Jan. 26, 1937. A. E. WEAVER 2,069,122

HYDRAULIC RECIPROCATING MOTION DEVICE

Filed Feb. 16, 1934 2 Sheets-Sheet 1

Fig. 1.

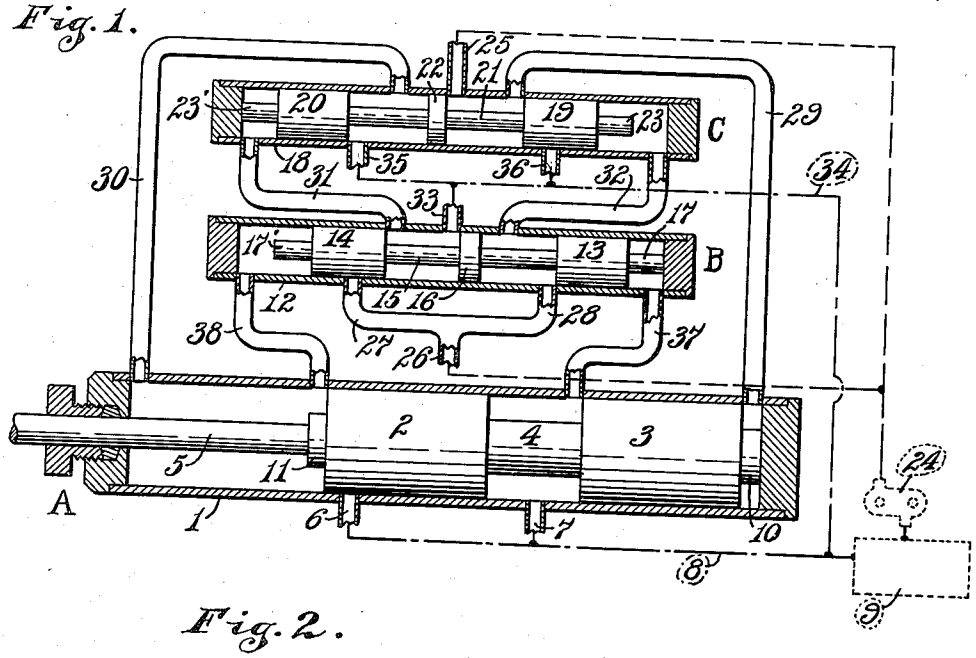
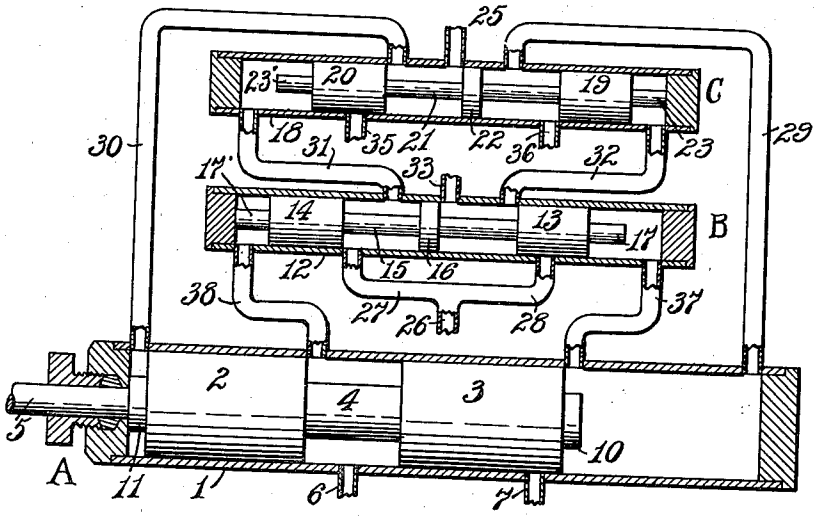


Fig. 2.



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Fig. 3.

