Oct. 23, 1934. M. E. MARTELLOTTI 1,978,350

AUTOMATIC CONVERTIBLE FEED SYSTEM

Filed Dec. 20, 1930 2 Sheets-Sheet 1

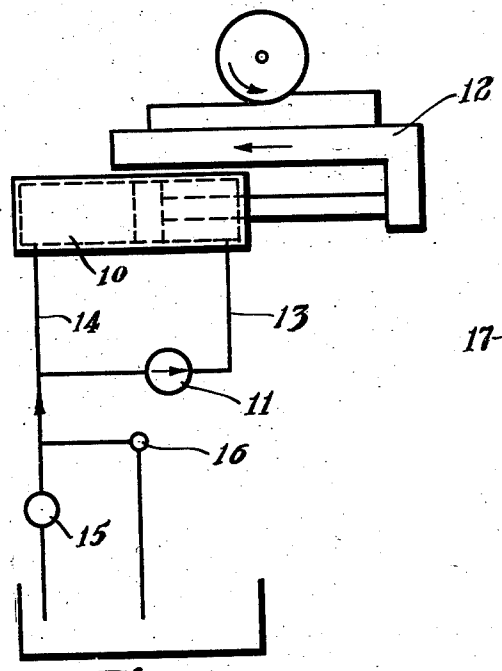


Fig. 1

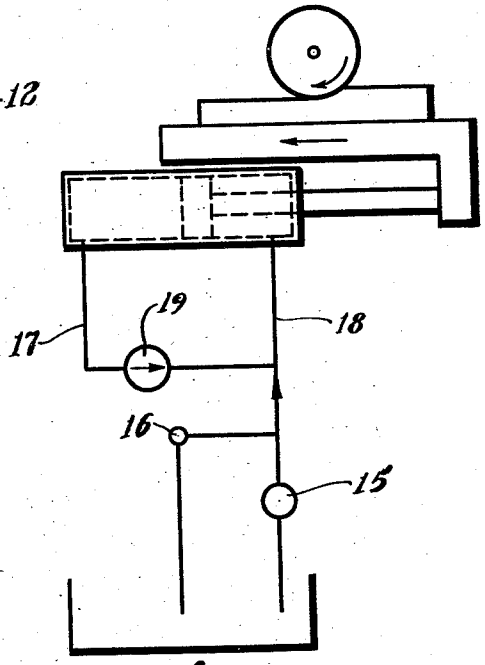


Fig. 2

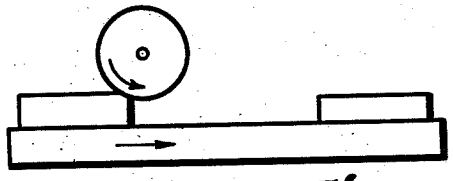


Fig. 4

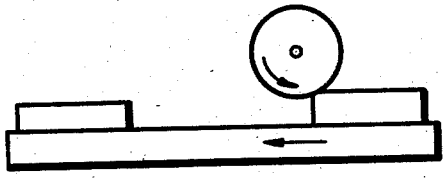


Fig. 5

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AUTOMATIC CONVERTIBLE FEED SYSTEM

