March 23, 1954 R. E. CROSS 2,672,884

TRAVERSE-AND-FEED-VALVE ASSEMBLY

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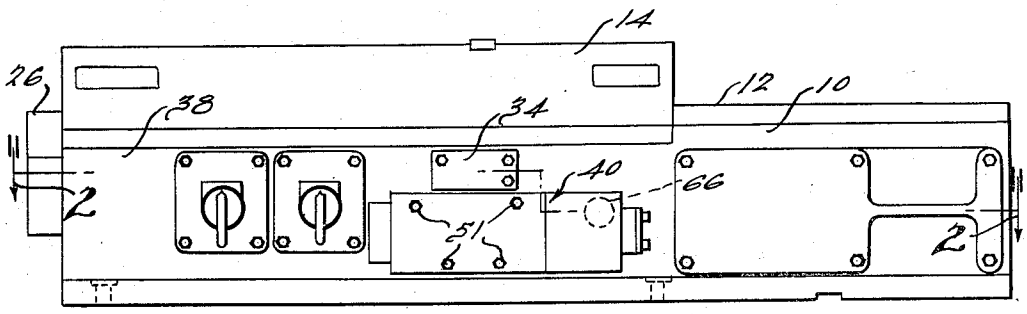


FIG. 1.

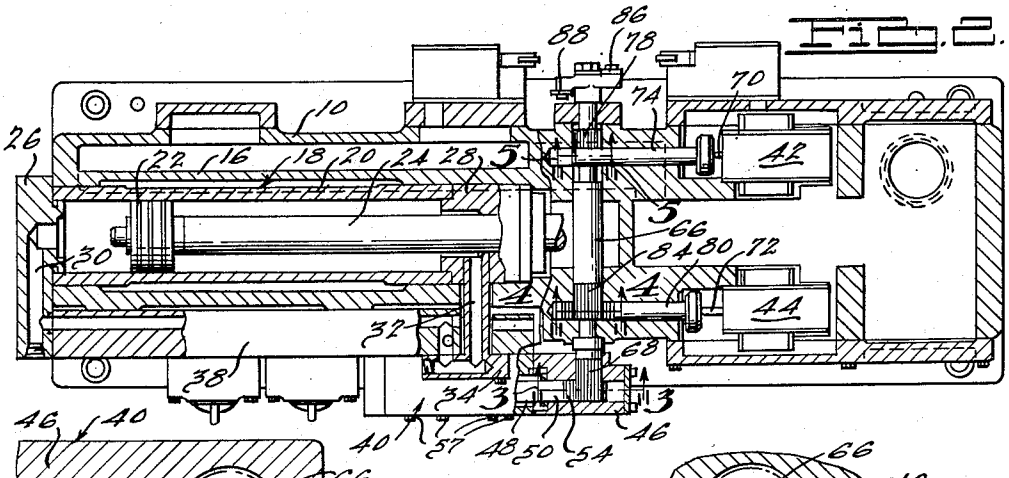


FIG. 2.

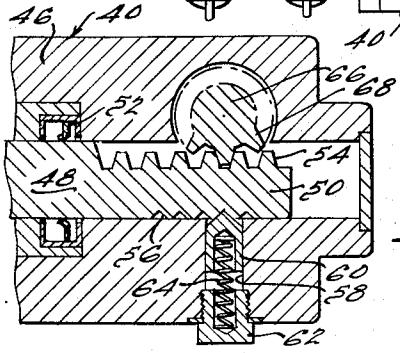


FIG. 3.

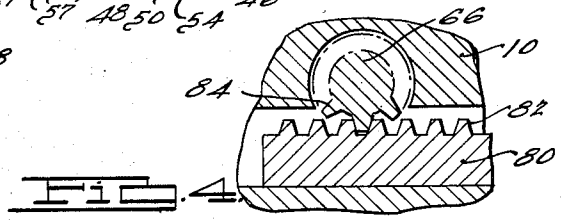


FIG. 4.

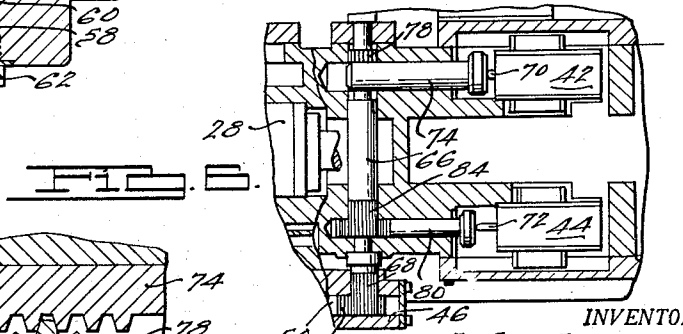


FIG. 6.