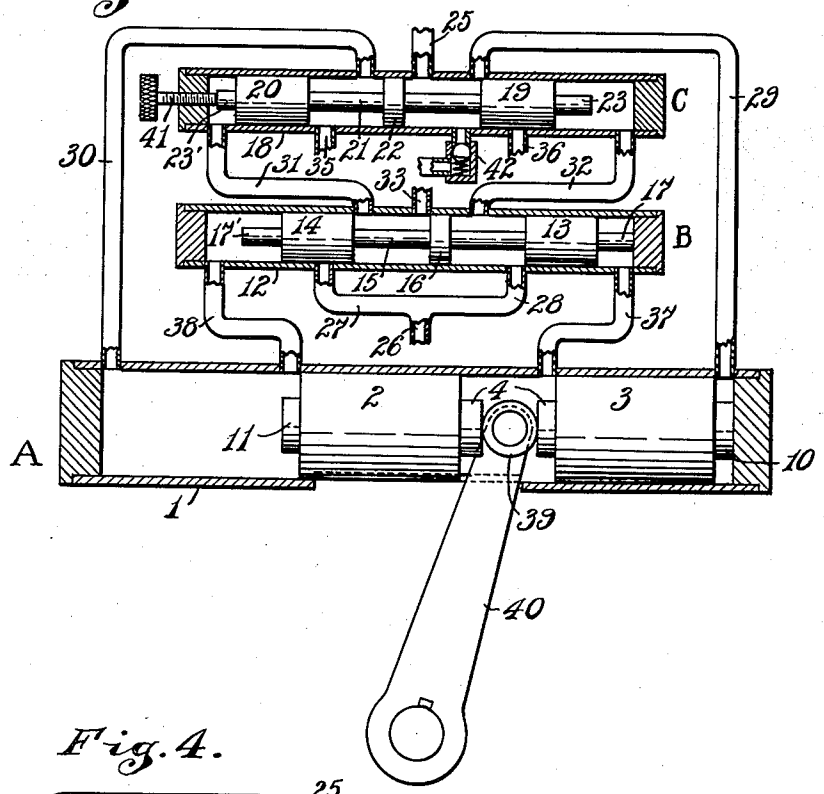
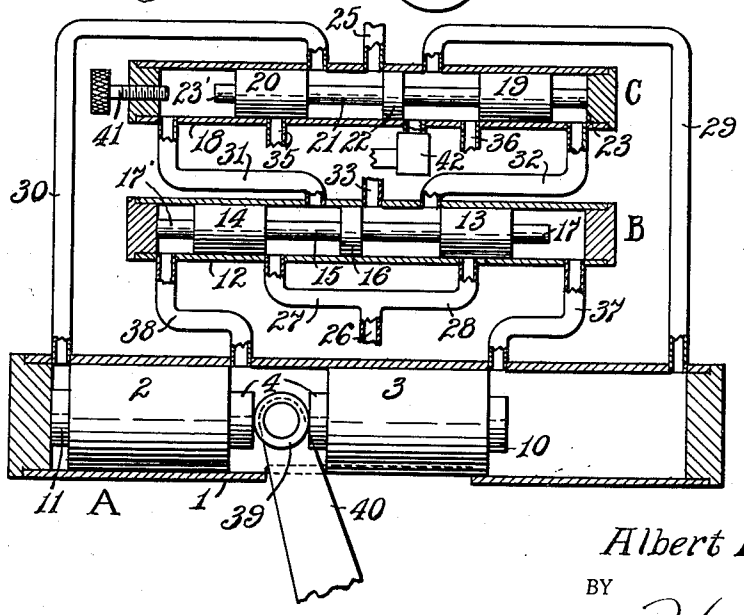


Fig. 4.



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UNITED STATES PATENT OFFICE

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HYDRAULIC RECIPROCATING MOTION DEVICE

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Application February 16, 1934, Serial No. 711,522

16 Claims. (Cl. 121—158)

My invention relates to reciprocating motors particularly of the fluid pressure type.

One of the objects of my invention is to provide a reciprocating motion device which is self-contained, fully automatic and which is operated by fluid pressure, the control of the admission of fluid pressure being accomplished without springs and without resort being had to outside mechanical devices.

Another object of my invention is to provide a reciprocating motion device operated preferably by fluid pressure, in which the control valves for controlling the admission of fluid pressure to what may be termed the motor part, are locked between strokes of the motor part.

For the purpose of disclosing my invention I have illustrated certain embodiments thereof in the accompanying drawings.

In said drawings

Fig. 1 is a more or less schematic view of a type of reciprocating motion device embodying my invention, showing the parts at the extremity of the stroke of the motor part in one direction;

Fig. 2 is a similar view of the structure illustrated in Fig. 1, showing the motor part at the extremity of its stroke in the opposite direction;

Fig. 3 is a schematic view showing a modified form of my invention, wherein the speed of the stroke in one direction may be relatively different from the speed of the stroke of the motor part in the opposite direction, and

Fig. 4 is a similar view to Fig. 3, showing the parts, however, in their reversed positions.