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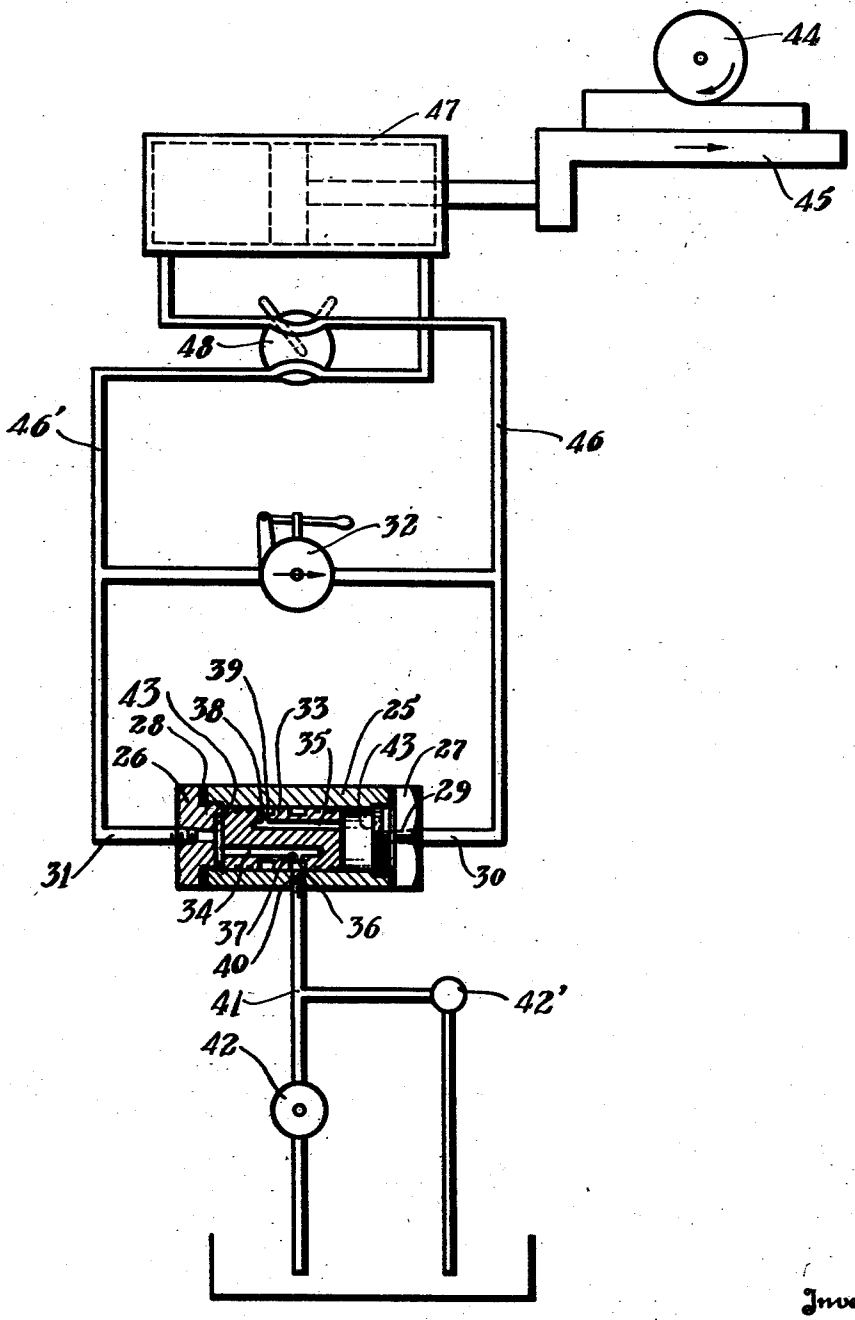


Fig. 3

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UNITED STATES PATENT OFFICE

1,978,350

AUTOMATIC CONVERTIBLE FEED SYSTEM

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Application December 20, 1930, Serial No. 503,747

11 Claims. (Cl. 90—21.5)

This invention relates to a convertible hydraulic transmission system and more particularly to improved control means therefor.

One of the objects of this invention is the provision of a new and improved means for automatically converting an hydraulic transmission system from one type to another.

Another object of this invention is to provide in an hydraulically operated milling machine having a cutter that may be rotated in either direction, automatic means for regulating the propulsion system in accordance with the direction of the cutting force thereby relieving the operator of such duty and insuring against damage which might arise from operation of the machine by an inexperienced operator.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification considered in conjunction with the accompanying drawings illustrative of one embodiment thereof but it will be understood that any modifications may be made in the specific structural details hereinafter disclosed within the scope of the appended claims without departing from or exceeding the spirit of the invention.

Referring to the drawings in which like reference numerals indicate like parts:

Figure 1 represents a conventional hydraulic system.

Figure 2 diagrammatically represents an hydraulic system known as the closed circuit or metering type of system.

Figure 3 illustrates diagrammatically a convertible type system.

Figures 4 and 5 show the relation of cutter rotation to opposed work pieces carried by the table.

The application of hydraulic transmissions to machine tools and more particularly to milling machines has resulted in at least two systems which may be differentiated and defined by their mode of operation. The first system, which may be known as a simple hydraulic transmission and shown more particularly in Figure 1, comprises an hydraulic motor 10 of the piston and cylinder type connected in series with a high pressure pump 11 for causing movement of the table or other member 12 against a load. In this system or circuit one side, as 13, is under high pressure and the other side, as 14, under low pressure, the pump forcing the oil in the direction of the arrow into conduit 13 and being supplied with oil from the conduit 14.

Since in every hydraulic system there is a certain amount of loss due to leakage, means must be provided for replacing these losses and in the system under consideration an auxiliary pump, which may be known as a replacement or booster pump 15, is provided which draws fluid from a reservoir and injects it into the system under low pressure. A low pressure relief valve 16 is usually provided in the delivery conduit from the pump to permit escape of the overflow. As previously mentioned, the pressure in one side of the system is high and in the other side low and it was deemed economical to inject the replacement oil in the low pressure side of the system. This resulted in the booster pump being connected to the in-take side of the high pressure pump. The result is a system suitable for working against an opposed constant load.