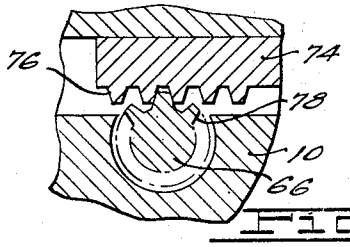


FIG. 5.

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TRAVERSE-AND-FEED-VALVE ASSEMBLY

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9 Claims. (Cl. 137—620)

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This invention relates to a mechanism for actuating hydraulic valves.

There are many types of automatic machine tools having a saddle slidably mounted on a suitable base and actuated by a fluid motor connected to the saddle. A hydraulic circuit is provided which includes the fluid motor and a valve for directing hydraulic liquid to the motor. Also, an electrical circuit is provided which includes at least two solenoids for operating the valve and the usual limit switches actuated by moving parts of the machine for energizing and de-energizing the solenoids.

Heretofore, it has been conventional practice to mount the solenoids with the valve which they operate so that they, in effect, form a single unit. This arrangement has several disadvantages. Perhaps the most important disadvantage is that the solenoids and the valve are mechanically correlated and connected in such a way that neither the valve nor the solenoids can be removed independently of the other for repair, replacement, or substitution of parts. The impracticability of this situation is at once apparent, as it is necessary to uncouple all hydraulic connections of the valve and all electrical connections of all the solenoids before the unit can be removed. In the case of the hydraulic system all or substantially all of the hydraulic fluid usually also must be drained and the system must be filled again when the valve-solenoid unit is replaced. One solenoid, for example, cannot be removed for repair without also disrupting the entire hydraulic circuit. Alternatively, if it is necessary to repair or replace some part in the hydraulic valve, it is necessary to disconnect all of the wiring leading to the solenoids. As a consequence, considerable unnecessary labor is required to make the change, and this means that labor costs are excessive for the work involved. Further, the machine is rendered inoperative longer than would otherwise be necessary, and valuable production time is lost. Another disadvantage of the conventional arrangement is that any hydraulic liquid leaking from the valve has direct access to and frequently impairs the operation of the solenoids or adjacent electrical connections and apparatus.

The present invention is a novel mounting arrangement for the valve and the solenoids and novel means for mechanically interconnecting the two which obviates the difficulties outlined above. For purpose of illustration the invention is shown incorporated in a machine tool of the

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type hereinabove described. It will be apparent, however, that, in its broader aspects, the invention is not limited to the particular setting in which it is shown. In actual practice, the invention can be used in any capacity where apparatus of this type has utility.

In the drawing forming a part of this specification, and wherein like numerals are employed to designate like parts throughout the same:

Fig. 1 is a side elevational view showing the saddle of a machine tool slidably mounted on a base and illustrating the manner in which the hydraulic valve is attached to the base;

Fig. 2 is a longitudinal, horizontal sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged, longitudinal, vertical sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is an enlarged, longitudinal, vertical sectional view taken on the line 4—4 of Fig. 2;

Fig. 5 is an enlarged, longitudinal, vertical sectional view taken on the line 5—5 of Fig. 2; and

Fig. 6 is a fragmentary, longitudinal, horizontal sectional view showing a modified plunger construction for operating the valve.

In the drawing, wherein for the purpose of illustration is shown the preferred embodiment of the invention, the numeral 10 designates the base of a machine tool having the usual ways 12 and a saddle 14 slidably mounted on the ways. In the apparatus shown, the base 10 is formed centrally thereof and below the saddle 14 with a cylinder 16 which receives a fluid motor 18. The latter includes the usual cylinder 20, piston 22, and piston rod 24. The outer end of cylinder 20 is closed by a cap 26 and the inner end thereof is closed by a cylinder head 28. The piston rod 24 extends from the cylinder 20 through the cylinder head 28, and the extending end thereof is mechanically connected to a lug (not shown) attached to and depending from the slide 14. The fluid motor construction and mounting arrangement here shown is illustrated and described in detail in my copending application Serial No. 170,508, filed June 27, 1950, now Patent No. 2,584,428.