Referring first to the structure illustrated in Figs. 1 and 2, I provide what may be termed a motor member A, a pilot valve B and a control valve C.

The motor member A preferably comprises a cylinder 1 having operating therein a group of spaced apart pistons 2 and 3 operatively connected together to work in unison through the instrumentality of a piston rod 4, one end 5 of which is extended through the end of the cylinder to provide a connection with the portion to be driven. This cylinder is provided with a pair of exhaust ports or openings 6 and 7 connected by the conduit 8 with a suitable oil supply source 9. The opposite ends of the pistons 2 and 3 are provided with stop projections 10 and 11 adapted to abut against the ends of the cylinder to leave a clearance between the ends of the pistons and the ends of the cylinder.

The pilot valve B likewise comprises a cylinder 12 having operating therein a pair of pistons 13 and 14 mechanically connected together by a piston rod 15 on which, intermediate of the pistons 13 and 14 is a secondary piston 16. Extensions 17 and 17' of the piston rod 15 limit the extent of the stroke, towards the end of the cylinder, of the pistons in either direction.

The control valve C likewise comprises a cylinder 18 having operated therein suitably spaced apart pistons 19 and 20 mounted on the piston rod 21 and likewise mounted on this piston rod 21' is an intermediate supplemental piston 22. The piston rod 21 is also extended at its opposite ends as at 23 and 23' to limit the stroke of the pistons in either direction.

A pressure device 24 is connected with the supply source 9 and this pressure device is likewise connected through an inlet pipe 25 with the cylinder 18 at a point intermediate of its ends. This pressure device 24 is likewise connected by the supply pipe 26 and its two branches 27 and 28 with the cylinder of the pilot valve B, the connections being such that one of these branches will be closed by one of the pistons when the other branch is opened.

A conduit 29 extends from the control valve, in front of the piston 19, to the motor cylinder at a point behind the piston 3 and at the end of the cylinder 1. A similar conduit 30 extends from the cylinder 18 from a point in front of the piston 20 to the opposite end of the cylinder 1 behind the piston 2.

The cylinder 18 is connected at one end by the conduit 31 with the cylinder 12 at a point in front of the piston 14 and a similar conduit 32 connects the opposite end of the cylinder 18 with the cylinder 12 at a point in front of the piston 13. Intermediate of the conduits 31 and 32 the cylinder 12 is connected by conduit 33 with an exhaust conduit 34 leading to the supply source 9, and the cylinder 18 is likewise connected by the conduits 35 and 36 at the points indicated, with the exhaust 34.

The motive fluid for operating the reciprocating motion device is preferably oil, although other fluid pressure mediums may be used, such as gas or water or the like, and the pressure member 24 preferably comprises a suitable oil pump, taking its supply from the source of supply 9 and delivering the oil under pressure to the various parts, as more fully hereinafter described.

In operation, with the parts shown in the position illustrated in Fig. 1, the pressure fluid is admitted to the cylinder 18 through the inlet pipe 25. It will be noted that with the parts in the position illustrated the two pistons 19 and 20 are in their extreme left hand position while

