Nov. 19, 1946. W. S. GALLOWAY ET AL 2,411,258

HYDRAULIC MACHINE

Filed Sept. 6, 1945 2 Sheets-Sheet 1

Fig. 1.

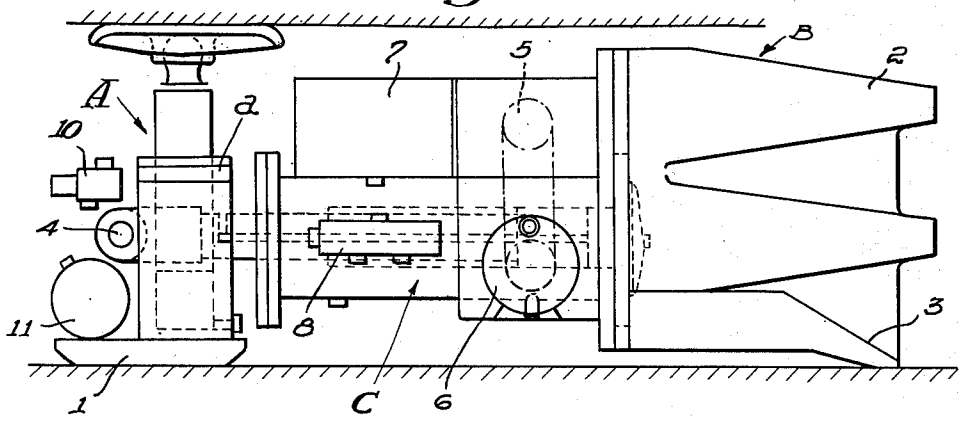


Fig. 3

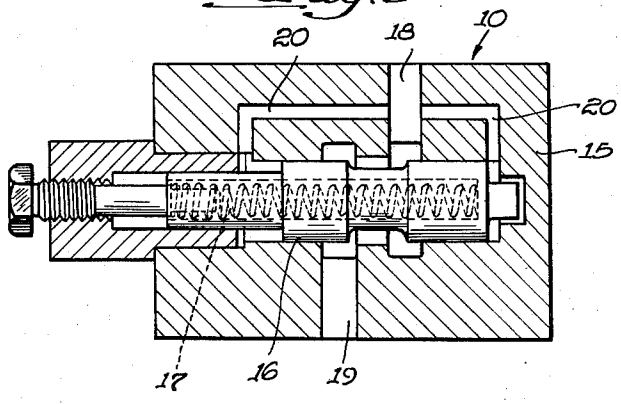
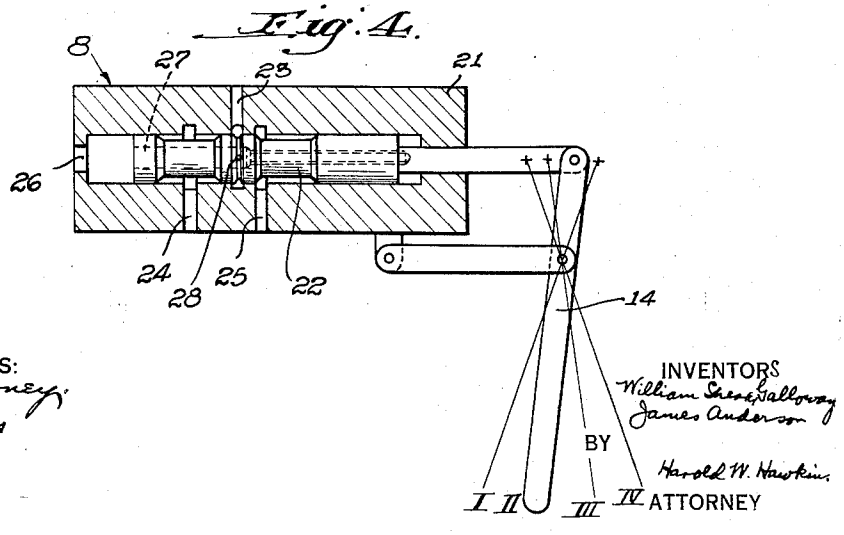


Fig. 4.



