June 16, 1964 H. A. BRYANT ETAL 3,137,213

AUTOMATIC BLEEDER VALVE

Filed April 15, 1963 3 Sheets-Sheet 1

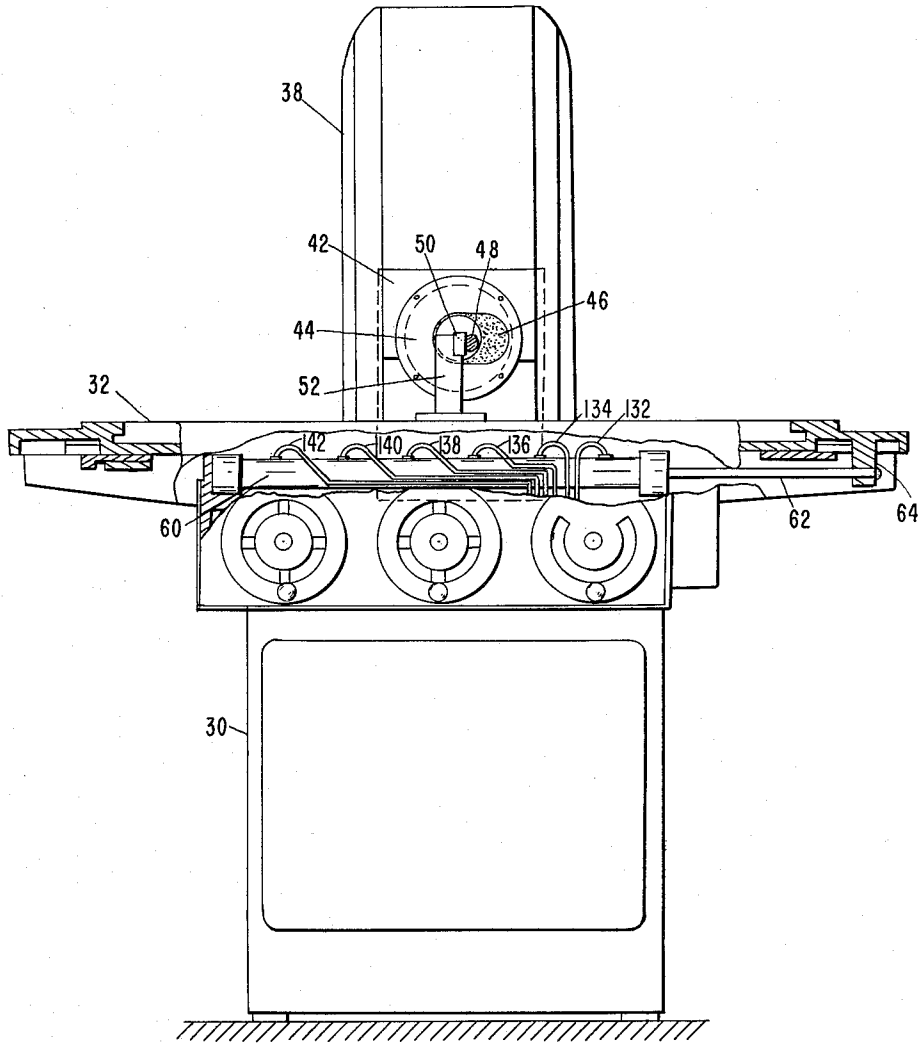


FIG. 1

INVENTORS
HAROLD A. BRYANT
JOSEPH H. MARCOTTE
BY Maxwell Fish
ATTORNEY

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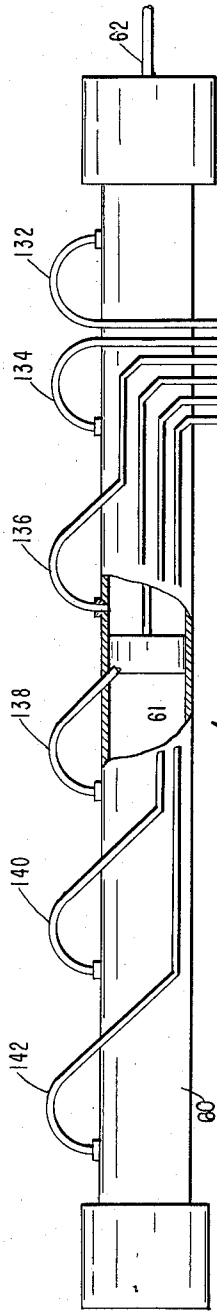


