

May 2, 1961

H. A. PANISSIDI
HYDRAULIC OSCILLATOR

2,982,262

Filed Nov. 2, 1956

3 Sheets-Sheet 1

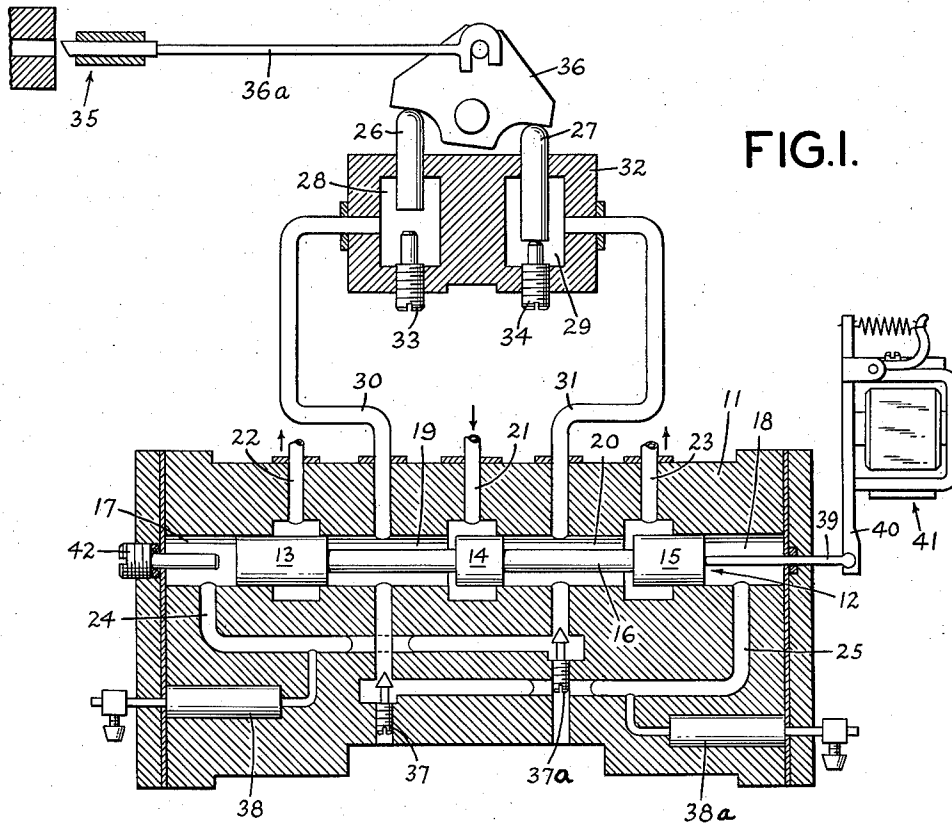


FIG. 1.

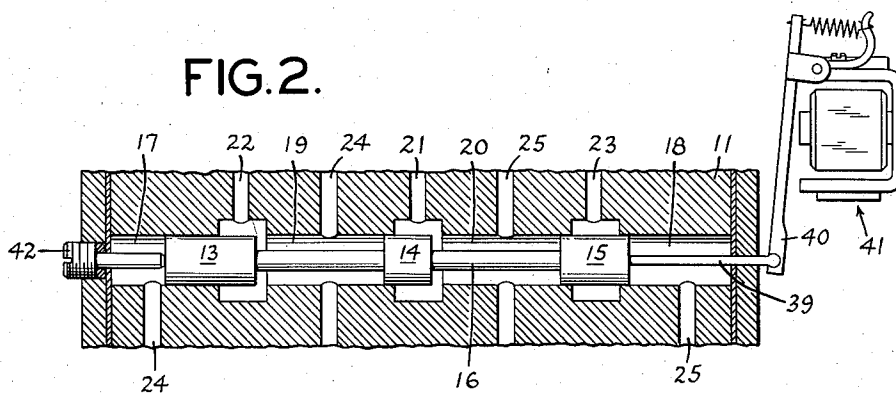


FIG. 2.

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FIG. 4.