This system has been applied to milling machines and was found suitable in the instance where the cutter rotates in a direction opposed to the direction of movement of the table as in such case the cutter forms a constant load or resistance to the movement of the table. It is oftentimes necessary, however, to rotate the cutter in the same direction as the movement of the support or in other words that the periphery of the cutter in contact with the work travels with the work and it is evident that the cutter load instead of being opposed to the movement of the table actually assists its movement. If this assistance is not controlled or retarded the work will ultimately be jammed under the cutter by the action of the cutter itself resulting in breakage of the parts.

The earlier system was found unsuitable for supplying this necessary control and there has, therefore, been developed a second system, as shown in Figure 2, known as the metering type system in which the high pressure pump is now a variable delivery pump driven at a constant rate of speed capable of metering by volume the fluid from one end of the cylinder and placing it in the opposite end. By thus volumetrically metering the fluid the effect of the cutter in speeding up the movement of the table could be controlled as the fluid could not be forced out of the cylinder by the cutting force at a greater rate than determined by the setting of the pump. This resulted in the higher pressure being in the conduit connected to the intake side of the pump rather than the delivery side as in the earlier circuit. It should thus be apparent that movement of the table is retarded by the back pressure in conduit 17 and only permitted at the rate determined by the pump. In such a system it will be

noted that the low pressure side is now in the delivery conduit 18 rather than in the in-take conduit, as in the previous system and accordingly the replacement oil is injected into the side of the system having the lower pressure which in the present instance is the delivery side of the high pressure pump 19.

From an examination of the foregoing systems it will be seen that in each circuit the replacement oil is injected into the low pressure side thereof but in the earlier circuit this low pressure side is the in-take side of the variable delivery pump while in the latter case it is the delivery side of the pump.

In an attempt to increase the usefulness of milling machines and thereby make it possible to operate the table either with or against the rotation of the cutter the above two systems have been combined into what may be herein known as a convertible system in which a valve has been provided for connecting the booster pump with either side of the circuit. This makes it possible to selectively connect the make-up or booster pump with the low pressure side of the circuit as determined by the direction of the cutting force relative to the direction of movement of the table.

It has been observed in the use of a manual valve for this purpose that an inexperienced operator may start the machine without observing the position of the valve in which case if the valve is incorrectly positioned damage would result upon entry of the cutter into its cut. Also in production work, where a piece is mounted upon opposed ends of the table and a finished piece is being removed while an unfinished work piece is being operated upon, if the cutter is rotating continuously in one direction, one work piece will approach the cutter in a direction similar to the direction of rotation of the cutter, as shown in Figure 4, while the opposed work piece will approach in a direction opposed to the direction of rotation of the cutter, as shown in Figure 5. Constant attention is thus demanded of the operator to shift the valve between each work piece in addition to his duties of changing the work.

For these reasons an automatic valve has been provided which is controlled by the effect that the cutter has upon the movement of the work table. Immediately upon contact of the cutter with the work a pressure differential builds up between the two sides of the circuit and advantage is taken of this to provide a valve which is immediately operated by the higher pressure as soon as established to shift the valve to a position that connects the booster pump with the low pressure side of the circuit irrespective of which side that may be. This valve, as shown in Figure 3, comprises the cylinder portion 25 having cylinder heads 26 and 27 threaded in each end. Gaskets, such as 28, may be interposed between the cylinder head and the cylinder to prevent leakage. Each cylinder head is provided with a central longitudinal bore 29 to which is connected a conduit pipe 30 and 31 respectively. The conduit 30 is connected to the delivery side of the variable delivery pump 32 and the conduit 31 is connected to the in-take side of said pump. The pump is connected by conduits 46 and 46' to the reversing valve 48 from which channels 49 and 49' lead to opposite ends of the hydraulic motor 47 comprising a piston and cylinder, one of which is attached to a reciprocating slide, such as a table 45 of a milling machine, adapted to receive therein a work piece for presentation to the cutter 44 to effect stock removal therefrom. The cutter 44 is adapted to be power rotated in either a clockwise or counter clockwise direction by suitable known means.