the pistons 13 and 14 of the pilot valve are in their right hand position, and the cylinders 2 and 3 of the motor cylinder 1 are in their right hand extreme position. With the parts in the position indicated the conduit 29 leading from the control valve C to the motor member A is uncovered by the piston 19. Therefore fluid pressure entering the cylinder 18 through the conduit 25 will pass through the conduit 29 in back of the piston 3, thus creating a pressure behind the piston 3 and driving the same to the left. This movement to the left is unopposed by any fluid in the cylinder which is at the left of the piston 2, because said fluid will exhaust from the portion of said cylinder through the conduits 30 into the cylinder 18 and, with the pistons 19 and 20 in the positions illustrated the exhaust conduit 35 will be opened so that this fluid will flow back to the source of supply. During this movement to the left of pistons 2 and 3, the pistons 19 and 20 will be locked in the position illustrated due to the fact that pressure from the conduit 28 will flow through the cylinder 12 and the conduit 32 behind the piston 19. Due to the fact that the pressure is exerted against one end of the piston structure including the pistons 19, 20, and 22, this structure will be held against movement. In this instance, it will be noted that the parts of this structure are held or locked against displacement by the active pressure of the pump. Furthermore, due to the fact that as soon as the pistons 2 and 3 start on their movement in either direction, they will close the ports in the cylinder 1, opening into the pipes 37 and 38 so that the fluid cannot escape from either end of the cylinder 12 and, as a result, the parts are held against movement by an immovable column of liquid and to this extent may be said to be pressure-locked. Therefore, during the major portion of the stroke of the pistons 2 and 3, the pilot valve is locked in its position and the pistons 13 and 14 can move in neither direction under the influence of vibrations or for any other cause. These pistons are only unlocked when the pistons 2 and 3 reach the extremities of their stroke. While I have used in the accompanying claims the expression "pressure-locked" as describing the condition of the pistons as being held against movement, as above described, it will be understood that this expression is used in both senses, namely, the sense where active pressure is exerted for maintaining the parts in position or the sense wherein the liquid column is sealed in the cylinder for the purpose of preventing movement of the pistons in the cylinder.

As soon, however, as the pistons 2 and 3 have moved to the limit of their stroke to the left the conduit 37 extending from the extreme right hand end of the cylinder 12 to the cylinder 1, and which upon the initiation of the movement of the piston 3 to the left had been in communication with the conduit 7, is opened to the right hand end of the cylinder 1. Therefore, pressure (bearing in mind that the control valve and pilot valve B are still in the position shown in Fig. 1), will be admitted from conduit 25 through cylinder 18, conduit 29 through cylinder 1 and conduit 37 behind piston 13. Therefore, a preponderance of pressure is exerted to move pistons 13 and 14 to the left or to the position illustrated in Fig. 2. This opens conduit 27 and closes conduit 28, thereby admitting pressure through the cylinder 12 and conduit 31 behind piston 20, and thereby exerting a preponderance of pressure to move pistons 20 and 19 to the right and to the position illustrated in Fig. 2. Attention should be called to the fact that when the piston 2 has moved to the extreme position to the left the conduit 38 connecting the left hand end of cylinder 12 with the cylinder 1 is opened so that an exhaust back to the source of supply 9 is provided for this end of the cylinder.

With the parts moved to the positions illustrated in Fig. 2 the parts are in position to deliver pressure behind the piston 2 to again reverse the movement of the pistons to the right and it will be noted that as the pistons 2 and 3 move to the right an exhaust is provided through the conduit 29, the cylinder 18 and conduit 36 for the right hand side of the cylinder. At the same time the pilot and control valves are locked against movement during the movement of the pistons 2 and 3 in the same manner as has been described with reference to Fig. 1, except, however, that the parts are reversed. That is, pressure is being exerted through conduit 27, cylinder 12 and conduit 31 to maintain the control valve C in its right hand position and the conduits 37 and 38 are closed as soon as pistons 2 and 3 start to move, thus preventing the escape or admission of any fluid under pressure to the opposite ends of pistons 13 and 14 and holding them securely locked against movement.

In Figs. 3 and 4 I have illustrated a modification wherein the movement of the pistons 2 and 3 to the left may be considerably slowed down. This structure is particularly applicable wherein a work stroke is desired in one direction only and the period of the return stroke can be varied. In this structure the work stroke would be to the right, while the return stroke would be to the left. In other words, in Fig. 3 the apparatus is starting on its return stroke, and in Fig. 4 the apparatus is starting on its work stroke. The two pistons 2 and 3 have arranged therebetween a roller 39 which is adapted to be connected to any suitable mechanism. The movement of the pistons 19 and 20 to the left is controlled by an adjustable stop 41 so that the piston 19 may move to a controlled position to more or less open the inlet to the pipe 29 when the pistons 19 and 20 are at the limit of their left-hand stroke. By controlling the size of the inlet to the pipe 29 by piston 19 the flow of oil to the cylinder 1 behind piston 3 is reduced, thereby considerably slowing down the movement of the piston to the left. In view of the fact that the pressure pump 24 operates at constant speed and therefore delivers a constant flow of oil into the cylinder 18 I provide relief valve 42 to permit the excess oil delivered by the pump 24 to pass back into the supply source 9.