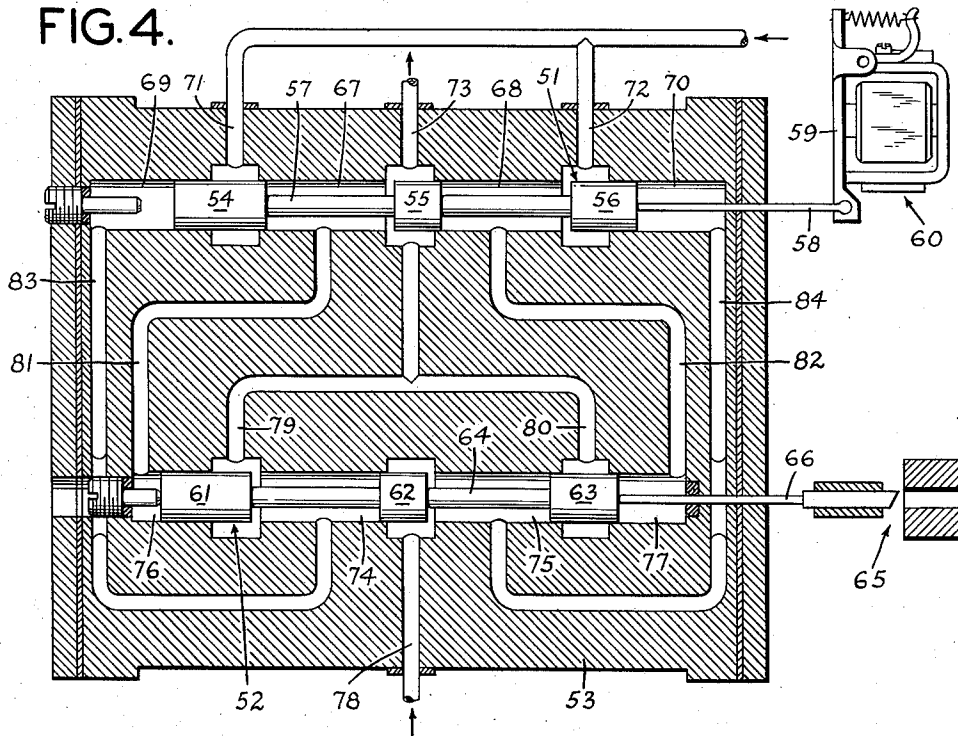
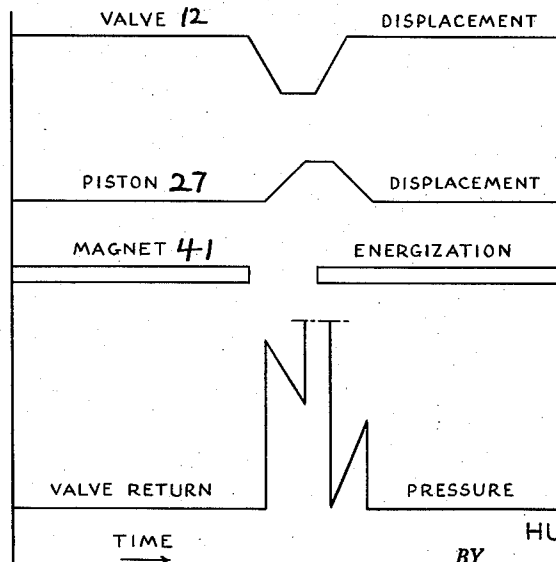


FIG. 3.



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FIG. 5.