The valve member is in the form of a piston 33 slidably mounted in the cylinder 25 and is provided with a bore 34 drilled in one end and a bore 35 drilled in the opposing end and in overlapping relation with the first bore. An annular groove 36 is formed in the piston and has a radial port 37 formed in the bottom thereof which communicates with the longitudinal bore or passage 34. A second annular groove 38 is formed in the piston having a radial bore 39 which communicates with the longitudinal bore or passage 35. A port 40 is formed in the cylinder body and connected by an exterior channel 41 to the booster pump 42. A low pressure relief valve 42' is provided to permit the escape of overflow. The piston member 33 is of such length that upon movement to extreme left position, as shown in the drawings, the annular groove 36 will register with the port 40 thus permitting the pump 42 to force fluid by means of the bore 34 and conduit 31 to the in-take side of the variable delivery pump 32. Upon movement of the piston 33 to the right the port 40 will register with the annular groove 38 thus connecting the booster pump through bore 35 and conduit 30 to the delivery side of the variable delivery pump. A recess 43 is formed on the interior of each cylinder head thereby establishing connection between the channels 35 and 30 or the channels 34 and 31 even although the piston is moved to its extreme right or left position.

The operation of the valve will now be explained. If the cutter 44 were rotating in a clockwise direction and the table moving in the direction of the arrow it would exert a resistance to the movement of the table thereby creating a high pressure in the channel 46 connected to the delivery side of the pump. This high pressure would be communicated to the conduit 30 and force the valve member 33 to the left to the position shown. This would establish communication between the pump 42 and the in-take side of the variable delivery pump which in this instance would be the low pressure side. If the cutter 44 were rotated in a counter clockwise direction it is apparent that it would assist the movement of the table in which case the fluid in the right end of the cylinder 47 would have to act to restrain the jumping ahead of the table and thereby would become the high pressure side of the circuit. This high pressure would be communicated to the conduit 31 which would force the piston member 33 toward the right and establish communication between the booster pump 42 and the conduit 30 through the annular groove 38 and longitudinal bore 35. It is thus apparent that the reaction of the cutter against the work automatically causes a pressure differential to build up between opposite sides of the circuit which immediately upon communication to the valve shifts it to a position to connect the booster pump to the low pressure side of the circuit and thus automatically converts the system from one type to the other.

That which is claimed is:

1. A milling machine having a table, an hydraulic motor for effecting reciprocation thereof including a piston and cylinder, a pump, intake and delivery conduits connecting the pump with

the motor, a make-up pump, a cylindrical valve having an intermediate port therein communicating with the make-up pump, a piston slidably mounted in the valve, a separate channel connecting each conduit to an opposed end of the cylinder, said piston having a pair of annular grooves formed therein communicating with the end chambers of the cylinder, whereby the pressure differential in the conduits will effect shifting of the valve piston to connect the intermediate port with the conduit of lower pressure to supply make-up fluid thereto.

2. In an hydraulic transmission the combination with a motor unit comprising a cylinder and a piston movable in the cylinder and subject to varying resistances, of a pump, conduits coupling the ends of the cylinder with the pump whereby the pump will serve to transfer fluid from one end of the cylinder to the other, a supplemental fluid pressure source, branch conduits extending from said fluid pressure source to each of the cylinder conduits intermediate the latter and the transferring pump; and means responsive to differences in pressure between the two branch conduits for sealing the high pressure branch and simultaneously opening the low pressure branch to the pressure source.

3. In a milling machine structure having a rotatable cutter and a work support movable transversely of the cutter and selectively in the direction of rotation of the cutter or in opposition to the direction of rotation thereof, the combination with means for controlling the movement of the work support including a cylinder and a piston within the cylinder coupled with the work support, conduits extending from the ends of the cylinder, and a pump connectible with the conduits for transferring contained hydraulic medium from one end of the cylinder to the other by way of the conduits, of a common supplemental source of hydraulic medium under pressure, branch conduits extending from said source to each of the cylinder conduits, and means for controlling the flow in said branch conduits including a supplemental cylinder, a piston valve reciprocable within said cylinder responsive to differences in pressure between the two branch conduits and movable thereby to seal the conduit of higher pressure and open the other conduit to said supplemental hydraulic source during uni-directional transfer of hydraulic medium from end to end of the main cylinder.

