April 4, 1961 L. BAINES 2,978,044

FLUID ACTUATED MECHANISMS

Filed Nov. 29, 1957 2 Sheets-Sheet 1

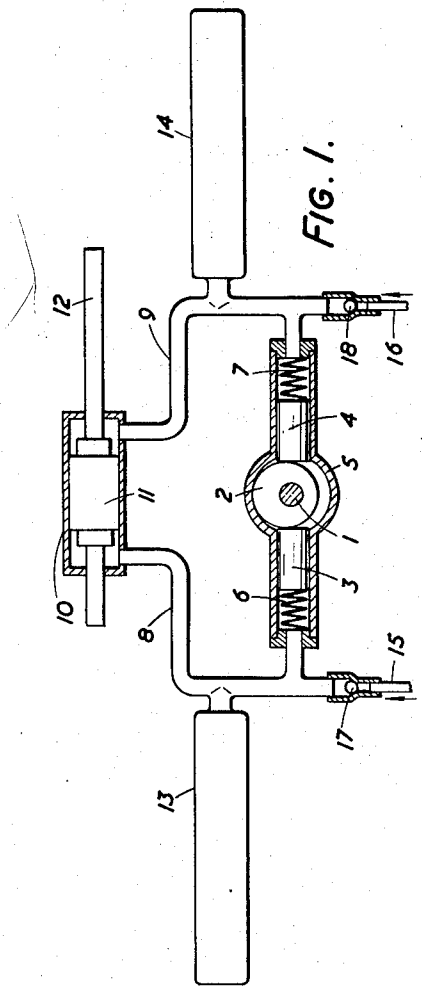


FIG. 1.

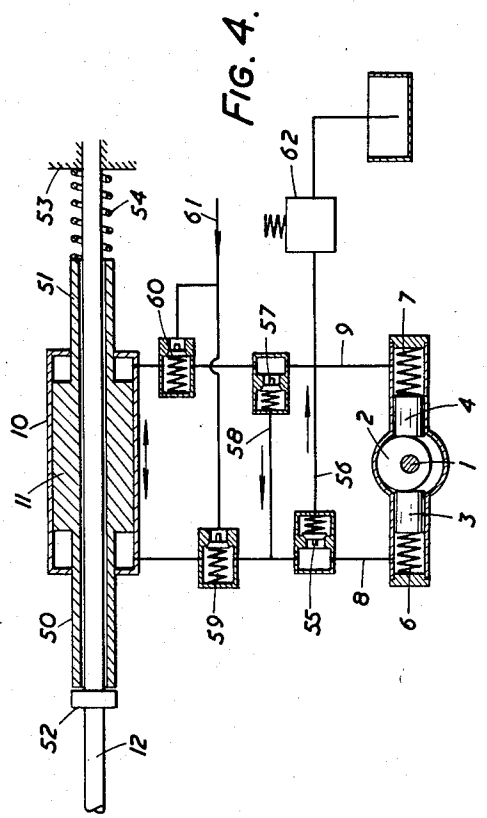


FIG. 4.

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FLUID ACTUATED MECHANISMS

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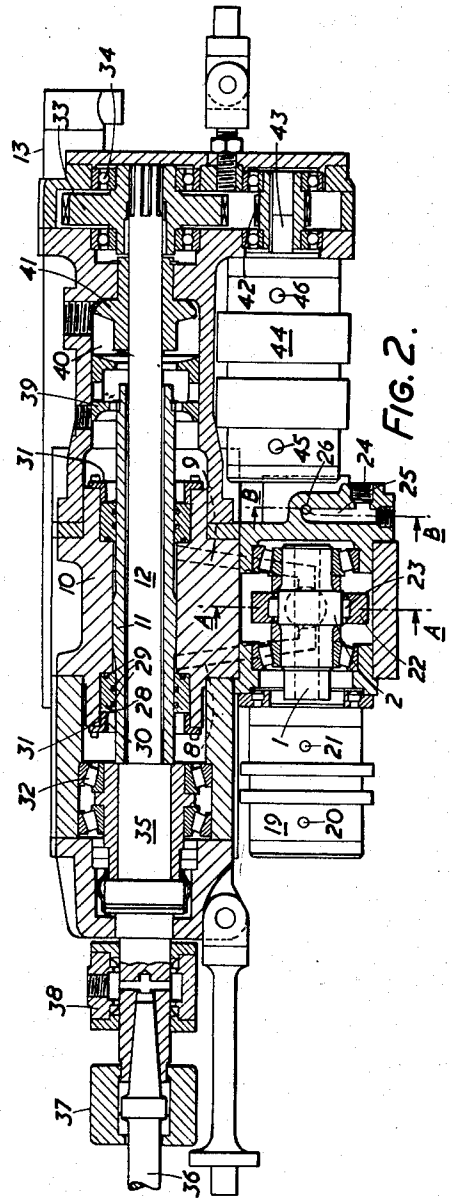


FIG. 2.