In this structure it will be noted that the lower portion of the cylinder 1 is slotted to accommodate the arm 40. However, the slotting of this cylinder at this point will not affect the operation of the apparatus except that certain of the oil will exhaust through this slot instead of through the exhaust pipes 6 and 7 as in Fig. 1. For certain types of apparatus, however, the flow of oil through this slot will not affect the operation. While I have described the pistons 2 and 3, 13 and 14, and 19 and 20 as separate pistons, in each instance the pistons 2 and 3 constitute in effect a single piston; the pistons 13 and 14 likewise constitute a single piston including the piston portion 16 and the pistons 19, 20, and 22 likewise constitute a single piston. It is quite apparent that instead of mounting the pistons on piston rods, as shown, the pistons of the dif-

ferent cylinder could be a unitary structure with suitable channels or grooves formed therein to provide for the valve operation thereof.

I claim as my invention:

1. A device of the character described, comprising at least three sliding valves each of which is operated by fluid pressure, and fluid pressure connections between said valves by which effective pressure is admitted to the other valves when one of said valves moves to the limit of its stroke, and by which each of the valves is pressure locked against movement during the movement of any one of the other valves.

2. A device of the character described comprising at least three cylinders, a piston in each of said cylinders, the piston of each cylinder being pressure-operated, pressure connections between said cylinders, the piston of each cylinder comprising a valve controlling the admission of effective pressure to the other two cylinders, and said pistons being so disposed that they pressure-lock the pistons of two of the cylinders against movement until the piston of the other cylinder has moved to the limit of its stroke.

3. A device of the character described, comprising at least three sliding valves each of which is operated by fluid pressure, fluid pressure connections between said valves by which effective pressure is admitted to and exhausted from the other valves when one of said valves moves to the limit of its stroke, and by which each of the valves is pressure-locked against movement during the movement of any one of the other valves, and means for adjusting the movement of one of said valves to control the rate of admission of fluid pressure to one of the other valves without affecting the exhaust rate therefrom.

4. A device of the character described, comprising at least three cylinders, a piston in each of said cylinders, the piston of each cylinder being pressure-operated, pressure connections between said cylinders, the piston of each cylinder comprising a valve controlling the admission of effective pressure to and exhausted from the other two cylinders, said pistons being so disposed that they pressure-lock the pistons of two of the cylinders against movement until the piston of the other cylinder has moved to the limit of its stroke, and adjustable means for adjusting the movement of the piston of one of said valves to vary the rate of admission of fluid pressure to one of said valves without varying the rate of exhaustion therefrom.

5. In combination, a cylinder, a pair of pistons operating therein and adapted to move synchronously, a control valve for said cylinder controlling the inlet and outlet of pressure to the opposite ends of said cylinder, a pressure operated pilot valve for controlling the admission of operating pressure to the control valve, the pistons in said cylinder being adapted to control the admission of operating pressure to the pilot valve and to seal the pilot valve against inlet or outlet of operating pressure during the movement of said pistons between the extremities of their stroke.

6. In combination, a cylinder, a pair of pistons operating therein and adapted to move synchronously, a control valve for said cylinder controlling the inlet and outlet of pressure to the opposite ends of said cylinder, a pressure operated pilot valve for controlling the admission of operating pressure to said control valve including a cylinder and pistons operating therein, conduits extending from the first-named cylinder to the opposite ends of said pilot valve cylinder, the pistons in said first-named cylinder controlling the admission of operating pressure to said conduits and being adapted to close said conduits between the limits of the stroke of said pistons.

7. In combination, a cylinder, a pair of pistons operating therein and adapted to move synchronously, a control valve for said cylinder controlling the inlet and outlet of pressure to the opposite ends of said cylinder, a pressure operated pilot valve controlling the admission of operating pressure to the said control valve including a cylinder and operating pistons operating therein, ducts at the opposite ends of the first-mentioned cylinder communicating with said control valve, ducts extending from the first-mentioned cylinder to the opposite ends of the pilot valve and the length of the pistons in the first-mentioned cylinder being equal to the distance between one of said control valve ducts and one of said pilot valve ducts whereby said pistons will close the pilot valve ducts except at the limit of the movements thereof.