FIG. 2

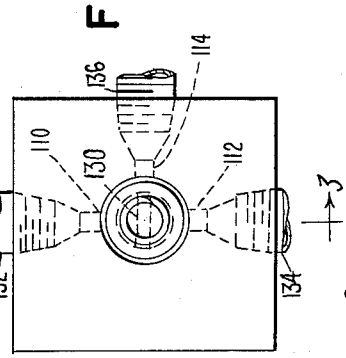


FIG. 4

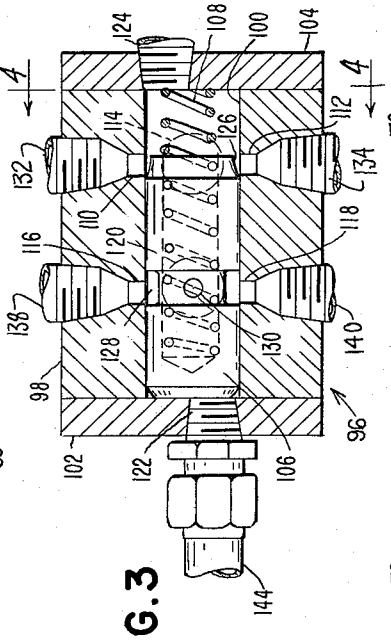


FIG. 3

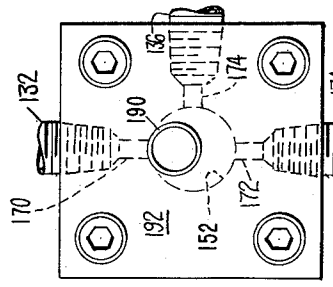


FIG. 8

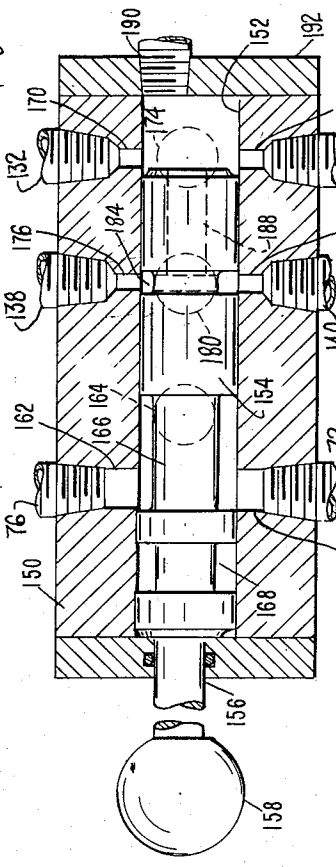


FIG. 6

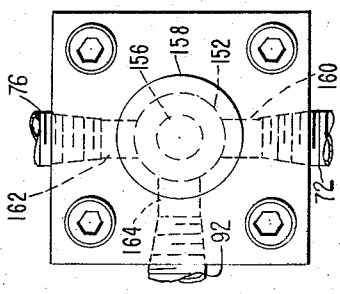


FIG. 7

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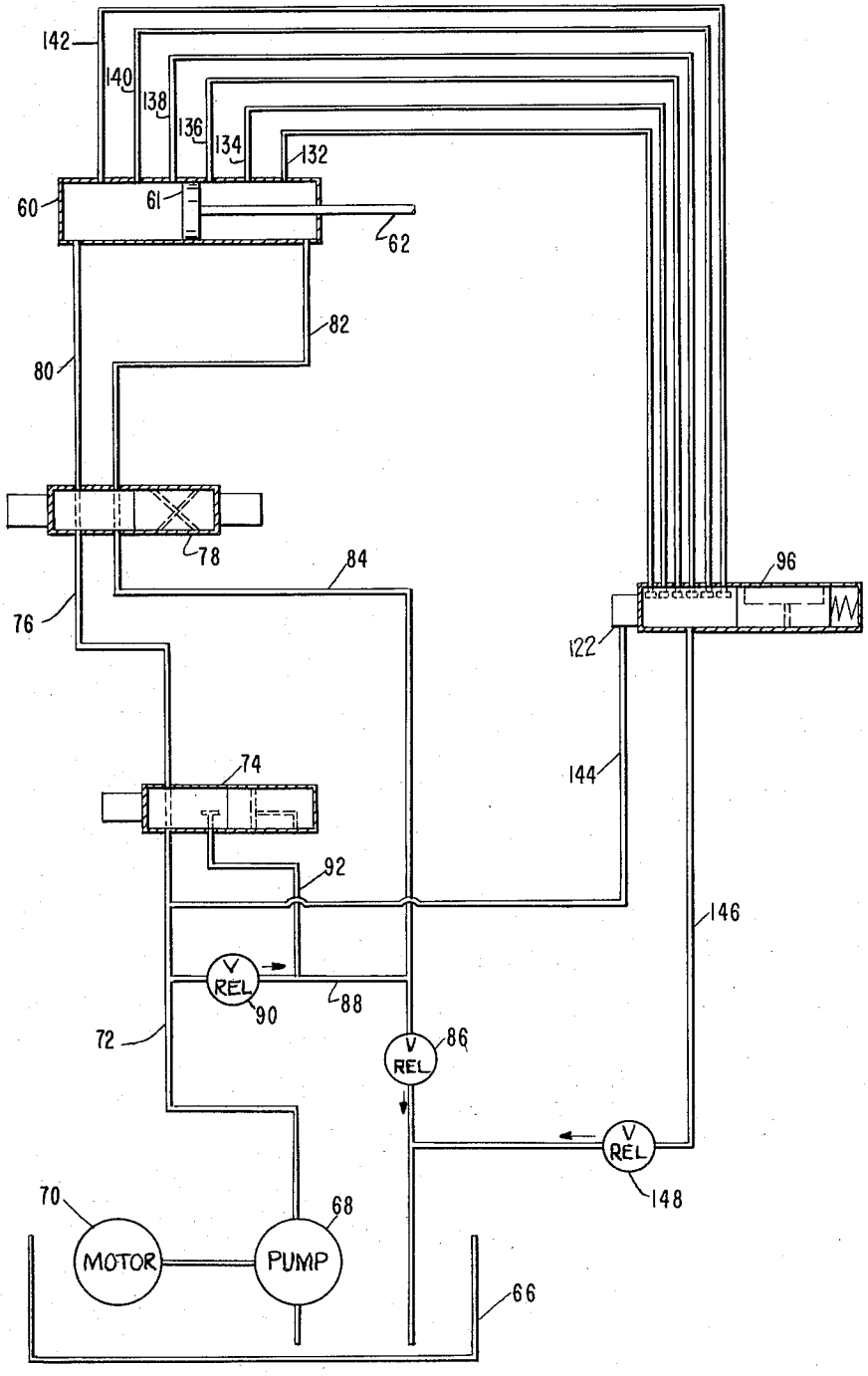


FIG. 5

United States Patent Office 3,137,213 Patented June 16, 1964

3,137,213
AUTOMATIC BLEEDER VALVE

Harold A. Bryant, North Providence, and Joseph H. Marcotte, Central Falls, R.I., assignors to Brown & Sharpe Manufacturing Company, Providence, R.I., a corporation of Rhode Island

Filed Apr. 15, 1963, Ser. No. 273,019
5 Claims. (Cl. 91—420)

The present invention relates to a device for bleeding air from a hydraulic system, and more particularly to a device for automatically bleeding air from a hydraulic operating circuit for a machine tool slide prior to the placing of said slide in operation.

It has been found that hydraulic operating systems for machine tools, when idled for any appreciable length of time, tend to pick up a certain amount of air which may collect, for example, in the operating cylinder for the movable support with the result that the operation of the support when first placed in operation will tend to be erratic.