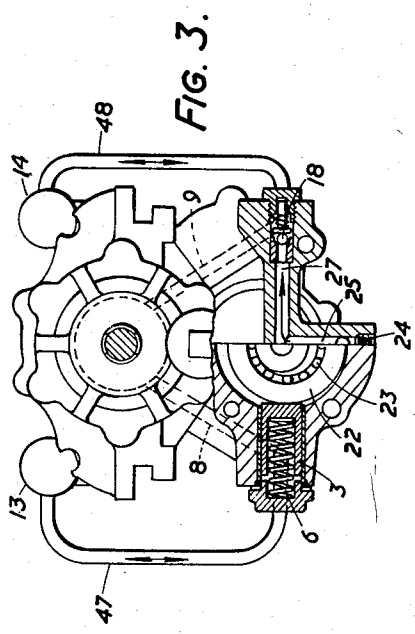


FIG. 3.

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FLUID ACTUATED MECHANISMS

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4 Claims. (Cl. 175—144)

This invention relates to fluid actuated mechanisms for reciprocating a member and has particular reference to mechanisms actuated hydraulically.

According to the present invention fluid actuated mechanism for reciprocating a member comprises a double acting cylinder, a piston reciprocable within the cylinder, a power unit having two pumping means for supplying fluid under pressure to the cylinder to produce reciprocation of the piston, and in which the outputs of each of the pumping means is greater than that which is utilizable by the cylinder, means being provided for receiving the excess output.

In one embodiment of the invention, the pumping means operate in anti-phase and the excess output of one pumping means is receivable by the other means.

In another form of the invention each pumping means is connected to an accumulator which is loaded to receive from the pumping means only the excess output of the latter.

Alternatively, the means for receiving excess output may comprise a source of low pressure fluid to which the pumping means are connected. Flow of excess output to the source is controlled by valves which may be suitably loaded or may be mechanically operated to open at suitable moments.

Alternatively, the cylinder may be formed with ports which are uncovered during movement of the piston in the cylinder to permit excess output to flow to the source.

The reciprocating movement of the piston is transmitted to the member or members to be reciprocated. The member may consist of a shaft which passes longitudinally through the axis of the piston and which has a flange or collar which is struck periodically by the piston, thus imparting to the shaft a blow of a percussive nature.

The power unit may supply fluid under pressure to a number of cylinders, each containing a reciprocable piston.

By way of example only, hydraulically operated rotary picks or drills suitable for use in coal mining equipment and embodying the invention will now be described in greater detail with reference to the accompanying drawings of which:

Fig. 1 shows the first embodiment of the invention in diagrammatic form only.

Fig. 2 is a side elevation partly in section of the first embodiment.

Fig. 3 is an end elevation with half-sections on the lines A—A and B—B of Fig. 2, and,

Fig. 4 shows a second embodiment in diagrammatic form.

Referring to Fig. 1, the mechanism illustrated comprises a power unit which includes shaft 1 carrying an eccentric 2 for imparting reciprocatory movement to pistons 3, 4 of two hydraulic pumps. The pistons are mounted in a housing 5 in diametrically-opposed positions with respect to shaft 1.

The pistons 3, 4 are moveable in the housing 5 against springs 6, 7 respectively.

The outputs of the hydraulic pumps are applied via pipe lines 8, 9 to a double-acting cylinder 10 at opposite ends thereof. The cylinder has a piston 11 mounted upon a shaft 12 which is the shaft of a rotary pick or drill.

The pipe lines 8, 9 are also connected to hydraulic accumulators 13 and 14 respectively and also to inlets 15 and 16 containing ball-valves 17, 18 respectively. The inlets 15, 16 are both connected to a source of low pressure hydraulic liquid (not shown) so that any deficiency of liquid in the system, due to irregularities of liquid in the swept volume of the pumps and/or leakage, can be made up.

