March 1, 1960 G. D. ROSE, JR 2,926,614

CONCRETE PUMP

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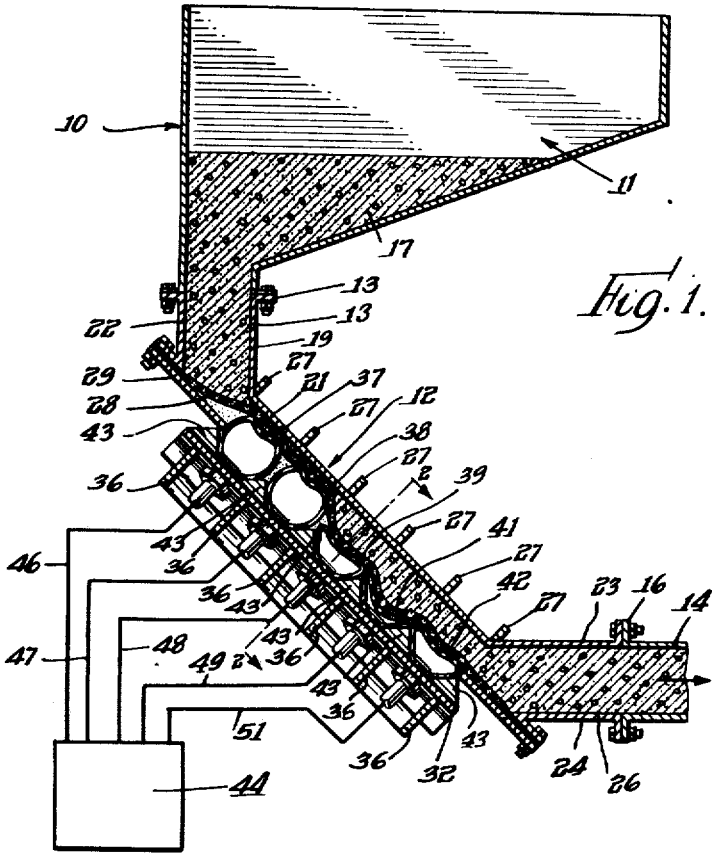

Fig. 1.

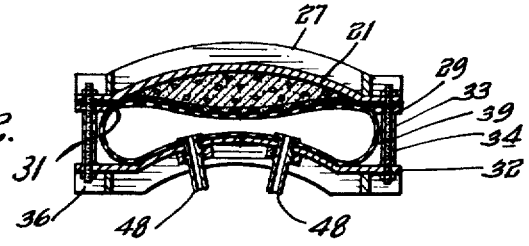

Fig. 2.

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CONCRETE PUMP

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This invention relates to a pump for pumping fluid and semi-fluid material, particularly materials, such as a concrete slurry which contains an aggregate in suspension in a viscous carrier.

Heretofore, pumps, such as, lobe or centrifugal pumps have been unable to pump for a sustained period fluid or semi-fluid materials with an aggregate in suspension inasmuch as the abrasive action of the aggregate rapidly cuts away the impellers, chambers and valves. Diaphragm pumps of various types have not attained wide commercial acceptance for the reason that the aggregate has interfered with a complete closing between a diaphragm and a cooperating wall, which resulted in a substantial amount of leakage and inefficient operation of the pump. Furthermore, pumps depending upon efficient operation of valves are ineffective for pumping the materials in question because the aggregate tends to abrade valve seats and lodges between the valve and the seat to prevent full closing. One of the objects of the invention herein disclosed is to provide a pump which pumps such concrete or other materials containing large particles without undue wear on the pump.

Another object of the present invention is to provide a positive displacement pump capable of producing high discharge pressure in which the flow of material through the pump is slow and nonturbulent.

A further object of the instant invention is to provide a pump in which the parts in contact with the material pump thereby are deformable to receive large particles, such as, aggregate.

A still further object of the invention herein described is to provide a pump which may be readily repaired on the job.

Other objects will become apparent to those skilled in the art upon reference to the appended specification in conjunction with the accompanying drawings.

In the drawings:

Fig. 1 is a cross-sectional view of a pump embodying the instant invention showing a hopper; and

Fig. 2 is a cross-sectional view taken on line 2—2 of Fig. 1 showing a tube in a partially collapsed condition.

Referring now to the drawings which show a preferred embodiment of this invention, Fig. 1 shows a pump, generally indicated by numeral 10, which pump shall be hereinafter called a "concrete pump" though any viscous material containing large hard particles in suspension may be pumped by the concrete pump 10.