4. In a milling machine structure having a rotatable cutter and a work support movable transversely of the cutter and selectively in the direction of rotation of the cutter or in opposition to the direction of rotation thereof, the combination with means for controlling the movement of the work support including a cylinder and a piston within the cylinder coupled with the work support, conduits extending from the ends of the cylinder, and a pump connectible with the conduits for transferring contained hydraulic medium from one end of the cylinder to the other by way of the conduit, of a common supplemental source of hydraulic medium under pressure, branch conduits extending from said source to each of the cylinder conduits, means for controlling the flow in said branch conduits including a supplemental cylinder, a piston valve reciprocable within said cylinder responsive to differences in pressure between the two branch conduits and movable thereby to seal the conduit of higher pressure and open the other conduit to said supplemental hydraulic source during uni-directional transfer of hydraulic medium from end to end of the main cylinder, and means independent of said automatic valve mechanism for reversing the connections between the cylinder conduits and motor to reverse the direction of movement of the piston in the cylinder and thus the direction of movement of the work support.

5. An hydraulic propulsion system combining an hydraulic motor, a high pressure control pump for said motor, conduits coupled with the motor, additional conduits coupled with the pump, means for selectively coupling the motor and pump conduits to determine the direction of actuation of the motor by the pump, additional conduits coupled with the inlet and outlet ports of the pump, a low pressure pump selectively couplable with either of said conduits, and a single valve member disposed for actuation by pressure differential in the supplemental conduits whereby said valve automatically seals the high pressure conduit while simultaneously coupling the low pressure pump with the low pressure conduit.

6. An hydraulic propulsion system combining an hydraulic motor, a high pressure control pump for said motor, conduits coupled with the motor, additional conduits coupled with the pump, means for selectively coupling the motor and pump conduits to determine the direction of actuation of the motor by the pump, additional conduits coupled with the inlet and outlet ports of the pump, a low pressure pump selectively couplable with either of said conduits, a single valve member disposed for actuation by pressure differential in the supplemental conduits whereby said valve automatically seals the high pressure conduit while simultaneously coupling the low pressure pump with the low pressure conduit, and additional valve mechanism for determining the maximum pressure in the low pressure side of the hydraulic system.

7. An automatic pressure actuable valve mechanism for sealing a high pressure line and simultaneously coupling an opposed low pressure line with a fluid source comprising a valve casing, conduits terminally connected with said casing, a piston valve member reciprocably mounted in the casing having circumferential grooves formed therein and longitudinally extending passages extending partially therethrough in an axial direction from each end thereof, means establishing communication between the passages extending from either end of the valve and the circumscribing groove nearer the opposed end thereof, and an inlet conduit coupled with and in communication with the valve casing centrally thereof, whereby pressure introduced into either end of the valve casing will shift the piston valve to align the groove at the pressure end thereof with the inlet, whereby communication is established through the groove and its associate passage with the opposite end of the cylinder substantially as and for the purpose described.

8. A machine tool having a slidable member, an hydraulic motor for effecting movement of the member, a pump having intake and delivery ports, conduits connecting said ports with the motor, means to create a pressure differential in said conduits, and means to supply make-up fluid alternatively to the one or the other of said conduits and selectively to the conduit having the lower pressure including a second pump and a pressure responsive device operable by the superior pres-

sure in one conduit to connect the second pump to the other conduit.

9. In an hydraulic transmission the combination with a motor unit comprising a cylinder and piston movable in the cylinder, said piston being subject to external resistances and pressures of a pump, conduits coupling the ends of the cylinder with the pump whereby the pump will serve to transfer fluid from one end of the cylinder to the other, means to insert make-up fluid in the circuit including an auxiliary pump, a delivery channel therefrom, a low pressure relief valve in said channel, said relief valve being set at a lower pressure than the high pressure side of the circuit and valve means responsive to differences in pressure between the two conduits to connect said delivery channel selectively to the conduit having the lower pressure.

10. In a machine tool having a reciprocable table adapted to receive a work piece on each end thereof for presentation to a rotary cutter, the constant direction of rotation of which will alternately produce opposing and assisting effects on the table movement during alternate engagement with the respective work pieces, the combination with a pump and intake and delivery channels coupling the pump to the motor to cause said feeding movement, the pressure in one channel being higher than the pressure in the other channel depending on said effect produced by the direction of cutter rotation, of means to supply make-up fluid to the system regardless of the effects produced by the cutter including a make-up pump, a valve for selectively connecting said make-up pump to either channel, and means responsive to the higher of the pressures produced in the respective channels to connect the make-up pump to the channel having the lower pressure.

11. In a milling machine having a reciprocable table adapted to receive a work piece on each end thereof for presentation to a rotary cutter, the constant direction of rotation of which will alternately produce opposing and assisting effects on the table movement during alternate engagement with the respective work pieces, the combination with an hydraulic system including a pump and intake and delivery channels connected for moving the table, of means for supplying make-up fluid to the system including a source of pressure, and means responsive to the pressure differential in said conduits to connect the pump to the conduit having the lower pressure.

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