The hydraulic pumps are of a capacity such that they deliver to the cylinder 10 a volume of liquid slightly in excess of the volume which the cylinder can accept, the excess volume being pumped into the hydraulic accumulators connected to the pumps.

Before use, the shaft 1 is coupled to a suitable source of power which may be a hydraulic motor. After the system has been filled with hydraulic liquid, rotation of the eccentric 2 reciprocates the pistons 3, 4 and liquid is pumped to and withdrawn from opposite ends of the cylinder 10 causing longitudinal movement of the shaft 12.

By providing an excess supply of liquid to the cylinder 10 it is ensured that the piston is positively moved to the full extent of its stroke, and is thus independent of any deficiency of oil in the power unit due to slip or other cause. In addition, by suitably determining the swept volumes of the double-acting cylinder and the power unit the point at which overspill occurs can be arranged so that the piston is travelling at maximum optimum speed after an acceleration period and is therefore able to give the maximum possible blow to the drill. For example, in the embodiments illustrated the pistons 3, 4 are driven by an eccentric and so the speed of the piston 11 will vary sinusoidally. In this case the swept volumes are arranged so that overspill occurs immediately after the acceleration of the piston 11 passes its maximum value when the piston has its optimum velocity.

The hydraulic accumulators 13, 14 are loaded so that only the excess hydraulic liquid passes into them.

Loading may be effected by means of springs or a gas or the accumulators may consist of an oil filled steel tube or rubber hose.

Figures 2 and 3 of the accompanying drawings show the invention embodied in a rotary percussive pick or drill suitable for use in coal mining machines. In Figures 2 and 3 parts identical with parts shown in Figure 1 have been given the same reference numbers.

The shaft 1 is driven by an hydraulic motor 19 having an inlet 20 and an outlet 21 for the supply and exhaust of working liquid and is secured to the housing 10 containing the shaft 12 of the drill. A part of the eccentric 2 is shown in Figure 2 and its eccentric movement is transmitted to the pistons 3, 4 by means of a ring 22 supported on the eccentric by roller bearings 23. As can be seen from Figure 2, the housing 10 is formed to accommodate the pistons 3, 4 and their springs 6, 7. The housing also has an inlet aperture 24 communicating with an internal passage 25 connected to passageways 26 and 27 leading to each piston. Flow of liquid from the passageways 26, 27 is controlled by the non-return valves 17 and 18 respectively.

Movement of hydraulic liquid between the pumps and the interior of the housing 10 takes place via pipelines 8 and 9 which are shown dotted in Figures 2 and 3. The pipelines communicate with two narrow annular spaces between the piston or "hammer" 11 and the interior wall

of the housing 10. Leakage along the hammer 11 is prevented by the sealing blocks 28 fitted with piston-ring seals 29. The blocks 28 are held in enlarged bores 30 in the housing 10 by means of flanges 31 and setscrews.

One end of the shaft 12 on which the piston 11 is slidably mounted is rotatably supported in the housing 10 by roller bearings 32 while the other end of the shaft is splined to pinion 33 supported by ball bearings 34 in the housing 10. The shaft 12 also has a portion 35 of enlarged diameter, one end of which forms an anvil against which the hammer 11 operates.

The forward end of the shaft 12 projects from the housing 10 and is formed to receive a pick-head 36 secured to the shaft by a coupling 37. The forward end of the shaft also carries another coupling 38 which permits water to be pumped into the shaft end and through the pick-head to flush a bore-hole made by the pick-head.

The housing 10 also accommodates an air recuperator or shock absorber for absorbing the impact of reverse movement i.e. movement to the right as seen in Figure 2, of the hammer 11. The recuperator consists of a piston head 39 secured to the hammer and movable therewith in a chamber 40 in the housing 10. The chamber 40 also accommodates a backstop 41 which limits reverse movement of the hammer.

In addition to the reciprocating movement imparted to the shaft 12 by hammer 11 the shaft is also given a rotary motion. The pinion 33 referred to above meshes with the second pinion not shown, which in turn engages pinion 42 secured to the shaft 43 of a hydraulic motor 44. The motor 44 has an inlet port 45 and an outlet port 46 for the supply and exhaust of working liquid.