It is a principal object of the invention to provide means which will act automatically when the previously idled hydraulic system of the machine is first brought up to its full operating pressure, but before said pressure is applied for the moving of a support, to bleed off any air which may have accumulated in the hydraulic system so that a fully dependable and accurate movement of the machine support from its rest position will be assured when the machine controls are set to call for such movement.

With the above and other objects in view, the several features of the invention consist in the devices, combinations and arrangement of parts hereinafter described and claimed which together with the advantages to be obtained thereby will be readily understood by one skilled in the art from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a view in front elevation of a grinding machine, a portion of the table having been broken away and parts sectioned to illustrate particularly the table operating hydraulic cylinder;

FIG. 2 is an enlarged view of the table driving cylinder of FIG. 1 shown partly in section and with the bleeder outlets formed therein;

FIG. 3 is a sectional view in side elevation of the bleeder valve forming part of applicant's bleeder valve assembly;

FIG. 4 is a sectional view taken on a line 4—4 of FIG. 3;

FIG. 5 is a somewhat diagrammatic view of the hydraulic system for operating the table of the grinding machine shown in FIG. 1 to illustrate the operation of the automatic bleeder valve;

FIG. 6 is a sectional view in side elevation of a mechanically interconnected start-and-stop valve and bleeder valve replacing the corresponding hydraulically interconnected valves of FIGS. 1 to 5 inclusive;

FIG. 7 is an end view of the valve assembly shown in FIG. 6 looking from the left; and

FIG. 8 is an end view of the valve assembly shown in FIG. 6 looking from the right.

The invention is herein disclosed as embodied in a surface grinding machine of the general type having a base 30, a table 32, adapted for traversing movement on the base, a cross slide which takes the form of a column support 38 mounted on ways, not shown, for forward and back movement with relation to the table, and a grinding wheel carriage 42 which is adapted for vertical movement on ways formed on the column support 38. Hydraulic circuits including operating cylinders are provided for operating both of the column support 38 and carriage 32. The machine in general may be similar to that described, for example, in prior U.S. patent to

Holland et al., No. 2,927,403, dated March 8, 1960, for "Hydraulic Operating and Control System for a Machine Tool." Only so much of the machine will be hereinafter set forth as believed necessary to illustrate the application of the present invention thereto. In the embodiment shown, the machine is set up for slicing thin discs from a circular work piece, an extremely thin internal grinding wheel being utilized for this purpose. The internal disc grinding attachment comprises a casing generally indicated at 44 within which is housed an internal grinding disc 46 driven from the machine arbor, not shown, carried by the grinding wheel carriage 42. A cylindrical work piece 48 is shown mounted on a work holder 50 which is in turn rigidly secured to a post 52 on the table 32. In operation the cross slide is advanced so that the work piece projects inwardly through the hole in the disc, and the table carrying the work piece is moved transversely a sufficient distance to cut off a disc from the work piece. The table is then backed off and the operation is repeated. With the setup shown it will be appreciated that a very small back-and-forth movement of the table only is required for making successive cuts in the work piece, each traversing and return movement being followed by a slight advance of the column support 38 which will position the internal grinding disc for the next succeeding cut.

The hydraulic operating circuit for the table 32 only is here shown in a somewhat diagrammatic form, only so much of the hydraulic system being shown as believed necessary to show the connection of the invention therewith. For a full disclosure of the hydraulic system for operating the column support 38 and the table 32, reference may be had to the Holland et al. U.S. Patent No. 2,927,403, above referred to. The hydraulic circuit for driving the table 32 as best shown in FIGS. 1 and 5 comprises generally a hydraulic cylinder 60 which is mounted on the base 30 and is provided with a piston 61, and piston rod 62 which is connected at its outer end to a depending lug 64 on the table 32. Oil is supplied from a sump or reservoir 66 by means of a pump 68 driven by a motor 70. From the pump 68 oil flows through a conduit 72 to a start-and-stop valve 74. With the start-and-stop valve in the on position shown, oil then flows through a pipe 76 to a reversing valve 78 which is connected by conduits 80 and 82 with the two ends of the table operating cylinder 60. Assuming the position of the reversing valve shown, oil is returned from the exhaust side of the cylinder 60 through the conduit 82 and reversing valve 78, through a return exhaust conduit 84 and a relief valve 86 to the reservoir 66. In the event that the pressure produced by the pump 68 in the system exceeds a predetermined maximum value, the oil is bypassed from the conduit 72 through a conduit 88 and a relief valve 90 directly into the exhaust conduit 84. In the illustration shown, the relief valve 90 is set at 110 p.s.i. When the start-and-stop valve 74 is shifted from the on to the alternative off position, oil is bypassed directly from the conduit 72 into an exhaust conduit 92 whence it flows through the bypass conduit 88 and exhaust conduit 84 to the reservoir 66. The relief valve 86 is set at 10 p.s.i. so that a base back pressure is maintained in the system at all times when the motor 70 and pump 68 are in operation.