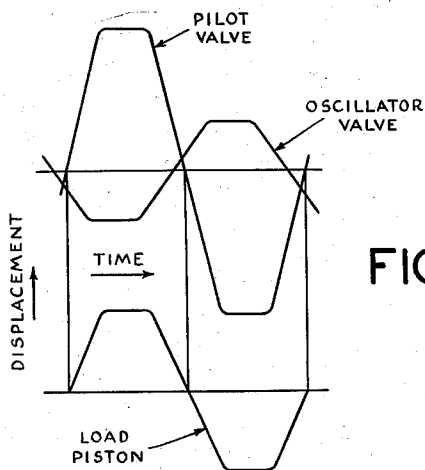
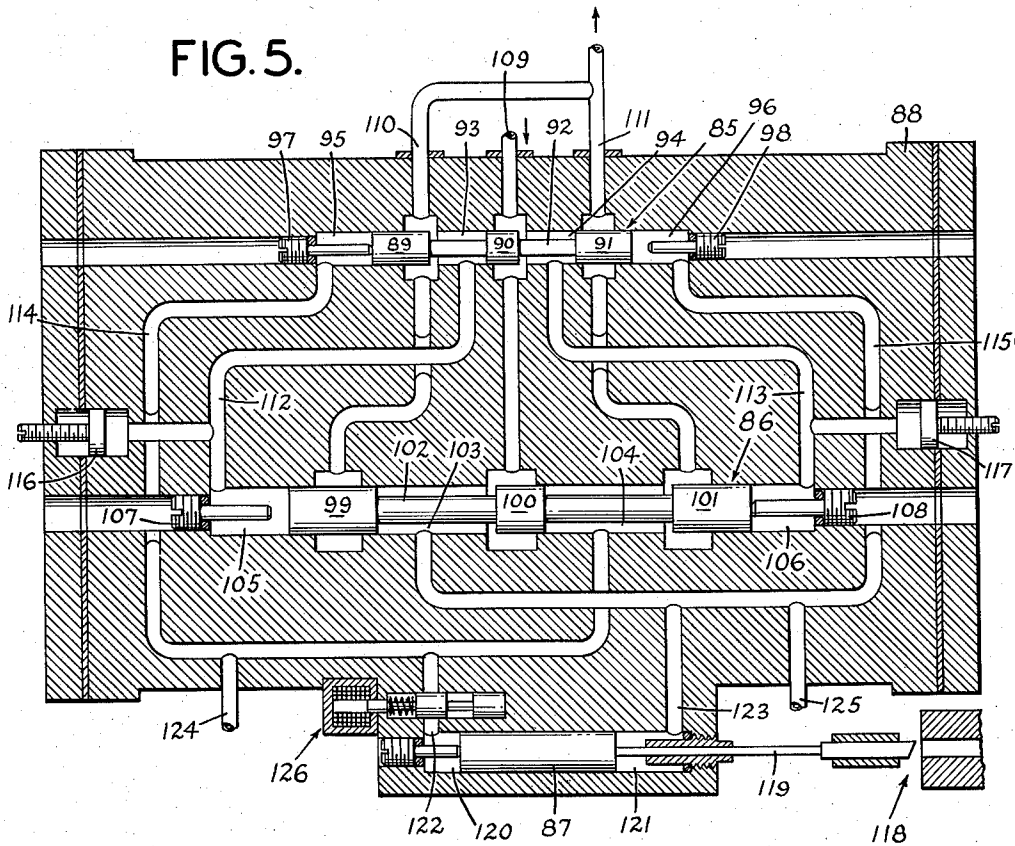


FIG. 6.

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HYDRAULIC OSCILLATOR

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3 Claims. (Cl. 121—150)

This invention relates to hydraulic systems and, more particularly, to new and improved hydraulic oscillators controlled by electrical circuits and adapted to provide a rapid reciprocating motion.

Mechanical devices for providing reciprocating motion embodying gears, cams, tappets and the like have the disadvantages of complexity of construction and shortened operating life resulting from wear of the operating parts.

It is an object of this invention, accordingly, to provide new and improved hydraulic apparatus for supplying reciprocating motion in a simple and efficient manner free from the above-mentioned disadvantages.

Another object of the invention is to provide reciprocating apparatus embodying a hydraulic oscillator under the control of an electrical circuit.

A further object of the invention is to provide new and improved hydraulic oscillators for actuating reciprocating members such as punches under the control of electrical circuitry.

These and other objects of the invention are attained by providing a hydraulic drive for a reciprocating member such as a punch, the drive being operatively connected to a hydraulic pressure source through oscillating valve apparatus. The punch drive and the valve apparatus are coupled so as to oscillate synchronously upon application of hydraulic fluid under pressure.