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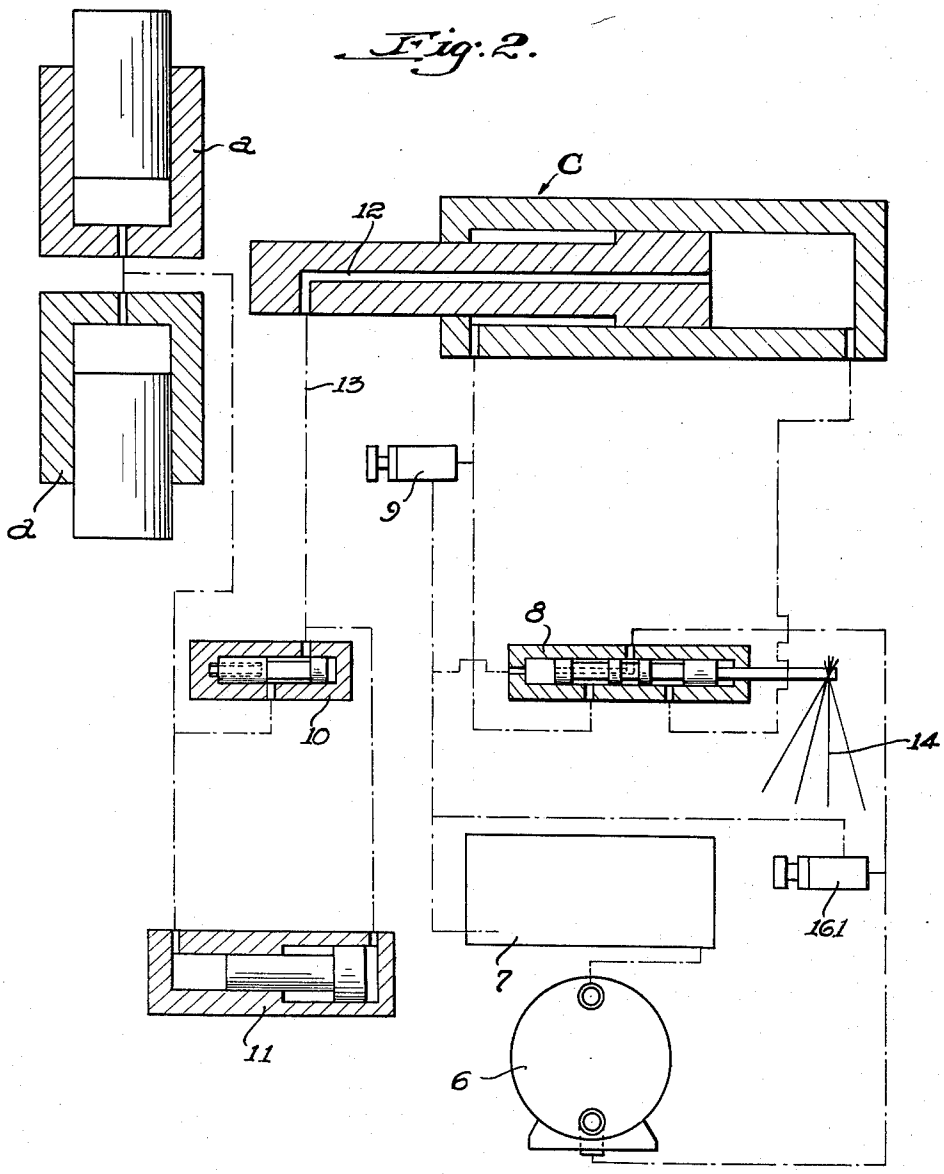
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Fig. 2.



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HYDRAULIC MACHINE

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6 Claims. (Cl. 262—8)

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This invention refers to hydraulic machines of the ram type.