8. In combination, a cylinder, a pair of pistons operating therein and adapted to move synchronously, a control valve for said cylinder controlling the inlet and outlet of pressure to the opposite ends of said cylinder, adjustable means for controlling the length of the stroke of said control valve in one direction to control the admission of pressure to the cylinder without affecting the exhaust therefrom, a pressure operated pilot valve for controlling the admission of operating pressure to the control valve, the pistons in said cylinder being adapted to control the admission of operating pressure to said pilot valve and to seal said pilot valve against the inlet or outlet of operating pressure during the movement of the pistons between the extremities of their strokes.

9. In combination, with a work cylinder, a pair of pistons operating therein in synchronism, a control valve for controlling the admission of the inlet and outlet of operating pressure to the opposite ends of said cylinder including a cylinder, a valve member operating in said cylinder and controlling the admission of fluid pressure to the opposite ends of the work cylinder, a pair of pistons connected to said valve member for operating the same and controlling the exhaust of operating pressure from the opposite ends of said work cylinder, a pilot valve including a cylinder and a valve member operating therein and controlling the admission of operating pressure to the opposite ends of the said control valve cylinder, and a pair of pistons connected to said valve member for operating the same, and connections extending between opposite ends of said pilot valve cylinder and said work cylinder, the pistons in said work cylinder controlling the admission of pressure to the opposite ends of said pilot valve cylinder and closing the opposite ends of said pilot valve cylinder against the inlet or outlet of operating pressure between the extremities of movements of said work cylinder pistons.

10. In combination, a work cylinder, a pair of pistons operating therein in synchronism, a control valve for controlling the inlet and outlet of operating pressure to the opposite ends of said work cylinder, comprising a cylinder, a pair of synchronously moving pistons in said cylinder and a valve piston intermediate of said pistons and operating therewith, a pressure inlet port to said cylinder, a pair of pressure outlets from said cylinder communicating with the opposite ends of said work cylinder, communication between

said inlet and said respective outlets being established by the movement of said valve piston, a pair of exhaust ports in said cylinder, communication being established between said respective exhaust ports and said outlet ports leading to the work cylinder by the movement of said pistons, a pilot valve comprising a cylinder, a pair of synchronously moving pistons in said cylinder and a valve piston intermediate of said pistons and moving synchronously therewith, an exhaust outlet in said cylinder, a pair of outlets in said cylinder respectively communicating with the opposite ends of said pilot valve cylinder, communication being established between said outlets and said exhaust by the position of said valve piston, a pair of pressure inlet ports in said pilot cylinder controlled by the position of the pistons therein, and a second pair of pressure inlet ports at opposite ends of said pilot cylinder communicating with outlet ports in said work cylinder, said outlet ports in said work cylinder being closed by the pistons thereof except when said pistons have reached the limits of their movements.

11. In combination, a work cylinder, a pair of pistons operating therein in synchronism, a control valve for controlling the inlet and outlet of operating pressure to the opposite ends of said work cylinder, comprising a cylinder, a pair of synchronously moving pistons in said cylinder and a valve piston intermediate of said pistons and operating therewith, a pressure inlet port to said cylinder, a pair of pressure outlets from said cylinder communicating with the opposite ends of said work cylinder, communication between said inlet and said respective outlets being established by the movement of said valve piston, a pair of exhaust ports in said cylinder, communication being established between said respective exhaust ports and said outlet ports leading to the work cylinder by the movement of said pistons, a pilot valve comprising a cylinder, a pair of synchronously moving pistons in said cylinder and a valve piston intermediate of said pistons and moving synchronously therewith, an exhaust outlet in said cylinder, a pair of outlets in said cylinder respectively communicating with the opposite ends of said control valve cylinder, communication being established between said outlets and said exhaust by the position of said valve piston, a pair of pressure inlet ports in said pilot cylinder controlled by the position of the pistons therein, and a second pair of pressure inlet ports at opposite ends of said pilot cylinder communicating with outlet ports in said work cylinder, said outlet ports in said work cylinder being closed by the pistons thereof except when said pistons have reached the limits of their movements, and means for adjusting the stroke of the control valve pistons in one direction to control the size of the opening admitting pressure behind the pistons in the work cylinder in one direction.