The hydraulic accumulators 13, 14 shown in Figure 1 are, in the embodiment shown in Figures 2 and 3 mounted on the housing 10 and are connected with the pistons 3 and 4 by means of pipelines 47 and 48 respectively.

The inlets 20 and 45 of the two hydraulic motors are joined to separate sources (not shown) of pressurized hydraulic liquid and the inlet 25 is connected to an external source of make-up liquid. The exhaust ports 21 and 46 of the motors are joined to a suitable resorvoir tank.

Rotation of the shaft 1 by the motor 19 reciprocates the pistons 3 and 4 and hydraulic liquid is pumped through the pipes 8 and 9 first to one side of the hammer and then to the other, causing the latter to reciprocate rapidly on the shaft 12 and impart a series of hammer blows to the anvil 35. At the same time motor 44 rotates the shaft 12 via the pinions 33 and 42.

Figure 4 of the accompanying drawings shows, in diagrammatic form only, a further embodiment of the invention in which excess working liquid circulates between the pumping means. In Figure 4, parts identical with those shown in Figures 1, 2 and 3 have received identical reference numbers.

The mechanism shown in Figure 4 has a power unit which includes the shaft 1 which carries the eccentric 2, arranged to impart a reciprocating movement to pistons 3 and 4 against their respective springs 6 and 7.

The pumping means are positioned diametrically opposite to one another with respect to the shaft 1 and the eccentrics are arranged so that the movements of the pistons 3, 4 in their respective cylinders are in anti-phase.

The outputs of the pumping means are applied to the double-acting cylinder 10 at opposite ends thereof by means of suitable pipe lines 8 and 9. The cylinder contains a piston 11 having tubular extensions 50 and 51 and a central passageway through which passes the shaft 12 of the rotary percussive pick. The shaft 12 has a flange or collar 52 and passes through a bearing indicated diagrammatically at 53. A helical spring 54 may be supported between the bearing 53 and one end of the extension 51 of the piston 11.

The volume of hydraulic liquid, for example a suitable oil, displaced by piston 3 is in excess of that which can be used by the cylinder 10 and the excess is fed by means of a spring-loaded discharge valve 55 and a pipe line 56 into the line 9. Similarly, a spring-loaded discharge valve 57 and line 58 is provided to enable excess output from piston 5 to be returned to line 8.

The lines 8 and 9 are joined via make-up valves 59 and 60 respectively and pipe line 61 to an external source of low pressure hydraulic liquid (not shown) so that any deficiency of liquid in the system due to irregularities in swept volume, leakage, and other causes can be made up. A master pressure-relief valve 62 prevents an excess of liquid in the system.

The operation of the embodiment shown in Figure 4 is similar to that of the embodiment described above.

Liquid pumped by the piston 3 to the cylinder 16 causes movement of the piston 11 to the right as seen in the drawing against the action of the spring 54. Since the pistons 3 and 4 operate in anti-phase, piston 4 is withdrawing liquid from the cylinder. After the cylinder 10 has absorbed its maximum volume of liquid excess passes to the line 9. The action of piston 4 is similar except that in this case movement of the piston 11 occurs to the left and a blow is imparted to the flange or collar 52.

In another embodiment of the invention, valves control the flow of excess hydraulic liquid from the pumps and are mechanically controlled to open and close at required instants. The cylinder in which the piston reciprocates may, alternatively, be formed with ports which are covered and uncovered by the piston during its movement to control the flow of excess liquid.

It will be appreciated that the pumps may be driven by other forms of motor, for example electric or pneumatic motors, could be used and such motors are also suitable for rotating the pick or drill.

I claim:

1. A high speed percussive mechanism comprising a housing, a cylinder formed within the housing, hydraulic liquid contained in the cylinder, a shaft mounted coaxially with the cylinder and extending through one end thereof, an anvil face on the shaft, a double acting piston slidably mounted within the cylinder for reciprocation relative to said shaft, a hammer face on the piston for co-operation with said anvil face, a double acting liquid transmitting power unit, a volume of hydraulic liquid contained in the power unit greater than the volume contained in the cylinder, two outlets from the power unit, means connecting the outlets to respective ends of the cylinder whereby transmission of liquid through the connecting means by operation of the power unit rapidly reciprocates the piston relative to the shaft to cause percussive blows to be imparted to the shaft by co-operation of the hammer face and the anvil face during alternate strokes of the piston, a different hydraulic accumulator connected to each outlet, and loading means for the accumulators, whereby only the excess hydraulic liquid discharged from the power unit into an outlet is absorbed by the associated hydraulic accumulator, this excess hydraulic liquid being replaced by the same accumulator during subsequent discharge of hydraulic liquid from the cylinder to that outlet.