A machine has been proposed for mining coal such that cutting of the coal at the coal face is effected by a direct shearing action, the machine comprising one or more hydraulic ram with a shearing head of wedge-like form adapted to be thrust by the ram directly into the coal to shear it away. A modification of this mining machine comprises, in association with the wedge-like head, a cutter of cutter-chain or cutter-disc type which moves bodily with the head but in advance thereof so as to make a more or less vertical longitudinal incision in the coal into which incision the head enters and splits the coal from the seam, see the Specification of co-pending Application for United States Patent Serial No. 545,432 in the name of John Bridie Mavor. In their usual form such mining machines comprise a hydraulic jack element which is adapted to jam between the roof and the floor of the mine to take the reaction of the hydraulic ram as the latter thrusts the head forward. That is, the machine comprises two hydraulic units, viz. the jack element and the thrusting ram, and it is desirable that the liquid pressure in the jack element while a thrusting stroke of the hydraulic ram is being made should be considerably higher than the pressure provided for in the ram.

The present invention is concerned with the supply and control of liquid under pressure from a pump to two associated hydraulic units, such as the jack element and the ram of the mining machines above described.

According to this invention, in a hydraulic machine comprising two hydraulic units and a pump, the hydraulic system provides for a supply of liquid to the first unit by way of the second unit at a pressure as delivered from the pump followed automatically, on resistance to the operation of that unit increasing beyond a predetermined limit, by a supply of liquid at a substantially higher pressure, while the liquid operating the second unit is at the delivery pressure from the pump, both units being in operation simultaneously only for the period during which the higher pressure is acting in the first unit, the second unit being held against operation during the building up of pressure in the first unit until release of a quantity of liquid trapped in the second unit.

In carrying the invention into practice, the liquid supply system for the first unit may include a pressure-operated valve and a hydraulic intensifier so arranged that initially liquid from the pump passes to that unit by way of the valve but,

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on resistance to the operation of the unit increasing above a pre-determined limit the valve automatically changes over and directs the liquid from the pump to the intensifier whence a supply of liquid at nigh pressure issues to the unit.

In one construction, the second or low pressure hydraulic unit is a double-acting ram with a passage extending from the front face of the piston rearwards through the piston rod to the outside of the cylinder whence it is connected to the intensifier and the automatic valve, in addition to which the pump is connected to a hand-operated control valve and that valve is connected to both ends of the cylinder of the second unit and to a reservoir from which the pump draws liquid. The arrangement is such that, assuming the piston to be at the forward end of the cylinder of the second unit with a quantity of liquid trapped at the rear of the piston, and the hand valve appropriately set, liquid under pressure from the pump is supplied to the front of that cylinder, passes through the piston rod passage and, by way of the automatic valve, passes to the first hydraulic unit which it operates until a high resistance is encountered by that unit whereupon the automatic valve brings the hydraulic intensifier into action to amplify the pressure of liquid supplied to the first unit, pressure then building up at the front of the cylinder of the second unit ready, on release of the trapped liquid by the hand valve, to thrust the piston and cylinder relative to one another to the other end of their stroke from which they can be returned by connecting the front of the second unit cylinder to the reservoir and the rear of said cylinder to the pump.

In applying the invention to a mining machine of the kind described, the first hydraulic unit is the jack element, the second hydraulic unit is the hydraulic ram with the wedge-like head, and one part of the ram, usually the piston rod, is connected at its rear to the jack element. Liquid under pressure supplied from the pump first of all brings the jack into contact with the roof whereupon it encounters high resistance, and intensified pressure is then applied in the jack, ensuring its being properly jammed, whereafter the ram makes its thrusting stroke. On the completion of this stroke and the head remaining stationary, admission of pressure to the rear of the ram cylinder and release of pressure from the front of the ram cylinder frees the jack and causes it to be drawn forward ready for the next thrusting stroke. This allows the jack element to make a comparatively long stroke under low pressure and quick delivery, followed by a

final short stroke, to tighten up, under higher pressure. During the working stroke of the ram, the pressure exerted by the jack element on roof and floor remains in a fixed ratio to the horizontal pressure of the ram so that no more force is applied to roof or floor than is required to sustain the working thrust.

The invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a side view showing diagrammatically a mining machine in accordance with the invention,

Figure 2 is a diagram showing the hydraulic system of the machine, and

Figures 3 and 4 are sectional views showing in detail the pressure-operated valve and the hand-operated valve, respectively.

Referring to Figure 1, the machine comprises a jack element A and a head element B, with a hydraulic ram C connecting them. The jack element has two jacks *a* side by side with a skid base 1. The head element B comprises a wedge part 2 and a scoop or shovel 3, the head element resting on the floor. The cylinder of the ram C is secured to the head element and the piston rod of the ram extends rearwardly and is pivotally secured at 4 to the jack element. On admission of liquid, usually oil, under pressure to the forward end of the ram cylinder the head element B is driven forward to make a working stroke, the jacks *a* being jammed in position and taking the backward reaction. At the end of the working stroke, the jacks are released and pressure admitted to the rear of the ram cylinder with the result that the jack element is drawn forward relative to the head element, the weight of the head element maintaining that element stationary. The machine is then ready for a further working stroke.

The hydraulic system comprises, in addition to the parts already referred to, a motor 5, an oil pump 6 driven by the motor, an oil reservoir 7, a hand-operated control valve 8, an automatic pressure-operated valve 10, and a hydraulic intensifier 11. These parts are connected by piping as shown in Figure 2, the intensifier 11 and valve 10 being carried by the jack element and the other parts by the head element. A passage 12 extends axially through the piston and piston rod of the hydraulic ram and then radially outwards at a position behind the rear of the ram cylinder, the ram being double-acting. A flexible pipe 13 connects the passage 12 to the valve 10.

The hand-operated control valve 8 is of piston valve type and is movable into any one of four different positions. A hand lever for operating this valve 8 is indicated at 14. The intensifier 11 has a low pressure end, viz. the right hand end, and a high pressure end, viz. the left hand end, Figure 2.

The operation of the system is as follows. Assuming the parts to be in the initial condition shown in Figure 1, the pump 6 draws oil from the reservoir 7 and delivers it to the hand valve 8, which, in the idling position returns it to the reservoir, no pressure being generated by the pump. The piston of the ram is at the forward end of its cylinder. It is assumed that all pipes, passages and spaces remain at all times full of oil. The operator moves the lever 14 to admit oil from the pump to the front of the ram cylinder while maintaining the seal on the oil behind the piston. A small pressure builds up on both sides of the piston and oil passes rearwards through the passage 12 and flexible piping 13 to the automatic valve 10 which directs the oil to the jack cylinders. The intensifier 11 is by-passed. The jack pistons are lifted against their weight until the jacks meet the mine roof. Thereupon the pressure in the system rapidly rises and when a pre-determined pressure is reached the automatic valve 10 changes over to bring the intensifier into circuit, cutting out the direct supply of oil through the valve 10 to the jack cylinders. Oil as delivered from the pump is admitted to the low pressure end of the intensifier and oil under high pressure is forced from the high pressure end to the jack cylinders. As a result the jacks become firmly jammed against the roof. The pressure increases at the front of the ram piston and the operator moves the hand valve 8 in such a way as to release the oil trapped at the rear of the piston. The pressure of oil at the front of the piston then drives the cylinder and the head element forward and a working stroke is made. On the completion of a working stroke, the operator changes over the hand valve 8 so as to connect the front of the ram cylinder with the oil reservoir 7 and the rear of the cylinder with the pump. The head and the ram cylinder remain stationary under their own weight and the pressure at the rear of the cylinder thrusts the piston and piston rod forward relative to the cylinder, drawing the jack element forward with them, the jack element having been released on release of the oil pressure from the front of the cylinder. The machine is then in condition for a further working stroke.

The jamming pressure in the jacks may be about 6000 lbs. per square inch and the pressure in the ram about 2,500 lbs. per square inch.

A spring-loaded relief valve is shown at 9, its function being to relieve the pressure at the rear of the cylinder should the operator omit to open the hand valve 8 and release the oil. A mains relief valve is shown at 161.

