

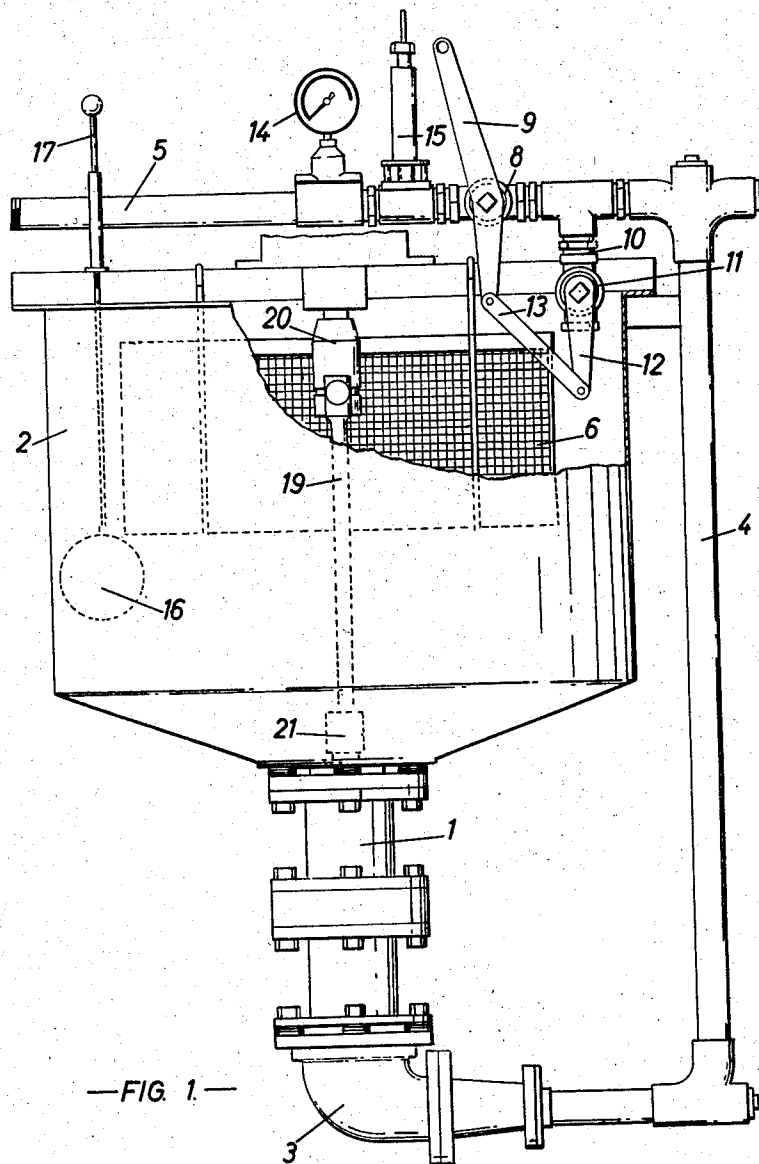
March 31, 1959

L. T. DAVIES
PUMPING APPARATUS

2,879,920

Filed Dec. 18, 1957

6 Sheets-Sheet 1



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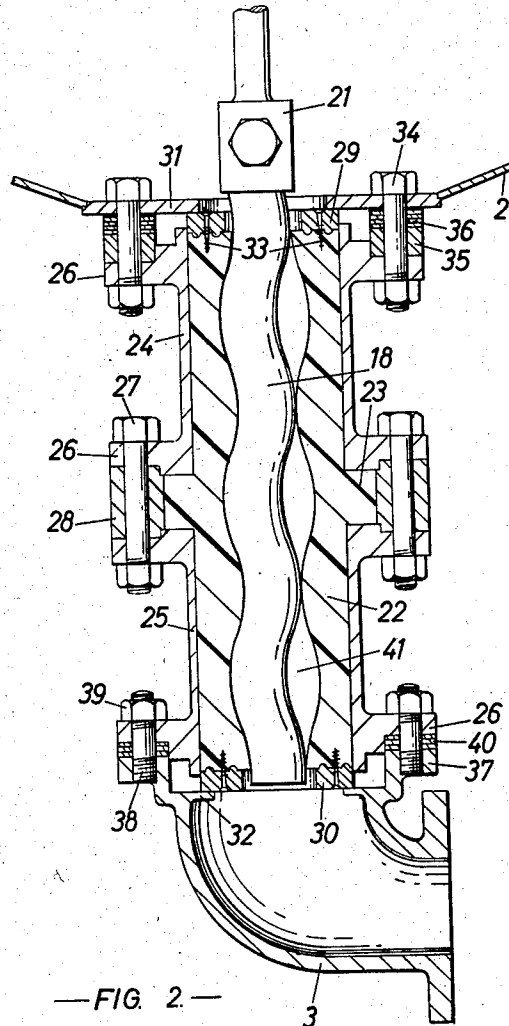
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—FIG. 2.—