It is characteristic of hydraulic operating systems of the general type thus far described that when the machine is idled and the hydraulic pressure is shut off for any extended period, there is a tendency for air to leak into the system and to collect particularly along the length of the hydraulic cylinder by means of which the machine support is driven. The hydraulic circuit may normally be purged of any air which may have found its way into the operating cylinder by effecting several long

traversing movements of the machine support as, for example, the table 32 back and forth so that any air which may have collected in the cylinder 60 is driven off. The improvement hereinafter described provides a procedure for eliminating any such air pocket prior to the actual starting of machine operation under conditions such as those provided by the set up shown in FIG. 1 in which the operator cannot traverse the table fully after the machine has been set up for the particular operation, or where the machine has been idled for any reason before completion of the operation.

In accordance with the invention, a series of bleeder connections are provided from the cylinder 60 along its length into a bleeder valve 96 which is automatically operated when the motor 70 and pump 68 are first put in operation and before the starting-and-stopping valve 74 is shifted from its stop to its start position to bleed off any air which may have accumulated in the system, and particularly in the upper portion of the hydraulic cylinder 60.

The bleeder valve 96 illustrated in detail in FIGS. 3 and 4 comprises a rectangular casing 98 having a central bore 100 along its length and end plates 102, 104 which close the ends of the bore. A cylindrical valve member 106 is supported within the bore 100 for axial movement therein between bleeding and shut-off positions. A coiled compression spring 108 seated within an axial bore in the valve member 106 and at its outer end engaging against the plate 104 acts to bias the valve member 106 to the left as shown in FIG. 3 to the open or bleeding position. The valve housing 98 is provided with three bleeder inlet ports 110, 112, 114 which extend into the bore 100 from three different sides of the housing in the same transverse plane. A second group of bleeder inlet ports 116, 118, 120 is provided through different sides of the casing 98 into the bore 100 in a second transverse plane. The valve is also provided with a hydraulic pressure inlet port 122 through end plate 102 into the left-hand end of the bore 100 and with an outlet port 124 which is formed in the end plate 104 and connects with the right-hand end of the bore 100. For the open or bleeding position of the valve shown in FIG. 3, oil is permitted to pass through the inlet ports 110, 112, 114 past a reduced end portion 126 of the valve member 106 into the bore 100 and thence out through the outlet port 124. Oil similarly is permitted to pass from the inlet ports 116, 118, 120 into an annular recess 128 formed in the periphery of the valve member 106, and thence inwardly through a radial drill 130 into the internal bore of the valve member 106, and out through the outlet port 124. Movement of the valve member 106 to the right against the pressure of spring 108 has the effect of shutting off all of said inlet ports. The inlet ports 110, 112, 114 of the bleeder valve are connected respectively through pipe connections 132, 134, 136 with small bleeder ports spaced along the top side of the table cylinder 60. The bleeder inlet ports 116, 118, 120 are similarly connected by means of pipes 138, 140, 142 with inlet ports spaced along the top of the cylinder 60. Oil under pressure is supplied to the hydraulic pressure inlet port 122 of the bleeder valve through a pipe connection 144 from the pressure supply line 72. Oil is exhausted from the outlet port 124 through an exhaust pipe connection 146 and a relief valve 148 set to provide a back pressure of 5 p.s.i., and thence flows through the lower end of the exhaust line 84 to the reservoir 66.