The concrete pump 10 has a large gravity type hopper 11 connected to a pump assembly 12 by a flange coupling 13 and the pump assembly is connected on its output side to a concrete conduit 14 by a flange coupling 16. Thus, a concrete slurry indicated by numeral 17 flows from the hopper 11 into the pump assembly 12 and then into the concrete conduit 14.

The pump assembly 12 has an inlet aperture 18 defined by an extended portion of an arcuate rigid plate 21 fixed to an arcuate inlet plate 22 and both plates 21 and 22 are integral with the flange coupling 13 thus providing a continuous conduit from the hopper 11 into the pumping assembly. At the opposite end of the pumping assembly, the arcuate rigid plate 21 has an extended portion 23 with an arcuate outlet plate 24 fixed thereon defining an outlet aperture 26. The ends of plates 21 and 24 are integral with flange 16 to provide a continuous flow path into the concrete conduit 14.

The arcuate rigid plate 21 has a plurality of reinforcing ribs 27 on the outer surface of the plate and a flexible cushion diaphragm 28 co-acts with the interior surface of the arcuate rigid plate 21 to comprise a pumping conduit. The flexible cushion diaphragm 28, in this embodiment, is made of a foam rubber, but it may be made of any suitable foamlike material, such as, foam polyurethane or other material which may be easily compressed but has a high strength. A diaphragm securing plate 29 having a tube receiving aperture 31 is fixed at one end to inlet plate 22 and at the other end to outlet plate 23 thereby securely mounting the diaphragm 28 in position and providing a suitable support for said diaphragm.

A transversely arcuate tube support 32 is attached to arcuate rigid plate 21 by means of bolts 33 with sleeves 34 between plate 29 and support 32, thereby sealing diaphragm 28 against plate 21 as may be seen in Fig. 2. The arcuate tube support 32 has a plurality of arcuate support ribs 36 integral therewith providing reinforcement to the support. Five flexible rubber tubes 37, 38, 39, 41 and 42 are positioned on the tube support 32 between the upper surface of the tube support and the diaphragm 28. Triangular blocks 43 are fixed to the upper surface of the tube support on the opposite sides of each of the flexible tubes preventing the tubes from moving along the support 32 and thereby acting as tube retaining means.

A pneumatic pump and control 44 is connected to tubes 37, 38, 39, 41 and 42 by sets of pneumatic pipes 46, 47, 48, 49 and 51, respectively. Each set of pneumatic pipes consists of two pipes opening into the respective tubes. As may be seen in Fig. 2, the set of pneumatic pipes 48 open into the flexible tube 39 on the opposite sides of the rise in the arcuate support 32 so that when the tube 39 partially collapses and the opposite sides of the tube meet a further collapse of the tube is permitted.

The concrete slurry 17 is poured into the top of the gravity hopper 11, and gravity forces the slurry into the input aperture 18 of the pumping apparatus 12. The pumping apparatus 12 forces the concrete through the pumping conduit and into the conduit 14 under pressure.

The operation of the pump apparatus 12 is best described in a sequential operation by enumerating the steps followed. In the first step, the tube 37 is fully collapsed, tube 38 is in a partially collapsed condition, tube 39 is in a fully expanded condition sealing diaphragm 28 against the inner surface of rigid plate 21, tube 41 is also in a fully expanded condition to reinforce the seal, and tube 42 is in a partially collapsed condition. In the second step, tube 37 is in a partially collapsed condition, tube 38 is fully collapsed, tube 39 is in a partially collapsed condition and tubes 41 and 42 are fully expanded sealing the diaphragm against the rigid plate. In the third step, tube 37 is fully expanded sealing the diaphragm against the rigid plate, tube 38 is in a partially collapsed condition, tube 39 is fully collapsed, tube 41 is in a partially collapsed condition, and tube 42 also fully expanded sealing the diaphragm against the rigid plate.

In the fourth step, which is shown in Fig. 1, tubes 37 and 38 are fully expanded sealing the diaphragm against the rigid plate, tube 39 is in a partially collapsed condition, tube 41 is fully collapsed, and tube 42 is in a

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partially collapsed condition. Step number five places tube **37** in a partially collapsed condition, tubes **38** and **39** in a fully expanded condition, tube **41** in a partially collapsed condition and tube **33** in a fully collapsed condition.

The pneumatic pump and control **44** selectively inflates and deflates the tubes so that the tubes are consecutively and sequentially expanded and collapsed in the order of the steps disclosed above.