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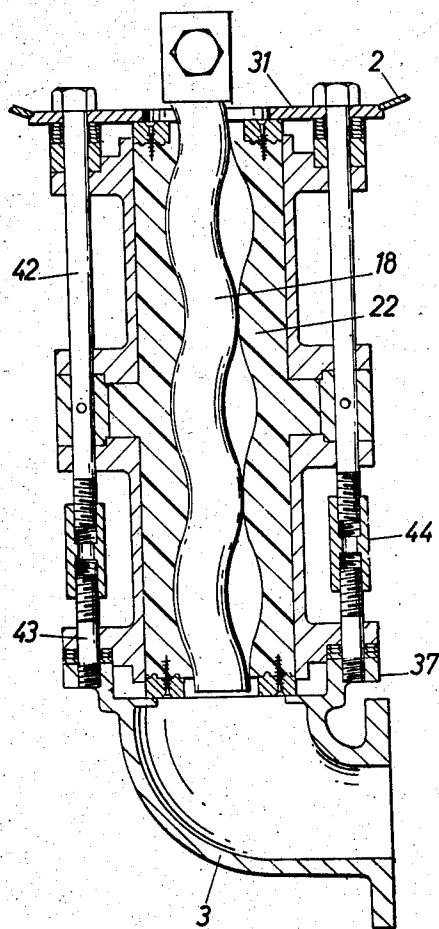
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— FIG. 3 —

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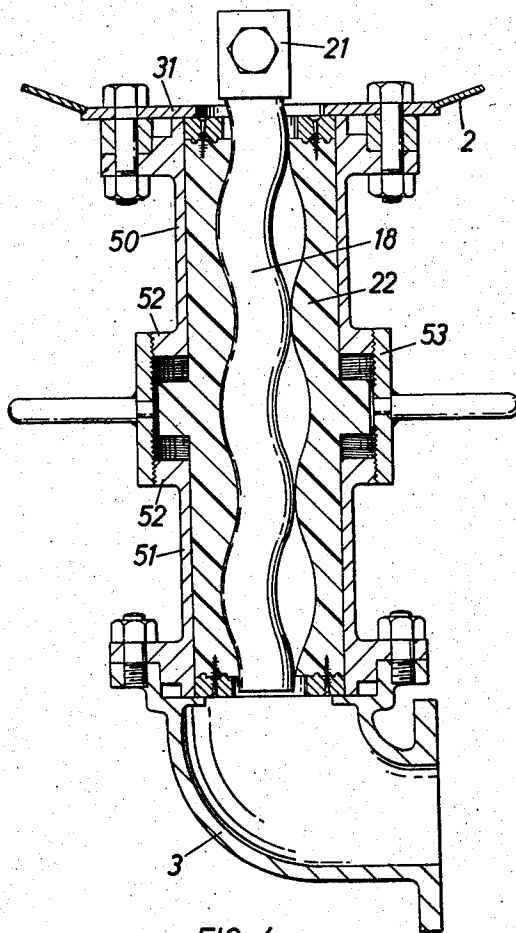
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— FIG. 4. —