The operation of the automatic bleeder valve 96 will be described with reference to the somewhat diagrammatic disclosure of the hydraulic operating system for the machine table 32 as follows:

In the diagram, the machine is shown in running position. It is assumed that the motor 70 and pump 68 are operating, that the start-and-stop valve 74 is in its run position, and that the reversing valve 78 is set so that oil at a pressure of 110 p.s.i. is supplied to the left-hand face

of the piston 62, this pressure being determined by the setting of the overflow relief valve 90. Oil is permitted to flow from the right-hand end of the cylinder 60 through the exhaust line 82, 84 to the reservoir against a back pressure of 10 p.s.i. provided by the relief valve 86. Under these conditions, oil is supplied at a full operating pressure of 110 p.s.i. also through the pipe 144 and inlet port 122 to the bleeder valve 96 causing the valve member 106 to be moved to its right-hand or closed position against the pressure of spring 108 so that the bleeder lines 132 to 142 are blocked off.

When the machine is stopped, as by shifting the start-and-stop valve 74 to the stop position, oil is bypassed from the supply line 72 through the start-and-stop valve to the exhaust line 92 and relief valve 86 to the reservoir 66, thus reducing the pressure on both sides of the piston 62 in cylinder 60 to an approximate 10 p.s.i. At the same time the pressure in the supply line 144 to the bleeder valve 96 is reduced to an approximate 15 p.s.i. which is insufficient to overcome the pressure exerted by the spring 108, so that the bleeder valve is shifted to the on position shown in FIG. 3. Oil under pressure is now permitted to escape through the bleeder lines and the bleeder valve past the relief valve 148 which as above noted is set at 5 p.s.i. to the reservoir 66.

If the machine is now completely shut down by stopping motor 70 and pump 68, the residual pressure in the system will gradually drop to 0. In the event that the machine is shut down for any length of time, there is a considerable probability that air will find its way into the system and, more particularly, into the cylinder 60 where it will collect along the upper inside surface thereof. For this stop condition of the machine, the bleeder valve 96 remains in its open or bleeding position.

When the machine is again started, the motor 70 and pump 68 are first placed in operation while the start-and-stop valve 74 remains in its stop position in which oil is bypassed from the supply line 72 through the start-and-stop valve past the relief valve 86 to the reservoir 66. Pressure in all parts of the system will now be controlled by the setting of the relief valve 86, and will thus approximate 10 p.s.i. The pressure in the connecting pipe 144 will approximate 15 p.s.i. which is not enough to move the valve member from its open position against the pressure of spring 108. Each of six bleeder lines 132–142 inclusive will, therefore, be operative to bleed off oil from the upper portion of the cylinder 60 along its length so that any air trapped in the cylinder will be drawn off, and discharged through the bleeder valve 96 into the reservoir 66. It will take approximately one minute to purge the system of any entrapped air and no movement of the table is necessary.

When the start-and-stop valve 74 is now shifted to its on position, full operating pressure of 110 p.s.i. is directed through the supply line 76 to the hydraulic cylinder 60, and through the pipe connection 144 to the bleeder valve causing the valve 106 to be shifted to its off position against the pressure of spring 108 to prevent further bleeding of oil from the cylinder.

With the arrangement above described, it will be readily appreciated that any air which may have found its way into the system will be drawn off through the bleeder valve 96 thus insuring a positive and accurate movement of the piston 62 and table 32 actuated thereby from its previously arrested position. The multiplicity of bleeder connections provided insures that air will be exhausted from the top of the cylinder 60 along its entire length so that accurate operation of the piston 62 from its stop position is assured regardless of where it has stopped or of the direction of travel from said position.