During the step one, gravity forces the concrete slurry into the volume defined by the diaphragm and the rigid plate. As the tubes assume their respective conditions during step two, gravity keeps the slurry in position. In the next step, the concrete slurry is sealed in the volume defined by the rigid plate and the diaphragm since tubes **37** and **42** seal opposite ends of the pumping conduit.

The concrete slurry then is forced out of the pumping conduit and into the discharge aperture **26** and on into material conduit **14** during step four because tube **42** collapses to break the seal between the diaphragm and the rigid plate and tube **38** is fully expanded to force the slurry out of the pumping conduit. The concrete slurry is further forced out of the pumping conduit during step five so that the slurry forced out is under pressure. At the same time tube **37** begins to collapse to receive more slurry.

Step one is then repeated to receive more slurry at the input end and the pumped slurry is further forced out under pressure and the same sequence described above is followed to continuously pump concrete slurry.

One of the important advantages of the instant invention is that the seal between the diaphragm and the plate is securely maintained even though the aggregate is trapped therebetween. The aggregate between the diaphragm and plate doesn't break the seal because the diaphragm is a flexible cushion diaphragm which completely surrounds the aggregate and the seal is formed completely therearound.

The flexible tubes are not hindered in creating a seal because they also form around the aggregate, thus, it should be noted that not only the cushion material adapts itself to receive and hold the foreign particles and maintain the seal, but so do the tubes.

Another important advantage which is achieved by the instant invention is that the foam rubber is not easily abraded by the aggregate which is pumped thereby. The aggregate simply imbeds itself in the foam and so the foam gives way so that there is no harsh abrasion and the parts do not readily wear.

The concrete pump herein disclosed has the advantage that, after all the slurry has been pumped, the compressor which was used to operate the flexible tubes may provide the air supply to force out any slurry which remains in the concrete pump. Thus, the pump is readily cleaned and it has its own cleaning system with it.

Should any one or more of the flexible tubes break during operation, and no spares are available, the tubes may be readily replaced by pieces of firehose without waiting for the factory to supply the necessary special tubes, and a job may continue with a minimum of down-time by making a replacement on the spot.

While the preferred embodiment of the present invention has been shown and herein described, it is obvious that many structural details may be changed without departing from the spirit and scope of the appended claims.

The invention is claimed as follows:

1. In a device of the character described the combination of an elongated plate, a flexible cushion diaphragm adjacent to one face of said plate and engageable therewith, said diaphragm being sealed to the side portions of said plate whereby to define a pumping conduit, and a plurality of flexible tubes adjacent said diaphragm on the side opposite the plate, said tubes traversing said conduit and being selectively expandable and collapsible

thereby forcing a selected portion of the diaphragm into engagement with the plate, whereby a material may be pumped through said conduit by consecutively and successively collapsing and expanding said tubes.

2. In a device of the character described a gravity feed hopper, a rigid arcuate plate affixed to the output of said hopper, a flexible cushion diaphragm fixed to the plate defining therewith a pumping conduit for carrying a concrete slurry from the output of the gravity feed hopper, a material conduit connected to the output of said pumping conduit, an arcuate tube support attached to the rigid plate proximate the diaphragm and on the side opposite said rigid plate, a plurality of flexible tubes mounted on the arcuate support between said support and the flexible cushion diaphragm, and pneumatic means for selectively expanding and collapsing the flexible tubes, whereby the concrete slurry is carried from the hopper and the selective and consecutive expanding and collapsing of the flexible tubes forces the material through the pumping conduit in a direction transverse the tubes into the material conduit.

3. In a concrete pump including a gravity feed hopper, a material conduit for carrying material to a desired location, and a pump assembly disposed under the hopper and connected to the material conduit for receiving the material from the hopper and delivering it under pressure to the material conduit, said pump assembly comprising an arcuate rigid plate, a flexible diaphragm fixed to and engageable with said plate and forming therewith a pumping conduit, and a plurality of flexible tubes adjacent to said diaphragm and engageable with the side of the diaphragm opposite the plate, said tubes selectively expandable and collapsible, whereby a material from the hopper is delivered by gravity to a space formed by the diaphragm and rigid plate with a first one of said tubes in a completely collapsed condition, a second one of said tubes adjacent to the first tube in a partially collapsed condition, and a third one of said tubes adjacent to the second tube in a fully expanded condition forming a seal between the diaphragm and the rigid plate, and the second tube is further collapsed and the first tube is expanded to move the material along the plate in a direction transverse the tubes.