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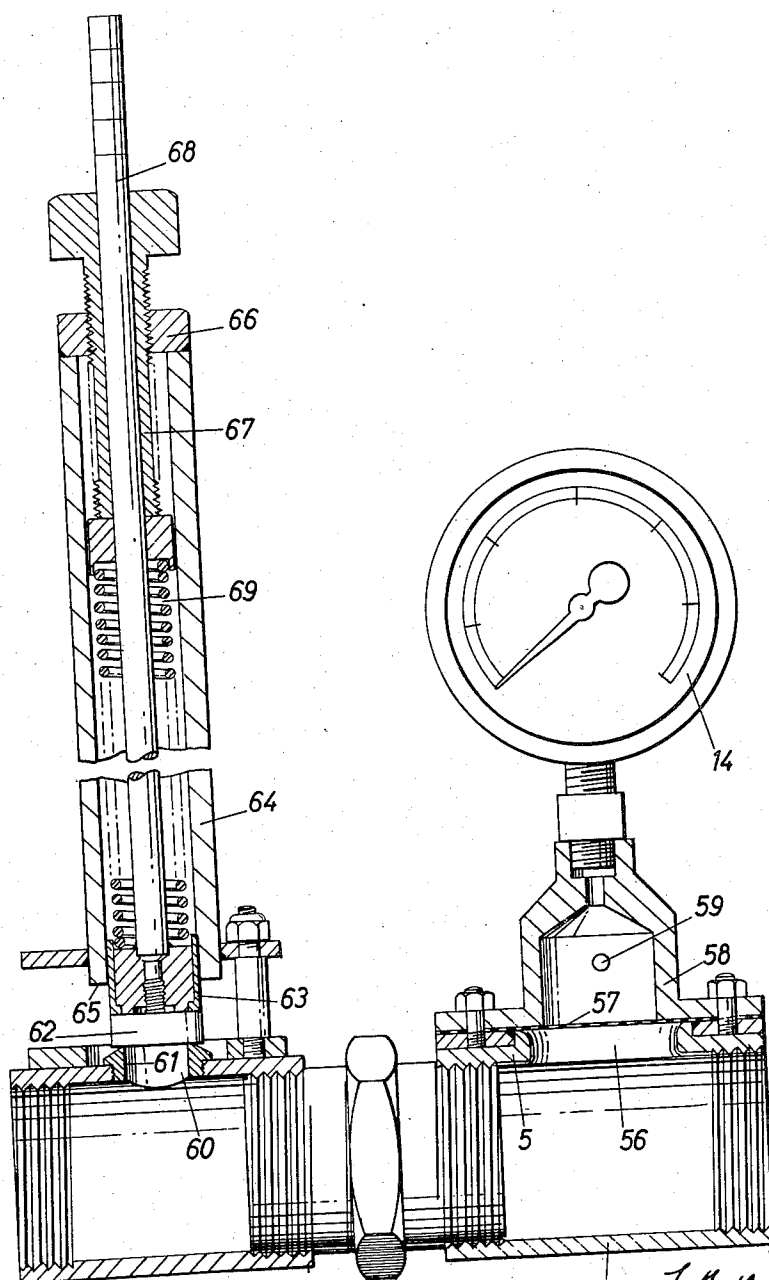
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6 Sheets-Sheet 5