FIGS. 6, 7 and 8 illustrate a modified form of the invention in which the bleeder valve is mechanically connected to the start-and-stop valve so that a shifting movement of the start-and-stop valve to the on position causes the bleeder valve to be shifted to its shut-off posi-

tion, and movement of the start-and-stop valve to the stop position will cause the bleeder valve to be shifted to its bleeding position. As shown in FIG. 6, the start-and-stop valve and the bleeder valve are supported within a single valve housing **150** formed with a central bore **152** adapted to receive an axially shiftable valve member **154** having connected to the left-hand end thereof a stem **156** and a manually operable knob **158**. The left-hand portion of the valve housing **150** and valve member **154** constitute a start-and-stop valve asembly which may be identical with that diagrammatically illustrated in FIG. 5. The right-hand portion of the valve housing **150** and valve member **154** constitute a bleeder valve assembly which is similar to that illustrated in FIGS. 3 and 4. The mechanically interconnected start-and-stop valve and bleeder valve assemblies contained within the valve housing **150** of FIG. 6 may be fitted bodily into the hydraulic system of FIG. 5 replacing specifically the start-and-stop valve **74**, the bleeder valve **96** and hydraulic pressure supply pipe **144**.

The start-and-stop portion of the combined valve **150** comprises an inlet port **160** which is connected with the supply line **72** of FIG. 5, an outlet port **162** which connects with the pipe **76** leading to the reversing valve **78** and operating cylinder **60**, and a bypass outlet port **164** which connects with the bypass pipe line **92**. The associated valve member **154** is provided with a relatively wide groove **166**, which for the off position of the combined valve shown connects all three of the ports **160**, **162**, **164**, and with a groove **168** which for the alternative on position of the valve connects the supply pipe **160** with the outlet port **162** while at the same time the bypass port **164** is shut off.

The bleeder valve portion of the combined valve **150** is similar to the bleeder valve illustrated in FIG. 3. Three inlet ports **170**, **172**, **174** in the same transverse plane connect respectively with the bleeder pipes **132**, **134**, **136** respectively from the right-hand end of cylinder **60**. Three inlet ports **176**, **178**, **180** in a second transverse plane connect with the bleeder pipes **138**, **140**, **142** respectively from the left-hand end of cylinder **60**. The valve member **154** is formed with an annular groove **184** which for the off position of the start-and-stop valve shown is aligned with the three inlet ports **176**, **178**, **180**. A radial passage from the groove **184** connects with an axial bore **188** in the valve member **154** and with an exhaust port **190** in end plate **192** through which oil flows into the exhaust line **146** of FIG. 5. For the machine stop, bleeding position of the valve member **154** illustrated in FIG. 6, oil is bled from the right-hand end of the operating cylinder **60** through the bleeder pipes **132**, **134**, **136** and inlet ports **170**, **172**, **174** directly into the central bore **152** of the valve housing **150** and thence through the outlet port **190** to the exhaust line **146**. Movement of the manually controlled knob **158** and valve member **154** to the on position to the right causes both groups of inlet ports **170** to **174** and **176** to **180** to be closed off.

The operation of the modified construction illustrated in FIGS. 6, 7 and 8 is similar to that previously described in connection with FIGS. 1–5, inclusive, in that for the machine stop position of the start-and-stop valve control knob **158**, shown in FIG. 6, oil supplied by the pump **68** is bypassed through the bypass connection **92** causing the pressure in the system to be reduced to a minimum value determined by the setting of relief valve **86** which may, for example, be in the order of 10 p.s.i. so that the portions of the operating cylinder **60** at both sides of the piston **62** will be maintained at the 10 p.s.i. level. Since at the same time the bleeder valve is moved to the on or open position of FIG. 6 oil will be bled through each of the bleeder lines **132–142**, inclusive, through the bleeder valve to the reservoir **66** against the relatively lower pressure of relief valve **148** which, as previously noted, is set at 5 p.s.i. Movement of the start-and-stop valve control knob **158** to the right from the position shown in FIG. 6 causes oil at the operating pressure from pump **68** to be channeled through pipe line **76** to the operating cylinder **60** while the bypass connection **92** is shut off. At the same time all of the inlet ports for the bleeder lines **132–142** are shut off so that no further bleeding of oil from the operating cylinder **60** will take place.