Hydraulic liquid is delivered to the cylinder 20 behind piston 22 through a passage 30 in the cap 26, and hydraulic liquid is delivered to the cylinder ahead of the piston through a passage 32 in a connector 34 fastened on the side of the base 10 and interengaging with the cylinder head 28 as shown in Fig. 2. Hydraulic liquid is directed to the passages 30 and 32 through a manifold 38 and the direction of flow of the liquid is controlled by a conventional hydraulic valve 40. Solenoids

42 and 44 are provided for actuating the valve 40. As suggested, the instant invention is concerned primarily with the particular manner in which the valve 40 and solenoids 42 and 44 are mounted on the base 10 with respect to each other and with the particular mechanical means which interconnect the solenoids and the valve.

The valve 40 has the usual valve casing 46 and a spool 48 is slidably mounted in the casing to control and direct the flow of hydraulic liquid to the fluid motor 18. The particular construction of the valve 40 is not important to the present invention except that the spool 48 has an extension 50 on one end thereof which extends from that part of the valve which controls the flow of liquid therethrough, and the extension 50 is sealed from the rest of the valve by a seal 52. The valve casing 46 is detachably fastened to the side of the base 10 forwardly of the fluid motor 18 by cap screws 51. The portion 50 of the spool 48 is formed in the top surface thereof with a rack 54 and in the undersurface thereof with a longitudinal series of notched serrations 56. Below the serrations 56 the casing 46 is formed with a bore 58 which slidably receives a detent 60. The outer end of bore 58 is closed by a threaded plug 62, and a spring 64 is confined between the detent 60 and the plug. It will be readily apparent that the spring-loaded detent 60 engages the spool 48 to hold it in selected adjusted position.

Mounted for rotation in and transversely of the base 10 is a cross-shaft 66, and one end of the shaft extends from the base into the valve casing 46 above the spool 48. As perhaps best shown in Fig. 2, the shaft 66 is positioned athwart valve spool 48; and, as shown in Fig. 3, the shaft is formed with a pinion 68 which meshes with the rack 54. In so far as the present invention is concerned, the pinion 68 can be formed integrally on the shaft 66 as shown in the drawing or it can comprise a separately formed gear suitably fastened on the shaft. In either event, however, the pinion should not be larger than the opening in the case 46 through which the shaft 66 extends so the valve 40 can be detached from the base 10 and disconnected from the shaft 66 by merely pulling the casing 46 outwardly from the base. As the valve 40 is pulled outwardly, the pinion 68 slides through the opening in the casing 46 to release the latter. Conversely, the valve 40 can be readily assembled on the base 10 by merely inserting the casing 46 over the projecting end of shaft 66 and then fastening the casing to the base by screws 51. As the casing slides over the shaft 66, pinion 68 on the end of the shaft automatically meshes with the rack 54.

According to the present invention the solenoids 42 and 44 are both positioned forwardly of the shaft 66 with the armatures 70 and 72 thereof projectible in the direction of shaft 66, and they are separately detachably fastened to the base in any convenient or suitable manner. Solenoid 42 is disposed slightly above shaft 66, and solenoid 44 is disposed slightly below the shaft. Interposed between the solenoid 42 and shaft 66 and slidably supported by the base 10 is a plunger 74. One end of the plunger seats armature 70, and the other end thereof extends over or above shaft 66 and is formed with a rack 76 which meshes with a pinion 78 formed on the shaft. Similarly, a plunger 80 is interposed between solenoid 44 and shaft 66. One end of plunger 80 seats the armature 72 and the other end thereof extends under shaft 66. The last-mentioned end of the plunger 80 is formed with a rack 82 which meshes with the pinion 84 formed on shaft 66.

From the foregoing, it will be readily apparent that energization of solenoids 42 and 44 will project their respective armatures in the direction of plungers 74 and 80. In Fig. 2, armature 70 is shown retracted in solenoid 42, and armature 72 is shown extended from solenoid 44. When either of the armatures 70 or 72 is projected from its respective solenoid, thrust exerted by the armature against the plunger on which it seats slides the plunger in the direction of shaft 66 and the rack-and-pinion connection between the plunger and the shaft rotatably drives the latter. By reason of the fast that plungers 74 and 80 are disposed on opposite sides of the shaft 66, plunger 74 rotates the shaft in one direction and plunger 80 rotates the shaft in the opposite direction. As described, rotation of shaft 66 slides the spool 48 in the valve casing 40 according to conventional practice to selectively direct hydraulic liquid to the motor 18. In the particular apparatus shown, the solenoids 42 and 44 position the spool 48 in two extreme positions. Arms on one end of shaft 66 have rollers 86 and 88 which are engaged by dogs (not shown) on the saddle 14 during travel of the latter to move the spool 48 to an intermediate position. The spring-loaded detent 60 holds the valve spool in all selected adjusted positions and prevents vibrations or other factors from inadvertently shifting the spool 48. However, it will be readily apparent that the device is operative with or without the rollers 86 and 88 and the latter may or may not be included, depending upon the exigencies of the particular situation.

