

The invention provides also a novel single wheel pump of the general class mentioned.

The invention will be better understood by reference to the following detailed description of one present illustrative embodiment thereof, reference for this purpose being had to the accompanying drawings, in which:

Fig. 1 is a side elevational view of a pump in accordance with the invention;

Fig. 2 is a top plan view of the pump of Fig. 1;

Fig. 3 is a vertical transverse section taken on line 3—3 of Fig. 1;

Fig. 4 is a vertical transverse section taken on line 4—4 of Fig. 2;

Fig. 4a is a fragmentary view similar to a portion of Fig. 4 but with the parts in a different position;

Fig. 5 is a view similar to a portion of Fig. 4, but showing a modification;

Fig. 6 is a side elevational view of another embodiment of the invention using a single wheel;

Fig. 7 is a vertical section taken on line 7—7 of Fig. 6;

Fig. 8 is an enlarged sectional detail taken from Fig. 6; and

Figs. 9, 10 and 11 are somewhat diagrammatic views showing successive positions in the operation of the pump.

The pump is provided with a frame structure 10, here illustratively shown as comprising a horizontal inverted channel member 11 adapted for engagement with a horizontal supporting surface, spaced horizontal channel members 12 mounted on the edges of base channel 11, upright channel members 13 and 14 at opposite ends of the channels 11 and 12, and a pair of outwardly facing upright channel members 15 and 16 extending from opposite sides of base channel 11 midway between the end members 13 and 14. An arcuate or substantially semi-circular open trough or conduit member 20, forming a longitudinally curved channel half round in cross section (see Fig. 3) is suspended between the upright end members 13 and 14. As here shown, this conduit 20 is formed as a casting provided at one end with a tubular inlet fitting 21, and at its opposite end with a similar tubular outlet fitting 22. These inlet and outlet fittings, which are formed with integral coupling flanges 23, are supported by plates 24 on the upper ends of upright members 13 and 14.

The tubular inlet and outlet fittings 21 and 22 are formed at the top of their inner ends with flanges 25 to which are secured opposite ends of a flexible strip 26, preferably of elastic material, such as rubber, which extends from end to end of the conduit member 20 and is fastened to outwardly turned edge flanges 20a of the latter by means of curved hold down straps 27 and a series of suitable screws 28. As here shown, the central members 28a of these screws are somewhat longer than the remainder of the series so as to pass also through the upper flanges of channel members 12, whereby to secure the conduit 20 to the base structure of the pump. The normal undeformed or unstretched position of the rubber strip 26 is in the curved plane defined by the top surfaces of the arcuate conduit flanges 25.

A carrier frame 30 for later described pneumatic tired wheels is rotatably mounted on an axis concentric with the center of the arc formed by the semi-circular conduit 20. In the illustrative embodiment, a shaft member 31 is mounted in frame members 15 and 16 on the axis of rotation for frame 30. On this shaft 31, and confined between the webs of channel members 15 and 16, is a bearing bushing 32, and rotatably mounted on the latter, are the tubular hubs 33 and 34 of a pair of spiders 35 and 36, respectively, constituting the aforementioned rotatable frame 30. The two spiders 35 and 36 are held against relative rotation to one another by interengaging clutch jaw formations at the adjacent ends of their hubs 33 and 34, as indicated at 37.

Keyed to an outwardly projecting hub portion 40 of spider 36 is a spur gear 41 driven by a pinion 42 on a drive shaft 43 journaled in a bushing 44 extending through the web of upright frame member 16 and supported by a tubular boss 45 welded to the latter. The frame 30 made up of the two spiders 35 and 36 is thus understood as constantly rotated when shaft 43 is driven by any suitable prime mover, not shown. The extremities of the arms of spiders 35 and 36 have journaled therein the opposite end hub portions 48 and 49 of pneumatic tired wheels generally designated by numeral 50. The hubs of these wheels are formed with axial bores receiving rotatable shafts 51 with a free-running fit. At one end, these shafts 51 carry a head 52 positioning a gear 53

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keyed or otherwise fixed to said shaft, and each such gear 53 meshes with an idler pinion 54 rotatably mounted on the spider arm inward of the gear 53 and meshing in turn with a fixed spur gear 55 whose hub surrounds bushing 32 and which is secured tightly to the web of frame upright 15 as by means of screw 56.

Each of the described wheels 50 comprises preferably an ordinary pneumatic inflatable tire 60, comprising casing 61 and inner tube 62, the latter furnished with valve stem 63 understood to have the usual tire valve, and as clearly shown in Fig. 3, such tire is mounted on a more or less conventional rim 64 mounted, in turn, in any suitable fashion, on the wheel hub, as clearly shown in Figure 3. The inflated tires engage the rubber strip 26, stretching and pressing it firmly down against the bottom of conduit 20.