—FIG. 5.—

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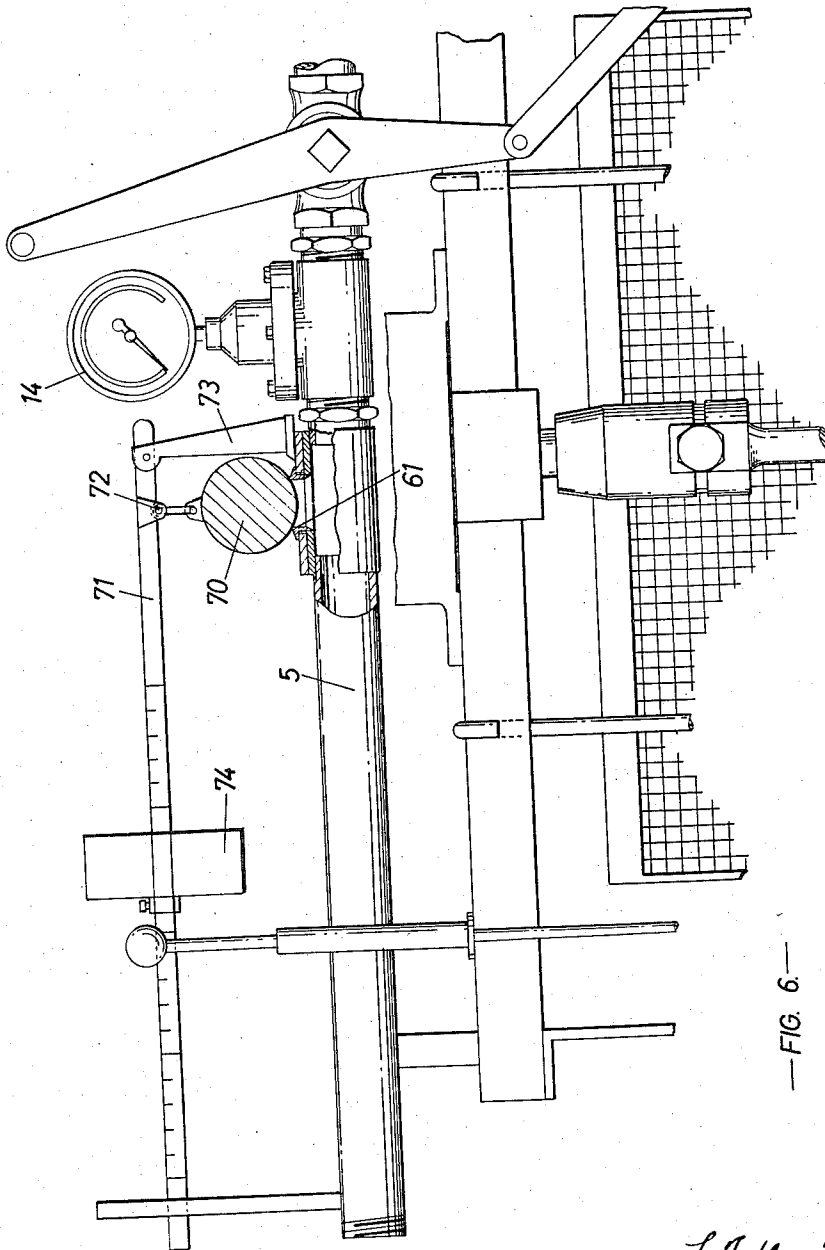
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—FIG. 6—

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PUMPING APPARATUS

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13 Claims. (Cl. 222—23)

The present invention relates to grout pumping apparatus and to the known Mono pumps which comprise an externally helically threaded rotor rotatable in an internally helically threaded pumping chamber in a stator of resilient material such as rubber or artificial rubber.

The pumping of grout has involved considerable difficulty. To pump over distances of the order of 1000 feet and at pressures of the order of 60 lbs. per square inch is not unusual. The character of grout is such that it gives rise to rapid wear of the pumping apparatus and because grout will set and become solid in a few hours it is necessary to clean the grout from the pump and from ancillary equipment connected therewith whenever pumping is interrupted for any considerable period of time e.g. at the end of each day's work. It is thus desirable that the pumping apparatus should be such that the grout can be cleaned therefrom in a simple manner by flushing and without dismantling.

I have found that the Mono pump is the most suitable form of pump for grout but even Mono pumps are fairly quickly worn by grout and one object of the present invention is to provide a ready means for compensating such wear. Another object of the invention is to provide a pumping apparatus embodying a Mono pump which is constructed and arranged so that the apparatus can be readily cleared of grout in a simple manner by flushing with water.

These and other objects of the invention which will be pointed out in more detail hereinafter or which will be apparent to one skilled in the art upon reading this specification, I accomplish by that construction and arrangement of parts of which I shall now disclose exemplary embodiments.

Reference is made to the drawings forming a part hereof and in which:

Fig. 1 illustrates the general arrangement of a grout pumping apparatus according to the present invention;

Fig. 2 is a fragmentary sectional view of the pump embodied in the apparatus of Fig. 1;

Figs. 3 and 4 are views similar to Fig. 2 showing slightly modified forms of pump;

Fig. 5 is a part sectional view of a pressure gauge and relief valve assembly;

Fig. 6 illustrates an alternative form of relief valve.

Referring to Fig. 1 a downwardly directed Mono pump 1 adapted to discharge at its lower end is connected at its upper end to a feed hopper 2 and at its lower end to a discharge connection 3 which discharges through a discharge pipe 4, 5. The hopper 2 contains a mesh sieve 6 into which the grout is fed and which serves to retain pieces of solid material which might inadvertently have become mixed into the grout and might damage the pump.