From the foregoing it will be readily apparent that I have achieved the objects of my invention. I have provided a solenoid-actuated mechanism for the valve 40 wherein the valve can be removed without affecting either the mechanical or electrical connections of the solenoids 42 and 44. Conversely, the solenoids 42 and 44 or either of them can be removed without affecting any of the mechanical or hydraulic connections of the valve 40. Thus, necessary repairs or replacements of these parts can be made in a minimum of time and with a minimum of labor. As a consequence, the machine in which the mechanism is incorporated need be taken out of service for only a relatively short time during which the actual repairs or replacements are made. Also, the solenoids 42 and 44 and the electrical connections associated therewith are positioned remote from the valve 40 and hydraulic connections thereto, so that any leakage from the hydraulic system does not have ready access to the electrical system.

Another advantage of the instant construction is that the plungers 74 and 80 counterbalance each other and thus tend to hold the spool 48 of valve 40 in its adjusted position. As a matter of fact, the detent 60 can be omitted altogether if the valve 40 and plungers 74 and 80 are horizontal. The counterbalancing action of the plungers operates perfectly under these conditions to hold the spool 48, and no additional holding devices need be provided. However, under conditions where the valve 40 is quite large and is mounted with the spool 48 in a vertical or near vertical position the weight of the spool tends to cause it to settle in the casing 46. It is a feature of the invention that this characteristic of the valve can be compensated either

by using a spring-pressed detent **60** as shown in Fig. 3 or by making the plunger **74** sufficiently larger than the plunger **80** to offset the weight of the spool as shown in Fig. 6. The latter expediency is desirable in many situations. It will be readily apparent in this connection that different sized plungers can be used whether the mechanism is vertical or not, since the relative size of the plungers has no adverse effect on the operation of the mechanism.

Having thus described the invention, I claim:

1. In combination, a base, a hydraulic valve on said base having a slidable spool and a casing detachably fastened to the base slidably supporting said spool and provided with a side opening in register with the spool, a rotatable shaft carried by said base extending into the casing through said side opening and arranged athwart said spool, rack-and-pinion means interconnecting said shaft and said spool, said rack-and-pinion means being readily disengageable and said shaft being retractable through the side opening in the casing when the latter is detached from said base, a pair of plungers slidable in said base and disposed on opposite sides of said shaft, rack-and-pinion means interconnecting each of said plungers and said shaft, one plunger adapted to rotate the shaft in one direction to selectively position said spool and the other plunger adapted to rotate the shaft in the opposite direction to position the spool in a different selected position, and a pair of separately demountable solenoids in said base remote from said valve and each positioned to actuate a respective one of said plungers.

2. In combination, a base, a selectively positionable, slidable member on said base, a mounting carrying said slidable member detachably fastened to the base and removable therefrom in a direction transverse to the length of said slidable member, a rotatable shaft carried by said base and arranged athwart said member, rack-and-pinion means interconnecting said shaft and said member and being automatically disengageable when the mounting is removed from the base, a pair of plungers slidable in said base and disposed on opposite sides of said shaft, rack-and-pinion means interconnecting each of said plungers and said shaft, one plunger adapted to rotate the shaft in one direction to selectively position said member and the other plunger adapted to rotate the shaft in the opposite direction to position said member in a different selected position, and a pair of separately demountable solenoids in said base each positioned to actuate a respective one of said plungers.

3. In combination, a base, a valve on said base having a slidable spool and a casing detachably fastened to the base supporting said spool and provided with a side opening in register with the spool, a rotatable shaft carried by said base extending into the casing through said side opening arranged athwart and detachably drivingly connected to said spool, said shaft being detachable from said spool and retractable through the side opening in the casing when the latter is detached from the base, a pair of plungers slidable in said base and each drivingly connected to said shaft on opposite sides thereof, one plunger adapted to rotate the shaft in one direction to selectively position said spool and the other plunger adapted to rotate the shaft in the opposite direction to position the spool in a different selected position, and a pair of separately demountable solenoids in said base remote and separate from the fluid in the valve and each positioned to actuate a respective one of said plungers.