In operation, spider frame 30 rotates in a clockwise direction as viewed in Figs. 1 and 4. In this rotation, idler gears 54 roll on fixed gear 55, causing rotation of wheel gears 53 in a counterclockwise direction, as indicated by the arrows in Fig. 1. The rubber tired wheels 50 accordingly turn in a counter-clockwise direction as frame 30 is driven in the clockwise direction. The relative size of gears 53, 54 and 55 is so chosen that the peripheral speed of the tires 50 about the wheel axes is just equal to the speed of travel of the outermost points of the tires relative to the arcuate conduit 20, with the consequence that the tires 50 roll along the rubber strip 26 pressed down in the conduit 20 without "skidding" and without material tendency to drag the rubber strip 26 in either direction along the conduit. The preferred embodiment of the invention incorporates this positive gear drive for the wheels. However, in simpler forms of the pump, such positive drive of the wheels may be eliminated, in which case the rubber tired wheels will rotate by means of frictional contact with the rubber strip 26 pressed down against the conduit.

In the operation of the pump, the fluid or semi-fluid material, with or without solids, is supplied via pipe or hose coupled to inlet fitting 21. As an individual wheel 50, such as the right hand wheel in Fig. 4, passes the inlet 21 and moves on toward a position such as shown in Fig. 4a, the rubber strip 26 opposite the inlet which has been stretched by said wheel (Fig. 4) tends to contract behind the wheel back towards its initial or normal position, as shown in Fig. 4a, and in so doing, acts in cooperation with the departing wheel 50 to develop a suction which draws a charge of the fluid or semi-fluid material inwardly through fitting 21 and into an upper end portion of the conduit 20 in back of the wheel. The next wheel in succession, passing the inlet 21, closes the same off, as clearly illustrated in Fig. 4, trapping a charge of the semi-fluid material in the conduit space 60, inside the rubber strip 26, and between the two adjacent wheels 50. This material is gradually advanced around the trough or conduit 20 toward the outlet by a rolling and pinching action of the rearmost of the two wheels, the foremost of the wheels correspondingly vacating space at the front end of the charge of material to permit its advance. The charge is thus caused to progress around the conduit 20, to be finally ejected via outlet fitting 22, and it will be seen that a charge, such as that in the space 61, will be forced out the outlet fitting 22 as the wheel in advance thereof passes the outlet fitting and the wheel to the rear then rolls the material forwardly, forcing it to discharge.

It may be readily seen that in the event that a solid particle of material, such as indicated in dotted lines at S in Fig. 4, should become temporarily "stalled" in the conduit 20, the pneumatic tire 50, as well as the rubber strip 26, will readily indent to pass over such obstacle, the deformation occurring under these conditions being indicated in dotted lines in the figure. Pumping may thus continue without the wheel becoming wedged against such solid material and the entire pumping mechanism jammed. The tires roll easily over any such lodged or slowed ma-

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terial, without the pumping action otherwise being interfered with, the remainder of the fluid mass being forced ahead in the normal manner. The rubber strip 26 tends to seal about the solid particle or particles being passed by the roller, so that the fluid material is forced ahead.

Likewise, in the event that the discharge conduit leading from outlet fitting 22 should become stopped, the pump can still continue to rotate by reason of the ability of the rubber tires to flatten as they encounter the stopped material. It will further be noted that any such flattening deformation of the rubber tires will increase the pressure thereof and will correspondingly increase the discharge pressure of the pump, thus tending automatically to clear the outlet. Accordingly, in the event that the material in the discharge outlet or conduit should become merely stopped or wedged, possibly because of accumulation of solid material, the pneumatic wheels will automatically deform to ride over the stopped material, but will also continue to exert a discharge pressure, which discharge pressure may, because of the deformation of the tire, be increased sufficiently to clear the discharge conduit of the obstruction. On the other hand, if the obstruction in the discharge conduit is positive, as by reason of closing a control valve therein, the pump can still continue to rotate, the tires simply deforming sufficiently to roll over the stopped material.

A modification shown in Fig. 5 consists in forming the bottom of the trough, here indicated by the numeral 20a, with a corrugated outline such as indicated at 20b. The engagement of the rubber tire with the rubber strip 26 pressed down on this corrugated formation provides a non-skid contact, and gearing means for positively driving the wheels on their individual axes are accordingly not used in this case.