Referring now to Figure 3 illustrating the pressure-operated valve 10, this valve comprises a valve body 15, plunger 16, spring 17 thrusting the plunger 16 towards the right, inlet passage 18, outlet passage 19, and branch passages 20. Oil from the flexible piping 13 enters through the passage 18 at low pressure and, with the plunger 16 in the position shown, proceeds to the jack element through the passage 19. Oil pressure builds up as already explained. When the jacks have taken hold on the roof the pressure in the jacks is transmitted back through the passage 19 to the passage 18 and into the branch passages 20. The right hand end of the plunger 16 having a larger effective area than the left hand end, there is a resultant thrust to the left and when this overcomes the spring thrust the valve is closed anl the oil directed to the intensifier. When the hand valve 8 is opened to exhaust, the plunger 16 returns to its original position.

Figure 4 shows the hand-operated valve 8. It comprises a valve body 21, plunger 22, and oil passages 23, 24, 25 and 26. The left hand part of the plunger 22 has an axial passage 27 with which radial ports 28 communicate. The valve has four positions, indicated I, II, III and IV at the handle 14. The figure shows the valve in position II, the idling or circulating position. Oil from the pump enters at 23 and proceeds through the ports 28 and axial passage 27 to 26 and so back to the reservoir. In position I, oil enters at 23 and passes out at 24 and thence to the rear of the ram cylinder, the oil at the front of the cylinder exhausting through 25, radial ports 28 and

axial passages 27 and 26. In position III oil enters at 23 and passes out at 25 to the front of the ram cylinder. At the same time 24 is closed, thereby trapping the oil at the rear of the cylinder. In position IV oil enters at 23 and passes out at 25 to the front of the cylinder, the oil at the rear of the cylinder exhausting through 24.

We claim:

1. A mining machine comprising a hydraulic jack unit adapted to jam between mine roof and floor, a shearing head unit of wedge-form, a hydraulic cylinder connected to one of said units, a piston in the cylinder, a piston rod connecting the piston to the other unit, means for supplying fluid under pressure to the end of the cylinder at the free end of the piston, conduit means to conduct said fluid under pressure to said jack unit, a normally open fluid pressure operated valve in said conduit means, a hydraulic pressure intensifier for said jack unit connected to said conduit means on opposite sides of said valve and adapted to operate automatically when rising fluid pressure in the jack unit closes the valve, means for trapping fluid in the cylinder at the rod end of the piston to lock the piston and cylinder against relative movement until said intensifier increases the fluid pressure in the jack unit, and means for releasing said trapped fluid from said cylinder to permit said fluid pressure in the other end of the cylinder to force said shearing head forward away from the jack unit.

2. A mining machine comprising a hydraulic jack unit adapted to jam between mine roof and floor, a shearing head unit of wedge-like form, a hydraulic cylinder connected to one of said units, a piston in the cylinder, a piston rod connecting the piston to the other unit, means for supplying fluid under pressure to the end of the cylinder at the free end of the piston, conduit means to conduct said fluid under pressure to said jack unit, a normally open fluid pressure operated valve in said conduit means, a hydraulic pressure intensifier for said jack unit connected to said conduit means on opposite sides of said valve and adapted to operate automatically when rising fluid pressure in the jack unit closes the valve, means for trapping fluid in the cylinder at the rod end of the piston to lock the piston and cylinder against relative movement until said intensifier increases the fluid pressure in the jack unit, means for releasing said trapped fluid from said cylinder to permit said fluid pressure in the other end of the cylinder to force said shearing head forward away from the jack unit, and means for releasing said fluid pressure from the cylinder and jack unit.