The discharge of grout through the discharge pipe 5 is controlled by a valve 8 operated by a lever 9. In advance of the valve 8 the pipe 5 is provided with a return connection 10 controlled by a valve 11 operated by a lever 12. The levers 9 and 12 are interconnected by a link 13 so

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that the valve 11 is open when the valve 9 is closed to enable grout discharged by the pump 1 to be returned to the hopper 2 when the valve 8 is closed. The discharge pipe 5 is provided with a pressure gauge 14 and a pressure relief valve 15. A float 16 and tell-tale rod 17 enable the depth of grout in the hopper to be readily observed.

The rotor 18 of the pump 1 which is not shown in Fig. 1 but can be seen in Figs. 2, 3 and 4 is driven from above the hopper 2 through a driving shaft 19 which itself is driven through a universal joint 20 and is connected to the rotor 18 through a universal joint 21.

The stator of the pump is indicated at 22 in Figs. 2 and 3. The stator is formed of resilient material such as rubber or synthetic rubber and has an annular flange 23 approximately at its mid-length. The stator is surrounded by a casing formed of two casing parts 24, 25 each having flanges 26 at its opposite ends. The adjacent flanges 26 are connected together by nutted bolts 27 but held in spaced relationship by a distance piece 28 to provide an annular recess in which the annular flange 23 of the stator is received. Annular caps 29, 30 are interposed between the upper end of the stator and the under side of the base 31 of the hopper 2 and between the lower end of the stator and an internal flange 32 on the discharge connection 3. The end caps 29, 30 are secured to stator 22 by screws 33.

The upper flange 26 of the upper casing part 24 is secured to the base 31 of the hopper 2 by means of nutted bolts 34 with distance pieces 35 and packing pieces or shims 36 therebetween. The discharge connection 3 has an external flange 37 to which the lower flange 26 of the lower casing part 25 is secured by studs 38 and nuts 39, with packing pieces or shims 40 therebetween.

If the stator becomes worn say at its lower end so that the chamber generally indicated by the reference numeral 41 has become enlarged in cross-section, its cross-section can be appropriately reduced by loosening the nuts 39, removing one or more of each set of shims 40 and retightening the nuts 39 whereby axial pressure is applied to the lower end of the stator to reduce the cross-section of the chamber. Compensation for wear at the upper end of the stator can similarly be made.

The arrangement illustrated in Fig. 3 is similar to that of Fig. 2 except that the nutted bolts 27, 34 and the studs 38 and nuts 39 are replaced by bolts 42 extending downwardly from the base 31 of the hopper 2, studs 43 extending upwardly from the flange 37 of the discharge connection 3 and nuts 44 in threaded engagement with the bolts 42 and studs 43. The bolts 42 and studs 43 are oppositely threaded and the nuts 44 are oppositely threaded at their opposite ends to enable the discharge connection 3 to be drawn towards the base 31 of the hopper 2 to apply axial compression to the stator 22 by rotation of the nuts 44.

The arrangement illustrated in Fig. 4 is similar to that of Figs. 2 and 3 except that the distance piece 28 is omitted and the adjacent ends of the upper and lower casing parts 50, 51 are formed with oppositely threaded flanges 52 in threaded engagement with an oppositely internally threaded muff coupling or cylinder 53 so that by rotation of the coupling 53 in an appropriate direction the overall length of the stator casing can be reduced to apply endwise compression to the stator 22.

The connection of the pressure gauge 14 to the pipe 5 is illustrated in Fig. 5. Pipe 5 is formed with an opening 56 which is closed by a diaphragm 57 and the gauge 14 has a fluid connection 58 to the pipe 5 at the exterior of the diaphragm. The gauge 14 and its fluid connection 58 are filled with a suitable liquid which is supported by the diaphragm 57 so that changes of pressure in the pipe 5 will be indicated on the gauge through flexure of the diaphragm 57. A valve controlled aperture 59

is provided in the fluid connection 58 for the purpose of filling the fluid connection 58 and gauge 14 with the liquid.

The relief valve 15 indicated in Fig. 1 is also shown in more detail in Fig. 5. A relief opening 60 in the pipe 5 is surrounded by a valve seat 61 engaged by a relief valve 62. A valve slide 63 fixed to the valve 62 is guided in a guide tube 64 which is coaxial with the valve seat and whose end 65 nearer the valve seat is spaced therefrom to permit grout discharged through the opening 60 to drain away. A cap 66 secured to the upper end of the tube 64 has a threaded opening therein to receive a relatively long threaded bolt 67 engaging in a threaded opening in the cap 66. The bolt 67 has an axial opening therethrough to receive a valve spindle 68. The valve is loaded by a spring 69 which is compressed between the bolt 67 and the slide 63 and the compression of which can be adjusted by adjustment of the bolt 67. The length of the bolt 67 permits of a considerable variation in the loading applied to the valve 62 by the spring 69.