4. In a device of the character described the combination of an arcuate rigid plate, a flexible cushion diaphragm fixed to and engageable with said plate for forming a seal therewith, a plurality of flexible tubes adjacent to said diaphragm and engageable with the side of the diaphragm opposite the plate, said tubes selectively expandable and collapsible for forcing a selected portion of the diaphragm into engagement and sealing with the plate, and arcuate tube support engaging the side of said tubes opposed the side engageable with the diaphragm, whereby the flexible tubes are selectively and consecutively expanded and collapsed between the support and the rigid plate thereby pumping material therebetween in a direction transverse to said tubes.

5. In an concrete pump including a gravity feed hopper, a material conduit for carrying a concrete slurry under pressure, a pump assembly extending from the hopper to the material conduit for pumping the concrete slurry from the hopper into the material conduit under pressure, and a pneumatic control for controlling and furnishing a source of air for operating said pump assembly, said pump assembly comprising a rigid plate, a flexible cushion diaphragm fixed to said plate defining therewith a pumping conduit, and five flexible tubes at an abrupt angle to said conduit and operatively engaging said diaphragm whereby said pneumatic source selectively expands and collapses said flexible tubes thereby sealing the diaphragm against said plate and forcing the concrete slurry under pressure in a direction transverse the tubes into the material conduit.

6. In a device of the character described the combination of a rigid plate, a flexible cushion diaphragm substantially coextensive with and adjacent to said plate

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for forming a seal therewith, said diaphragm being marginally fixed to said plate in such manner as to form a pumping conduit therewith, a plurality of flexible tubes operatively engageable with said diaphragm on the side opposite said plate, a tube support engaging said tubes on the side opposite said diaphragm, and tube retaining means between adjacent tubes and at each side of the tubes thereby preventing movement of said tubes along the support, whereby the tubes are selectively and consecutively expanded and collapsed to move a material between said diaphragm and said rigid plate under pressure in a direction transverse said tubes.

7. In a concrete pump including a gravity feed hopper, a material conduit for carrying concrete slurry under pressure, a pump assembly extending between the hopper and the material conduit for delivering the concrete slurry from said hopper to the material conduit under pressure, said pump assembly comprising an arcuate rigid plate, a flexible cushion diaphragm substantially coextensive with and fixed to said rigid plate and forming therewith a pumping conduit, an arcuate tube support attached to said rigid plate adjacent the side of the diaphragm opposite the rigid plate, a plurality of flexible tubes mounted on the arcuate tube support between said support and the flexible cushion diaphragm, pneumatic means for selectively expanding and collapsing the flexible tubes, whereby the selective and consecutive expanding and collapsing of the flexible tubes moves the concrete slurry between the diaphragm and rigid plate in a selected direction transverse to the tubes to the material conduit under pressure, and tube retaining means engaging opposite sides of each tube preventing movement of said tubes along said support.

8. In a device of the character described the combination of an arcuate tube support, an arcuate rigid plate complementary to the arcuate tube support and attached thereto, a flexible cushion diaphragm fixed to the plate and disposed between the plate and the support for engagement with said plate and sealing therewith, a plurality of flexible tubes mounted on said tube support between said support and the diaphragm and operatively engaging said diaphragm, and a tube retaining means

engaging opposite sides of each flexible tube, whereby a selective and consecutive expanding and collapsing of the flexible tubes forces a concrete slurry to move between the diaphragm and the rigid plate transverse to said tubes under pressure.

9. A concrete pump comprising a hopper for containing material, said hopper including a neck portion disposed in the lower regions thereof for discharging said material from said hopper, a pair of parallel elongated rigid plates angling downward from said neck portion, a tough flexible diaphragm substantially coextensive with said plates and mounted between said plates, said diaphragm being sealed to the side portions of a first one of said plates defining a pumping conduit therewith, a plurality of mutually adjacent elongated air bladders traversing said conduit, said bladders being mounted in the second one of said plates and being disposed adjacent said diaphragm on the side opposite said first plate, pneumatic means for selectively expanding and collapsing said bladders, said pneumatic means including a plurality of small air passages which open into said bladders on the side opposite said diaphragm, and discharge means connected to said pumping conduit for discharging said material under pressure.

10. A concrete pump as set forth in claim 9, wherein said bladders are tube shaped and are of such size as completely to seal off said conduit when said bladders are completely expanded.

11. A concrete pump as set forth in claim 9, wherein a plurality of reinforcing ridges extend transversely along said first plate on the surface remote from said diaphragm.

12. A concrete pump as set forth in claim 9, wherein said first plate has a uniform concave cross sectional configuration.

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