The invention having been described what is claimed is:

1. A hydraulic propulsion system for a machine tool support which comprises a hydraulic circuit including a hydraulic cylinder connected to move the support, means for supplying liquid at an operating pressure to said hydraulic circuit, an exhaust connection including a hydraulic resistance through which fluid is exhausted from said circuit against a base back pressure, a start-and-stop valve in said circuit shiftable between on and stop positions, and hydraulic connections in said circuit operative for the on position of said start-and-stop valve to produce an unbalanced pressure in said cylinder for moving said support, and for the stop position of said start-and-stop valve to produce a balanced pressure in said cylinder to stop said support, bleeder connections from said hydraulic cylinder including a bleeder valve shiftable between shut-off and bleeding positions, and means interconnecting the bleeder valve with said start-and-stop valve responsive to the shifting of said start-and-stop valve to the on position to shut off the bleeder valve and responsive to the shifting of said start-and-stop valve to the stop position to open said bleeder valve.

2. A hydraulic propulsion system for a machine tool support which comprises a hydraulic circuit including a hydraulic cylinder connected to move the support, means for supplying liquid at an operating pressure to said hydraulic circuit, an exhaust connection including a hydraulic resistance through which fluid is exhausted from said circuit against a base back pressure, a start-and-stop valve in said circuit shiftable between on and stop positions for controlling the flow of said liquid under pressure to start and stop said tool support, bleeder connections from said hydraulic cylinder including a bleeder valve shiftable between shut-off and open positions, an exhaust connection from said bleeder valve including a hydraulic resistance having a value below that of said base back pressure, and means interconnecting the bleeder valve with said start-and-stop valve responsive to the shifting of said start-and-stop valve to the on position to shut off the bleeder valve and responsive to the shifting of said start-and-stop valve to the stop position to open said bleeder valve.

3. A hydraulic propulsion system for a machine tool support which comprises a hydraulic circuit including a hydraulic cylinder connected to move the support, means for supplying liquid at an operating pressure to said hydraulic circuit, an exhaust connection including a hydraulic resistance through which fluid is exhausted from said circuit against a base back pressure, a start-and-stop valve in said circuit having a valve member shiftable between on and stop positions for directing the flow of said liquid under pressure through said circuit to start and to said exhaust connection to stop said tool support, bleeder connections from said hydraulic cylinder including a bleeder valve having a valve member shiftable between bleeding and shut-off positions, an exhaust connection from said bleeder valve including a hydraulic resistance having a value below that of said base back pressure, and means mechanically interconnecting the said bleeder valve member with said start-and-stop valve member for movement as a unit to open said bleeder valve when said start-and-stop valve is in the stop position, and to shut off said bleeder valve when the start-and-stop valve is in the on position.

4. In a hydraulic propulsion system for a machine tool support, the combination of a hydraulic circuit including a hydraulic propulsion cylinder connected with

said support, means for supplying a liquid medium at an operating pressure to said circuit, an exhaust connection from said circuit including a hydraulic resistance for maintaining a base back pressure in said circuit, bleeder connections from said hydraulic cylinder including a bleeder valve shiftable between shut-off and bleeding positions, a start-and-stop valve shiftable to channel liquid at said operating pressure through said circuit and alternatively to bypass said liquid pressure to said exhaust connection, and control means actuated by said channeled operating liquid pressure to close the bleeder valve and by the reduction of said pressure to said bypass level to open the bleeder valve.

5. In a hydraulic propulsion system for a machine tool support, the combination of a hydraulic circuit including a horizontally disposed hydraulic cylinder and piston connected to move said machine tool support, said cylinder having connected into the top surface thereof a plurality of bleeder outlets spaced along the length

of said cylinder, means for supplying a liquid medium at an operating pressure to said circuit, an exhaust connection including a hydraulic resistance through which fluid is exhausted from said circuit against a back pressure, a start-and-stop valve in said circuit shiftable between start-and-stop positions for controlling the flow of said liquid under pressure to start and stop said tool support, a bleeder valve connected between said bleeder outlets and exhaust, including a relief valve between said bleeder valve and exhaust operable at a pressure less than said back pressure, said bleeder valve being shiftable between bleeding and shut-off positions, and means interconnecting the bleeder valve with said start-and-stop valve responsive to the shifting of said start-and-stop valve to the on position to shut off the bleeder valve, and responsive to the shifting of said start-and-stop valve to the stop position to open said bleeder valve.

No references cited.