In one embodiment of the invention, an electromagnet controls the operation of the punch, the oscillating valve being retained in one position when the magnet is energized. Upon deenergization of the electromagnet, the valve and punch drive means oscillate synchronously, reciprocating the punch.

Another arrangement utilizes two oscillating valves, one being adapted to operate the punch and an electromagnet being connected to the other to prevent its oscillation when energized.

In a further embodiment of the invention, two synchronously oscillating valves supply hydraulic pressure to a series of punch drives adapted to operate a series of punches selectively.

Other objects and advantages of the invention will be apparent from a reading of the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a cross-sectional view taken through a typical hydraulic oscillator illustrating one embodiment of the invention;

Fig. 2 is a partial sectional view of the oscillator of Fig. 1 showing its operating elements in another position;

Fig. 3 is a graphical representation illustrating the relative motion of the elements of the oscillator shown in Figs. 1 and 2 during one cycle of oscillation;

Fig. 4 is a cross-sectional view taken through another typical oscillator showing a second embodiment of the invention;

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Fig. 5 is a cross-sectional view of a third oscillator constructed according to the invention; and

Fig. 6 is a graphical illustration showing the relative motion of the elements of the oscillator illustrated in Fig. 5 during one cycle of oscillation.

The embodiment of the invention shown in Fig. 1 comprises a valve casing 11 in which a spool valve 12 is slidably supported. The valve 12 comprises three spaced pistons 13, 14 and 15 mounted on a piston rod 16, thereby forming two end chambers 17 and 18 and two intermediate chambers 19 and 20. An intake port 21 and two exhaust ports 22 and 23 circulate hydraulic fluid to the valve 12, two ducts 24 and 25 connecting the end chambers 17 and 18 with the non-adjacent intermediate chambers 20 and 19, respectively.

Two punch-operating pistons 26 and 27, adapted to be driven by hydraulic pressure in two chambers 28 and 29, are connected to the intermediate chambers 19 and 20 by two ducts 30 and 31 respectively. A casing 32 slidably supports the pistons 26 and 27 and houses the chambers 28 and 29. Two adjustable stops 33 and 34 control the stroke of the pistons 26 and 27 and limit the reciprocating movement of a device such as a punch 35, coupled to the piston by a rocker arm 36 and a shaft 36a.

In order to control the frequency of oscillation of the system, adjustable needle valves 37 and 37a restrict the flow of fluid in the ducts 24 and 25, fluid accumulators 38 and 38a being respectively connected to these ducts to receive fluid displaced from the chambers 17 and 18.

Extending from one end of the valve 12 is a shaft 39 having its outer end connected to the armature 40 of an electromagnet 41. An adjustable stop 42 positioned at the opposite end of the valve 12 limits its stroke.

In operation, the electromagnet 41 is normally energized, retaining the valve 12 in the right-hand position shown in Fig. 1. In this condition, the punch 35 is held in an open position, fluid entering the port 21 being directed to the chambers 19 and 28 by the piston 14. Fluid pressure is also applied to the chamber 18, urging the valve 12 to the left, but the energized electromagnet 41 is sufficiently strong to hold the valve to the right.

Upon deenergization of the electromagnet 41, the valve 12 is driven to the left by hydraulic pressure in the chamber 18 and the piston 14 directs fluid to the chambers 20 and 29 upon completion of half its stroke. This drives the piston 27 against the rocker arm 36 to actuate the punch 35, fluid displaced from the chamber 28 by the piston 26 being directed to the exhaust port 22 by the piston 13, as shown in Fig. 2. Referring to the curves of Fig. 3, it will be observed that the operation of the piston 27 momentarily decreases the valve return pressure in the chamber 17 so that leftward motion of the valve is not substantially impeded, the fluid displaced from the chamber 17 being directed into the accumulator 38.

Upon completion of the punch stroke, the valve return pressure in the chamber 17 increases to equal the input pressure, driving the valve 12 to the right, the punch 35 being returned to its open position when the piston 14 reopens the chamber 28 to the input duct 21. If the magnet 41 has been reenergized in the meantime, the valve 12 is retained in the right hand position and the punch 35 remains in the open position. Otherwise, the above will be repeated at a frequency determined by the position of the needle valves 37 and 37a.