12. A device of the character described operated by a liquid under pressure from a substantially constant source, comprising in combination a working cylinder, a piston member operating therein in one direction at a substantially constant rate with full effective pressure on a work stroke, and in the opposite direction in a timing stroke at a controlled variable rate, a pilot valve comprising a cylinder and piston therein operated by the liquid pressure effecting the movement of said pistons at the ends of their respective strokes and hydraulically locked by the position of the pistons in said movement, a control valve including a cylinder and pistons, said pilot valve causing the actuation of the control valve by effective pressure, said control valve being adjustable in its stroke in one direction to regulate the volume of liquid admitted back of the work piston, a pressure relief valve means for said liquid allowing excess liquid to escape to exhaust without overload to the liquid pressure source, said control valve having a full stroke in one direction and to admit full volume and pressure of liquid back of the piston member in said work cylinder on a work stroke, and said control valve being hydraulically locked by effective pressure from said pilot valve during the operation of said work cylinder piston member.

13. In combination, a work cylinder, a pressure operated piston in said work cylinder, a control valve cylinder, a pressure operated piston control valve in said cylinder, a pilot valve cylinder, a pressure operated piston pilot valve in said pilot valve cylinder, connections between said control valve cylinder and said work cylinder controlled by said control valve for alternately admitting and exhausting operating pressure to and from the opposite sides of said work piston, connections between said pilot valve cylinder and control valve cylinder for admitting and exhausting operating pressure alternately to and from the opposite ends of said control valve cylinder controlled by said pilot valve piston, said piston maintaining the inlet pressure sealed in the control valve cylinder during the movement of the pilot valve piston, and connections between the work cylinder and the pilot valve cylinder for admitting and exhausting pressure to and from said pilot valve cylinder from and to said work cylinder, the piston of said work cylinder maintaining said connections sealed between its strokes.

14. In combination, a work cylinder, a pressure operated piston in said work cylinder, a control valve cylinder, a pressure operated piston control valve in said cylinder, a pilot valve cylinder, a pressure operated piston pilot valve in said pilot valve cylinder, connections between said control valve cylinder and said work cylinder controlled by said control valve for alternately admitting and exhausting operating pressure to and from the opposite sides of said work piston, means for adjusting the movement of said valve to vary the extent of pressure admitted to one side of said work cylinder without varying the extent of the exhaust from the opposite side of said work cylinder, connections between said pilot valve cylinder and control cylinder for admitting and exhausting operating pressure alternately to and from the opposite ends of said control valve cylinder controlled by said pilot valve piston, said piston maintaining the inlet pressure sealed in the control valve cylinder during the movement of the pilot valve piston, and connections between the work cylinder and the pilot valve cylinder for admitting and exhausting pressure to and from said pilot valve cylinder from and to said work cylinder, the piston of said work cylinder maintaining said connections sealed between its strokes.

15. In combination, a work cylinder, a pressure operated piston in said work cylinder, a control valve cylinder, a pressure operated piston control valve in said cylinder, means for adjusting the stroke of the control valve to vary the extent of the pressure admitted to one side of the work cylinder without varying the extent of exhaust from the opposite side of said work cylinder, a pressure operated relief valve for exhausting excessive pressure developed in said control valve

cylinder by the restriction of the extent of pressure to the work cylinder, connections between said control valve cylinder and the work cylinder controlled by said control valve for alternately admitting and exhausting operating pressure to and from the opposite ends of said work cylinder, connections between said pilot valve cylinder and said control valve cylinder controlling the admission and the exhaust of pressure to and from said control valve cylinder controlled by said pilot valve, and connections between said work cylinder and said pilot valve cylinder for controlling the admission and exhaust of pressure to and from said pilot valve cylinder from and to said work cylinder controlled by said work cylinder piston.

16. In combination, a work cylinder having a piston operating therein, ports arranged at the opposite ends of said cylinder, a control valve comprising a cylinder, a pair of synchronously moving pistons and a valve piston operating therein controlling the admission and exhaust of pressure through the ports in said work cylinder, means for adjusting the stroke of the control valve piston in one direction to vary the flow of pressure to one of the ports of the work cylinder without affecting the escape of pressure from the other work cylinder port, a pressure operated relief valve in said control valve cylinder for permitting the escape of excess pressure from the control valve cylinder when said valve restricts the admission of pressure to one of the ports of the work cylinder, a pilot valve for controlling the admission of operating pressure to the control valve comprising a cylinder and valve pistons operating therein, and pressure connections between the pilot valve cylinder and the work cylinder controlled by the position of the piston in the work cylinder.

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