2. A high speed percussive mechanism comprising a housing, a cylinder formed within the housing, hydraulic liquid contained in the cylinder, a shaft mounted coaxially with the cylinder and extending through one end thereof, an anvil face on the shaft, a double acting piston slidably mounted within the cylinder for reciprocation relative to said shaft, a hammer face on the piston for co-operation with said anvil face, a double acting liquid transmitting power unit, two outlets from the power unit, means connecting the outlets to respective ends of the cylinder, hydraulic liquid contained in the power-unit, the volume of liquid transmittable from the power unit into an outlet being in excess of that receivable by the portion of the cylinder to which that outlet is connected, whereby transmission of liquid through

the connecting means by operation of the power unit rapidly reciprocates the piston relative to the shaft to cause percussive blows to be imparted to the shaft by co-operation of the hammer face and the anvil face during alternate strokes of the piston, a two-way flow relief valve arrangement connected between the outlets, whereby the excess hydraulic liquid discharged from the power unit into an outlet actuates the relief valve arrangement to allow flow of the excess liquid in one direction through the relief valve to the other outlet.

3. A high speed percussive mechanism comprising a housing, a cylinder formed within the housing, hydraulic liquid contained in the cylinder, a shaft located within the housing and extending through the cylinder co-axially therewith, means mounting the shaft allowing limited sliding movement thereof, a collar rigidly secured to the shaft near one end of the cylinder, an anvil face on the collar, a double acting hollow piston surrounding the shaft, the piston being slidably mounted within the cylinder for reciprocation relative to the shaft, a hammer face formed on one end of the piston for co-operation with said anvil face, a double acting liquid transmitting power unit, two outlets from the power unit, means connecting the outlets to respective ends of the cylinder, hydraulic liquid contained in the power unit, the volume of liquid transmittable from the power unit into an outlet being in excess of that receivable by the portion of the cylinder to which that outlet is connected, whereby transmission of liquid through the connecting means by operation of the power unit rapidly reciprocates the piston relative to the shaft to cause percussive blows to be imparted to the shaft by co-operation of the hammer face and the anvil face during alternate strokes of the piston, a one-way relief valve connected between the outlets to allow liquid flow in one direction only, a further one-way relief valve connected between the outlets to allow liquid flow only in an opposite direction, whereby the excess liquid discharged from the power unit into an outlet actuates one of the relief valves to allow said excess liquid to flow to the other outlet.

4. A high speed percussive mechanism comprising a housing, a cylinder formed within the housing, hydraulic liquid contained in the cylinder, a shaft located within the housing and extending through the cylinder co-axially therewith, means mounting the shaft and allowing limited axial sliding movement thereof, a collar rigidly secured to the shaft adjacent one end of and exterior to the cylinder, an anvil face on the collar formed on the face of the collar nearer to the cylinder, a double acting hollow piston co-axially mounted to surround the shaft, the piston being slidably mounted within the cylinder for reciprocation relative to the shaft, a tubular extension piece secured to either end of the piston to surround the shaft, the extension pieces extending through the ends of the cylinder, a hammer face formed on the free end of the extension piece nearest the collar for co-operation with said anvil face, a double acting liquid transmitting power unit, two outlets from the power unit, means connecting the outlets to respective ends of the cylinder, hydraulic liquid contained in the power unit, the volume of liquid transmittable from the power unit into an outlet being in excess of that receivable by the portion of the cylinder to which that outlet is connected, whereby transmission of liquid through the connecting means by operation of the power unit rapidly reciprocates the piston relative to the shaft to cause percussive blows to be imparted to the shaft by co-operation of the hammer face and the anvil face during alternate strokes of the piston, a different hydraulic accumulator connected to each outlet, and loading means for the accumulators, whereby only the excess hydraulic liquid discharged from the power unit into an outlet is absorbed by the associated hydraulic accumulator, this excess hydraulic liquid being replaced by the same accumulator during the next ensuing discharge of hydraulic liquid from the cylinder to that outlet.

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