In another hydraulic oscillator constructed according to the invention, shown in Fig. 4, two spool valves 51 and 52 are slidably supported in a valve casing 53. Three spaced pistons 54, 55 and 56 mounted on a piston rod 57 comprise the valve 51. A shaft 58 extending from

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one end connects the valve to the armature 59 of an electromagnet 60 which retains the valve at one end of its stroke when energized. The valve 52 is similarly constructed, having three pistons 61, 62 and 63 disposed on a piston rod 64, the piston 63 being connected to a punch 65 by a shaft 66.

Two intermediate chambers 67 and 68 and two end chambers 69 and 70 are formed by the pistons of the valve 51. The chambers 67 and 68 are supplied with hydraulic fluid under pressure through two intake ports 71 and 72 controlled by the pistons 54 and 56 respectively, an exhaust port 73 being gated by the central piston 55.

The valve 52 likewise has two intermediate chambers 74 and 75 and two end chambers 76 and 77, hydraulic fluid entering through another intake port 78 being directed to either of the two intermediate chambers 74 and 75 by the piston 62. Two outlet ducts 79 and 80, gated by the pistons 61 and 63, connect the chambers 74 and 75 to the exhaust port 73.

In order to produce synchronous operation of the valves 51 and 52, the intermediate chambers 67 and 68 are connected to the end chambers 76 and 77 by two ducts 81 and 82, the chambers 74 and 75 being channeled to the end chambers 69 and 70 by two more ducts 83 and 84.

In operation, when the valves 51 and 52 are in the positions shown in Fig. 4, hydraulic fluid entering through the port 72 is directed to the chambers 68 and 77, urging the valve 52 to the left and holding the punch 65 in an open position, the port 71 being closed by the piston 54. Similarly, the chambers 75 and 70 receive hydraulic fluid through the intake port 78 and pressure in the chamber 70 tends to drive the valve 51 to the left. If the electromagnet 60 is energized the valves will remain in the illustrated positions, the pressure in the chamber 70 being insufficient to overcome the pull of the magnet.

Deenergization of the electromagnet 60 permits the valve 51 to be driven to the left, allowing fluid from the port 71 to enter the chambers 67 and 76 when the stroke is half completed. This reverses the pressure differential across the valve 52, driving it to the right and operating the punch 65.

When the punching stroke is half completed the piston 62 directs fluid to the chambers 69 and 74, the piston 63 opening the chambers 70 and 75 to the outlet duct 80. This returns the valve 51 to the right-hand position. Midway in its return stroke the valve 51 reverses the pressure differential across the valve 52, driving it back to its left-hand position. Synchronous oscillation of the two valves will continue in this manner until the electromagnet 60 is reenergized to hold the valves in the positions shown in Fig. 4.

A third embodiment of the invention, illustrated in Fig. 5, comprises a pilot valve 85, an oscillator valve 86 and a load piston 87, each slidably supported in a valve casing 88. The pilot valve 85 comprises three pistons 89, 90 and 91 mounted on a piston rod 92, forming two intermediate chambers 93 and 94 and two end chambers 95 and 96. Two adjustable stops 97 and 98 are positioned at the ends of the valve to limit its travel. The oscillator valve 86 is of similar construction, having three pistons 99, 100 and 101 on a piston rod 102 forming two intermediate chambers 103 and 104 and two end chambers 105 and 106, its travel being limited by adjustable stops 107 and 108.

An intake port 109 supplies hydraulic fluid under pressure to the two valves and two exhaust ports 110 and 111 provide outlets for the fluid. In order to produce synchronous oscillation of the valves, the intermediate chambers 93 and 94 of the pilot valve 85 are connected to the end chambers 105 and 106 of the oscillator valve 86 by two ducts 112 and 113, the intermediate chambers 103 and 104 being connected to the end chambers 95 and 96 by two more ducts 114 and 115. The frequency of oscillation of the valves may be changed by adjust-

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ing two pistons 116 and 117 which control the volume of fluid associated with the ducts 112 and 113.