4. In combination, a base, a selectively positionable, slidable member, support means detachably fastened to the base carrying said member and provided with a side opening in register with said member, a rotatable shaft carried by said base extending into the casing through said side opening arranged athwart and detachably drivingly connected to said member, said shaft adapted to disengage said member and being readily retractable through the side opening in the casing when the latter is detached from said base, a pair of plungers slidable in said base drivingly connected to said shaft on opposite sides thereof, one plunger adapted to rotate the shaft in one direction to selectively position said member and the other plunger adapted to rotate the shaft in the opposite direction to position the member in a different selected position, and a pair of separately demountable solenoids in said base each positioned to actuate a respective one of said plungers.

5. In combination, a base, a valve having a valve casing detachably fastened to the base and provided with a side opening therein, said valve also having a valve spool slidable in said casing and disposed adjacent to said side opening in all sliding positions thereof, a shaft journaled in said base with an end thereof extending into said casing through said side opening and athwart said spool, means detachably drivingly connecting said shaft and said spool so that rotational movement of the shaft about its axis moves said spool back and forth in said casing, said driving means being readily detachable from the spool and said shaft being readily retractable through the side opening in the casing when the latter is detached from the base, a pair of separately mounted plungers on opposite sides of said shaft and drivingly connected therewith, and a pair of separately demountable solenoids each positioned to actuate the respective one of said plungers.

6. In combination, a base, a valve having a valve casing detachably fastened to the base so as to be removable therefrom and a valve spool slidable in said casing, a shaft journaled in said base with an end thereof extending into said casing and athwart said spool and retractable from the casing when the latter is removed from the base, a rack on the spool, a pinion on the shaft and in mesh with said rack, a pair of plungers slidable in said base and disposed on opposite sides of said shaft, rack-and-pinion means interconnecting each of said plungers and said shaft, one plunger adapted to rotate the shaft in one direction to selectively position said spool and the other plunger adapted to rotate the shaft in the opposite direction to position the spool in a different selected position, and a pair of separately demountable solenoids in said base each positioned to actuate a respective one of said plungers.

7. In combination, a base, a hydraulic valve having a valve casing fastened to the base and a valve spool slidable in said casing, a rack on said spool, a shaft journaled in said base with an end thereof extending into said casing athwart said spool, a pinion on the shaft in mesh with said rack, a pair of plungers operatively associated with said shaft on opposite sides thereof for rotating the same in opposite directions, a pair of solenoids in said base each in operative associ-

ation with a respective one of said plungers and both remote from said valve so that hydraulic liquid from the valve does not have ready access thereto, said valve casing being demountable from the base and disengageable from the coactive end of said shaft without affecting the solenoids, and each of said solenoids being separately demountable from the base without affecting the other solenoid or said valve.

8. In combination, a base, a valve on said base having a slidable spool and a casing detachably fastened to the base slidably supporting said spool and provided with a side opening in register with the spool, a rotatable shaft carried by the base extending into the casing through said side opening and arranged athwart said spool, rack-and-pinion means interconnecting said shaft and said spool, said rack-and-pinion means being readily disengageable and said shaft being retractable through the side opening in the casing when the latter is detached from said base, a pair of plungers slidable in said base and disposed one above and one below said shaft, rack-and-pinion means interconnecting each of said plungers and said shaft, and a pair of separately demountable solenoids in said base each positioned to actuate a respective one of said plungers, the plunger disposed above said shaft being larger than the plunger disposed therebelow to counterbalance the weight of the spool when the valve is positioned so that the weight of the spool tends to change its position in the valve.

9. In combination, a base, a valve on said base having a slidable spool and a casing detachably fastened to the base slidably supporting said spool and provided with a side opening in register

with the spool, a rotatable shaft carried by the base extending into the casing through said side opening and arranged athwart said spool, rack-and-pinion means interconnecting said shaft and said spool, said rack-and-pinion means being readily disengageable to separate the spool and the shaft and the latter being readily retractable through the side opening of the casing when said casing is detached from the base, a pair of plungers slidable in said base and disposed one above and one below said shaft, rack-and-pinion means interconnecting each of said plungers and said shaft, and a spring-loaded detent in engagement with said spool to hold the same selectively positioned.

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