An alternative form of relief valve is illustrated in Fig. 6 where the valve seat 61 is closed by a ball shaped or spherically surfaced valve 70 which is pivoted to a lever 71 pivoted at 72 to a bracket 73 fixed to the pipe 5. The lever 71 carries a weight 74 which can slide along the lever 71 to adjust the loading applied to the valve 70.

It will be noted that valve 62 and valve 70 and likewise the diaphragm 56 each forms part of the boundary of the discharge passage within the pipe 5 so that at the end of a pumping operation grout at the underside of the valve and at the underside of the diaphragm can be cleared by simple flushing through the pipe 5. Grout cannot penetrate into the pressure gauge 14 where it would be difficult to remove because it is prevented from doing so by the diaphragm 56. Likewise the two alternative forms of relief valves are each constructed so that so long as the valve is seated grout cannot penetrate beyond the underside of the valve itself and so that when the valve lifts grout can readily drain away from the exterior of the valve.

Because the rotor of a Mono pump oscillates during its rotation it is commonly driven by a driving shaft enclosed in a sleeve rotatable with the rotor. If such a driving arrangement were used with grout it would be necessary to dismantle the sleeve to clear the grout therefrom at the end of each pumping operation. The apparatus of the present invention avoids this difficulty in that the pump is downwardly directed and discharges at its lower end and is fed at its upper end by a hopper through which the driving shaft can pass and in which it can oscillate during its rotation and through which the whole apparatus can be readily flushed with water at the end of each pumping operation.

I claim:

1. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, casing means enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a hopper connected to the upper end of said casing to feed the pump, a driving shaft connected to the upper end of the rotor and extending upwardly through said hopper, a discharge pipe leading from the lower end of the pump, said pipe having an opening therein, a flexible diaphragm closing said opening and a pressure gauge having a fluid connection to the pipe at the exterior of said diaphragm to enable changes of pressure in the pipe to be shown on the gauge through flexure of said diaphragm.

2. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having

an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, casing means enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a hopper connected to the upper end of said casing to feed the pump, a driving shaft connected to the upper end of the rotor and extending upwardly through said hopper, a discharge pipe leading from the lower end of said pump, a pressure relief opening in said pipe, a valve seat surrounding said pressure relief opening, a valve adapted to engage said seat to close said opening and loading means for said valve.

3. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, casing means enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a discharge pipe leading from the lower end of the pump, said pipe having an opening therein, a flexible diaphragm closing said opening and a pressure gauge having a fluid connection to the pipe at the exterior of said diaphragm to enable changes of pressure in the pipe to be shown on the gauge through flexure of said diaphragm.

4. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, casing means enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a discharge pipe leading from the lower end of said pump, a pressure relief opening in said pipe, a valve seat surrounding said pressure relief opening, a valve adapted to engage said seat to close said opening and loading means for said valve.

5. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, casing means enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a hopper connected to the upper end of said casing to feed the pump, a driving shaft connected to the upper end of the rotor and extending upwardly through said hopper, a universal joint between said driving shaft and said rotor, a universal joint at the upper end of said driving shaft, a discharge pipe leading from the lower end of the pump, said pipe having two openings therein, a flexible diaphragm closing one of said openings, a pressure gauge having a fluid connection to the pipe at the exterior of said diaphragm to enable changes of pressure in the pipe to be shown on the gauge through flexure of said diaphragm, a valve seat surrounding the second of said openings, a valve adapted to engage said seat to close said second opening and loading means for said valve.

6. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, casing means enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a discharge pipe leading from the lower end of the pump, said pipe having two openings therein, a flexible diaphragm closing one of said openings, a pressure gauge having a fluid connection to the pipe at the exterior of said dia-

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phragm to enable changes of pressure in the pipe to be shown on the gauge through flexure of said diaphragm, a valve seat surrounding the second of said openings, a valve adapted to engage said seat to close said opening and loading means for said valve.

7. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, a casing enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a hopper connected to the upper end of said casing to feed the pump, a driving shaft connected to the upper end of the rotor and extending upwardly through said hopper, a discharge pipe leading from the lower end of said pump, a pressure relief opening in said pipe, a valve seat surrounding said pressure relief opening, a valve adapted to engage said seat to close said opening, loading means for said valve, and guiding means for said valve spaced from the seat so as to enable grout discharged through said opening to drain away from the valve and opening.

8. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, a casing enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a hopper connected to the upper end of said casing to feed the pump, a driving shaft connected to the upper end of the rotor and extending upwardly through said hopper, a discharge pipe leading from the lower end of said pump to above said hopper, a pressure relief opening in said pipe above the hopper, a valve seat surrounding said pressure relief opening, a valve adapted to engage said seat to close said opening, a guide tube fixed to the discharge pipe co-axial with said pressure relief opening with its end nearer the opening spaced from the valve seat, a valve slide fixed to the valve and engaging in said nearer end of the guide tube, a cap having a threaded opening therein at the opposite end of said tube, a relatively long bolt engaging in the threaded opening of said cap, said bolt having an axial opening therethrough, a valve spindle extending from the valve through said opening in said bolt and a valve spring between the bolt and said slide.

9. Grout pumping apparatus comprising a downwardly directed Mono pump arranged to discharge at its lower end and embodying a stator of resilient material having an internally helically threaded pumping chamber, a helically externally threaded rotor in said chamber, a casing enclosing the stator and constructed to enable its effective axial length to be reduced at at least one end to reduce the cross-section of the stator at that end, a hopper connected to the upper end of said casing to feed the pump, a driving shaft connected to the upper end of the rotor and extending upwardly through said hopper, a discharge pipe leading from the lower end of said pump to above said hopper, a pressure relief opening in said pipe above the hopper, a valve seat surrounding said pressure relief opening, a bracket fixedly mounted on said pipe adjacent said opening, a lever pivoted to said bracket, a spherically surfaced valve seated on said valve

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seat and pivotally attached to said lever and loading means for said lever to keep the valve on said seat.

10. Grout pumping apparatus comprising an upwardly directed hopper having an opening in its base, a discharge connection beneath and spaced from said opening in the hopper base, a downwardly directed Mono pump arranged between the underside of the hopper and said discharge connection and embodying a stator of resilient material in endwise abutment with the underside of the hopper and with said discharge connection and having an internally helically threaded pumping chamber, an externally helically threaded rotor in said chamber, a tubular casing surrounding the stator, said casing having flanges at its opposite ends, threaded connections between said flanges and the base of the hopper and said discharge connection and shims between the upper flange of the stator casing and the underside of the hopper and between the lower flange of the stator casing and said discharge connection to enable the stator to be axially compressed between said hopper and said discharge connection by removal of shims and retightening of said threaded connections.

11. Apparatus according to claim 10 in which said stator casing is formed of two interconnected parts providing an annular recess approximately at its mid-length and the stator is formed with an annular flange engaging in said recess whereby one end of the stator can be compressed independently of the other end by the removal of shims and tightening of said threaded connections at that end.

12. Apparatus according to claim 10 comprising threaded connection elements extending downwardly from the base of the hopper and oppositely threaded connections extending upwardly from the flange of the discharge connection and nuts having opposite threads at opposite ends engaging the adjacent ends of said upwardly and downwardly extending threaded connections.

13. Grout pumping apparatus comprising an upwardly directed hopper having an opening in its base, a discharge connection beneath and spaced from said opening in the hopper base, a downwardly directed Mono pump arranged between the underside of the hopper and said discharge connection and embodying a stator of resilient material in endwise abutment with the underside of the hopper and with said discharge connection and having an internally helically threaded pumping chamber, an externally helically threaded rotor in said chamber, upper and lower tubular casings surrounding the stator connected respectively to the hopper base and to said discharge connection, the adjacent ends of said tubular casings being axially spaced and formed with outwardly directed flanges which are oppositely peripherally threaded and a muff coupling which is internally oppositely threaded at its opposite ends and in threaded engagement with the flanges of said tubular casings to enable rotary adjustment of said muff coupling to draw said discharge connection towards the hopper whereby axially to compress the stator and to reduce its cross-section.

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