3. A mining machine comprising a hydraulic jack unit adapted to jam between mine roof and floor, a shearing head unit of wedge-like form, a hydraulic cylinder connected to one of said units, a piston in the cylinder, a piston rod connecting the piston to the other unit, means for supplying fluid under pressure to the end of the cylinder at the free end of the piston, conduit means to conduct said fluid under pressure to said jack unit, a normally open fluid pressure operated valve in said conduit means a hydraulic pressure intensifier for said jack unit connected to said conduit means on opposite sides of said valve and adapted to operate automatically when rising fluid pressure in the jack unit closes the valve, means for trapping fluid in the cylinder at the rod end of the piston to lock the piston and cylinder against relative movement until said intensifier increases the fluid pressure in the jack unit, means for releasing said trapped fluid from said cylinder to permit said fluid pressure in the other end of the cylinder to force said shearing head forward away from the jack unit, means for releasing said fluid pressure from the cylinder and jack unit, and means for directing fluid under pressure to said rod end of the cylinder to draw the released jack unit forward toward the shearing head.

4. A mining machine comprising a hydraulic jack unit adapted to jam between mine roof and floor, a shearing head unit of wedge-like form, a hydraulic cylinder connected to one of said units, a piston in the cylinder, a piston rod connecting the piston to the other unit, means for supplying fluid under pressure to the end of the cylinder at the free end of the piston, the piston and rod being provided with a fluid passage connecting said end of the cylinder with the outside of the cylinder, a conduit connecting the outer end of said passage with said jack unit, a normally open fluid pressure operated valve in said conduit, a hydraulic pressure intensifier for said jack unit connected to said conduit on opposite sides of said valve and adapted to operate automatically when rising fluid pressure in the jack unit closes the valve, means for trapping fluid in the cylinder at the rod end of the piston to lock the piston and cylinder against relative movement until said intensifier increases the fluid pressure in the jack unit, and means for releasing said trapped fluid from said cylinder to permit said fluid pressure in the other end of the cylinder to force said shearing head forward away from the jack unit.

5. A mining machine comprising a hydraulic jack unit adapted to jam between mine roof and floor, a shearing head unit of wedge-like form, a hydraulic cylinder connected to one of said units, a piston in the cylinder, a piston rod connecting the piston to the other unit, means for supplying fluid under pressure to the opposite ends of the cylinder, a multiple position manual valve for controlling the flow of fluid to and from the cylinder, one position of the valve admitting fluid under pressure to the end of the cylinder at the free end of the piston while trapping fluid in the other end of the cylinder, conduit means to conduct fluid under pressure from said first-mentioned end of the cylinder to said jack unit, a normally open fluid pressure operated valve in said conduit means, and a hydraulic pressure intensifier for said jack unit connected to said conduit means on opposite sides of said pressure valve and adapted to operate automatically when rising fluid pressure in the jack unit closes the pressure valve, another position of said manual valve releasing said trapped fluid from said cylinder after said intensifier has increased the fluid pressure in the jack unit, whereby to permit said fluid pressure in the other end of the cylinder to force said shearing head forward away from the jack unit.

6. A mining machine comprising a hydraulic jack unit adapted to jam between mine roof and floor, a shearing head unit of wedge-like form, a hydraulic cylinder connected to one of said units, a piston in the cylinder, a piston rod connecting the piston to the other unit, a source of fluid under pressure, a multiple position manual valve for selectively connecting the opposite ends of the cylinder with said source and with exhaust, one position of the valve connecting said source to the end of the cylinder at the free end of the piston while trapping fluid in the other end of the cylinder, conduit means to conduct fluid under pressure from said first-mentioned end of the cylinder to said jack unit, a normally open fluid pres-

sure operated valve in said conduit means, a hydraulic pressure intensifier for said jack unit connected to said conduit means on opposite sides of said pressure valve and adapted to operate automatically when rising fluid pressure in the jack unit closes the pressure valve, another position of said manual valve connecting said trapped fluid with exhaust after said intensifier has increased the fluid pressure in the jack unit, whereby to permit said fluid pressure in the other end of the

cylinder to force said shearing head forward away from the jack unit, and a third position of the manual valve connecting the jack unit and the end of the cylinder at the free end of the piston with exhaust and simultaneously connecting said source of fluid under pressure to the rod end of the cylinder to draw the jack unit forward toward the shearing head.

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