In the event that the material to be pumped is supplied to the inlet with sufficient pressure, as from an elevated hopper, the pump is self-filling, and the flexible strip 26 then need not have elastic properties, as the pump will fill without the necessity of elastic contraction of the flexible strip behind the advancing wheels. Moreover, other obvious biasing means can be used to cause the strip 26, or equivalent side wall of the squeezed conduit, to be constrained open. If desired, the depth of the trough can be reduced or eliminated if the flexible member provides commensurate embracement.

Figs. 6 to 11 show another illustrative embodiment of the invention, employing a single pneumatic tired wheel. The supporting frame structure is shown to comprise base plate 100 supporting frame 101 supporting tubular inlet and outlet fittings 103 and 104, respectively, formed in the upper end portions of arcuate track 105 which rests at the bottom on base plate 100 and is suitably secured to the latter.

Secured to the top end portions of track 105, above inlet and outlet fittings 103 and 104, and along the longitudinal edges of track 105, as by suitable screws, as shown, is a flexible strip or diaphragm 106, composed of fabric, or an elastic material, such as rubber. This strip, in this embodiment, has somewhat greater width than the track 105, so as to be capable of bowing or bulging upwardly, (see Fig. 7), thereby defining a conduit 107 for the material to be pumped. This conduit is adapted to be progressively closed and opened by means of the illustratively single pneumatically tired wheel 110, as presently described.

The wheel 110 comprises two annular pressed steel members 111, riveted together as at 112, and formed at the outside to provide a rim for rubber tire 113 having inner tube 114. The tire 113 has a radius nearly as large as the radius of arcuate track 105, and it is mounted for gyration about the center of the arc defined by track 105. In the arrangement here shown, the inner portion of the wheel is tightly mounted on the outside of the outer sleeve 120 of a ball bearing assembly 121 whose inner bearing sleeve 123 is press-fitted onto an eccentric 124.

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The eccentric 124 is mounted on a shaft 125 furnished with bearings 126 and 127 carried by brackets 128 and 129, respectively, extending upwardly from frame 101. Shaft 125 may be rotated by any suitable means, not shown, such as gears, chain and sprocket, or the like.

Preferably, though not necessarily, the flexible strip or diaphragm 106 is secured to the casing of tire 113 at a point approximately opposite inlet 103, and this fastening may be by means of a rivet such as indicated at 130. The point of fastening should be sufficiently below the upper end of the flexible strip or diaphragm 106 such that the diaphragm is capable of flexing with the movement of the tire, as presently described. The drive shaft 125 for eccentric 124 is concentric with the center of curvature of arcuate track 105, and the throw of eccentric 124 is equal to the difference between the radius of the arcuate track and the radius of the tire. This means that as the eccentric turns through the lower half of its stroke, the tire progressively moves along the track from the inlet to the outlet, pressing the flexible diaphragm firmly against the track as it travels around, and squeezing any contents of the conduit 107 progressively forward. During the upper half of the stroke of the eccentric, the tire is cleared from the track, as represented in Fig. 9.

Operation is as follows: the fluid or semi-fluid to be pumped, with or without included solids, is supplied via a suitable conduit coupled to the inlet fitting. The tire will be seen to describe a gyratory motion, its center describing a circle whose radius is equal to the throw of the eccentric, and which throw is equal to the difference between the radius of the track and the radius of the tire. In this case, owing to the attachment of the tire to the flexible diaphragm at 130, the tire does not rotate on its axis, but gyrates bodily as described. In this gyratory action the tire, from such a position as illustrated in Fig. 9, approaches inlet 103 and presses the diaphragm firmly against the track over this inlet. The point at which the tire presses the diaphragm tightly against the track, then progresses around the track from the inlet to, and past, the outlet, passing from the position of Fig. 9 through those of Figs. 10 and 11 and back to Fig. 9. As the point of contact moves on beyond inlet 103, the diaphragm is retracted from the inlet opening by reason of the fastening at 130, developing a suction which draws a charge of material in through the inlet and into the conduit, as indicated at c in Fig. 11. A previously intaken charge of material c' in the conduit ahead of the tire is at the same time progressively advanced and forced out outlet 104. The tire then passes through the position of Fig. 9, the charge of material remaining in the conduit (charge c' in Fig. 9) being advanced to and out through the outlet 104 on the next trip of the tire along the track.