The alternating pressure differential produced by this oscillation in the two ducts 114 and 115 is adapted to operate a punch 118 connected to the load piston 87 by a shaft 119, two chambers 120 and 121 at opposite ends of the load piston being connected to the ducts 114 and 115 by two channels 122 and 123. Other similar pistons (not shown) may be reciprocated by applying alternating pressure from two ports 124 and 125 connected to the ducts 114 and 115, the oscillation of each piston being controlled by an electromagnetic gate valve 126.

The operation of the hydraulic oscillator is illustrated graphically in Fig. 6. With the valves in positions shown in Fig. 5, hydraulic fluid entering the port 109 applies pressure to the chambers 94, 96, 103, 106 and 121, the chambers 93, 95, 104 and 105 being open to the exhaust port 110. The pressure in the chamber 106 drives the oscillator valve 86 to the left, reversing the pressure differential across the pilot valve 85 at its midway position and driving that valve to the right. As the oscillator valve 86 approaches the left hand stop 107, the pilot valve 85 passes its midway position and reverses the pressure differential across the oscillator valve, driving it to the right. The pilot valve is similarly reversed when it reaches the stop 98, synchronous oscillation of the two valves in this manner continuing as long as pressure is applied to the port 109.

With the gate valve 126 in the closed position, the punch 118 remains open, the intermittent pressure in the chamber 121 urging the piston 87 to the left. To operate the punch 118, an electrical signal is applied to open the valve 126, allowing fluid under pressure from the duct 114 to fill the chamber 120, driving the load piston 87 to the right. Reversal of the pressure differential in the ducts 114 and 115 returns the piston to the left, the motion being in phase with that of the pilot valve 85, as illustrated in Fig. 6. The operation of the punch 118 is terminated by closing the electromagnetic gate valve 126.

It will be apparent from the above description that the invention provides novel means for operating reciprocating apparatus with a hydraulic oscillator under the control of an electrical circuit without requiring mechanical actuators such as cams, tappets and the like.

Although the invention has been described with reference to particular embodiments, many variations and modifications will occur to those skilled in the art. Accordingly, the scope of the invention is not intended to be restricted except as defined in the appended claims.

I claim:

1. A hydraulic oscillator for driving a reciprocating member comprising an unbalanced, self-oscillating valve including three rigidly connected, spaced pistons forming two intermediate chambers and two end chambers, a first hydraulic circuit connecting the end chambers alternately to a fluid pressure source to supply hydraulic pressure to actuate the valve according to the position of the valve so as to normally maintain valve oscillation, load piston means coupled to said member and including two load piston chambers operatively associated therewith, a second hydraulic circuit connecting the load piston chambers to the two intermediate chambers of said oscillating valve so that hydraulic fluid under pressure applied to said hydraulic circuits causes said oscillating valve and the load piston means to oscillate synchronously, and an electromagnet connected to said oscillating valve normally inhibiting its reciprocation and responsive to a momentary change in energization to permit a single cycle of operation.

2. A hydraulic oscillator for operating a reciprocating member under the control of an electrical circuit comprising a hydraulic fluid intake port, an unbalanced self-oscillating valve having three rigidly connected spaced

pistons forming two intermediate chambers and two end chambers, said pistons being adapted to direct fluid from the intake port to the two intermediate chambers alternately, a pair of load pistons to reciprocate said member, a pair of chambers associated with the load pistons, a first hydraulic circuit connecting said load piston chambers with said intermediate chambers, a second hydraulic circuit connecting the intermediate chambers with the end chambers including a pair of fluid ducts each leading directly from a corresponding one of the intermediate chambers to the end chamber which is farther from that intermediate chamber so that hydraulic fluid under pressure applied through said intake port causes synchronous oscillation of said valve and said load pistons, and an electromagnet means connected to the self-oscillating valve normally inhibiting its reciprocation and responsive to a momentary change in energization to permit a single cycle of operation.

3. A hydraulic oscillator according to claim 2 wherein

the electromagnetic means comprises an electromagnet and an armature connected to the oscillating valve normally retaining the valve in a stationary condition, whereby the momentary change in energization of the electromagnet causes it to release the armature to permit a single cycle of operation of the valve and retain it thereafter.

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