An alternate arrangement results from omitting the fastening of the diaphragm to the tire casing. In this case, of course, the tire is enabled to roll around the track, as in the embodiment of Figs. 1 to 5. In this case, some means is required to induce inflow of material through inlet 103. This means may be any arrangement to create an inlet pressure; for example, create a pressure head at the inlet, e. g., a riser pipe connected to the inlet through which the material is conveyed to the inlet. Or, inflow may be induced by employing an elastic diaphragm and the trough type of conduit such as shown in the embodiment of Figs. 1-5. The embodiment of Fig. 6 shows a single wheel driven by an eccentric of small eccentricity, which is of evident advantage. However, it will be seen that the embodiment of Figs. 1-5 will operate in the same general fashion by eliminating three of its four wheels. It is then a single wheeled pump, of smaller wheel radius, but larger throw. This type of pump is especially well fitted to the pumping of paste-like materials which do not readily run backwards in the conduit when the wheel moves out of contact.

It will be understood that the drawings and description are for illustrative purposes only, and that various changes

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in design, structure and arrangement may be made without departing from the spirit and scope of the appended claims.

I claim:

1. In a pump, the combination of: a conduit for the pumped material, an inlet communicating with one end portion of said conduit, an outlet leading from the opposite end portion of said conduit, a flexible wall forming at least one side wall of said conduit between said inlet and outlet and arranged to be deflected toward engagement with an opposing side of said conduit, a plurality of wheels fitted with pneumatic tires adapted for running longitudinally along said conduit over said flexible wall and for pressing said wall toward contact with the interior of said conduit, and means for guiding and moving said pneumatic-tired wheels in spaced relation from one another progressively along said conduit from said inlet toward said outlet, said pneumatic tires being deformable to pass over material stopped in said conduit.

2. The subject matter of claim 1, wherein said flexible wall is composed of an elastic material which is elastically stretched by the successive wheels passing thereover.

3. The subject matter of claim 1, including means for rotating said wheels on their individual axes at peripheral speeds equal to the speed of travel of the wheels along the trough whereby to eliminate tendency for skidding of the wheels relative to the conduit.

4. The subject matter of claim 1, wherein said conduit is longitudinally curved into the arc of a circle, and said means for guiding and moving said wheels comprising a frame rotatable on an axis coinciding with the center of said arc, said wheels being mounted for individual rotation on said rotatable frame in circumferentially spaced positions about said axis.

5. In a pump for fluid or semi-fluid materials, the combination of: a conduit for the material, and inlet and an outlet communicating with opposite ends of said conduit, said conduit having opposed side wall portions extending longitudinally between said inlet and outlet, at least one of said opposed side wall portions being flexible and deflectable toward contact with the opposed side wall portion, a plurality of wheels fitted with soft, resiliently deformable tires, and wheel supporting and driving mechanism for rolling said tired wheels in succession on and along said flexible wall portion of said conduit in a fixed path in which the peripheries of the tires progressively deflect said flexible conduit wall portion toward the opposed conduit wall portion and thereby compress the conduit and advance the material contained therewithin, said tires being deformable to pass over large solids in the material in the conduit or over stopped material in the conduit in event of jamming or choking between the tire and said outlet.

6. The subject matter of claim 5, wherein said tires are pneumatic.

7. The subject matter of claim 5, wherein said flexible side wall portion of said conduit is composed of an elastic material which is elastically stretched by the wheels running therealong.

8. The subject matter of claim 6, wherein said flexible side wall portion of said conduit is composed of an elastic material which is elastically stretched by the wheels running therealong.

9. In a pump for fluid or semi-fluid materials, the combination of: a conduit for the material, an inlet and an outlet communicating with opposite ends of said conduit, said conduit having opposed side wall portions extending longitudinally between said inlet and outlet, at least one of said opposed side wall portions being flexible and deflectable toward contact with the opposed side wall portion, a wheel fitted with a soft, resiliently deformable tire, and wheel supporting and driving mechanism for moving said tired wheel on and along said flexible wall portion of said conduit in a fixed path in which the periphery of the tire progressively deflects said flexible con-

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duit wall portion toward the opposed conduit wall portion and thereby compresses the conduit and advances the material contained therewithin, said tire being deformable to pass over large solids in the material in the conduit or over stopped material in the conduit in event of jamming or choking between the tire and said outlet.

10. The subject matter of claim 9, wherein said conduit is arcuate in longitudinal contour, and there is a single wheel and tire, a bearing at the center of said wheel and a driving eccentric therein, said eccentric having an axis of rotation concentric with the center of curvature of said conduit, and the throw of said eccentric being a minor fraction of the radius of said arcuate conduit.

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11. The subject matter of claim 10, wherein said tire and flexible wall portion are attached to one another in the region of said inlet.

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