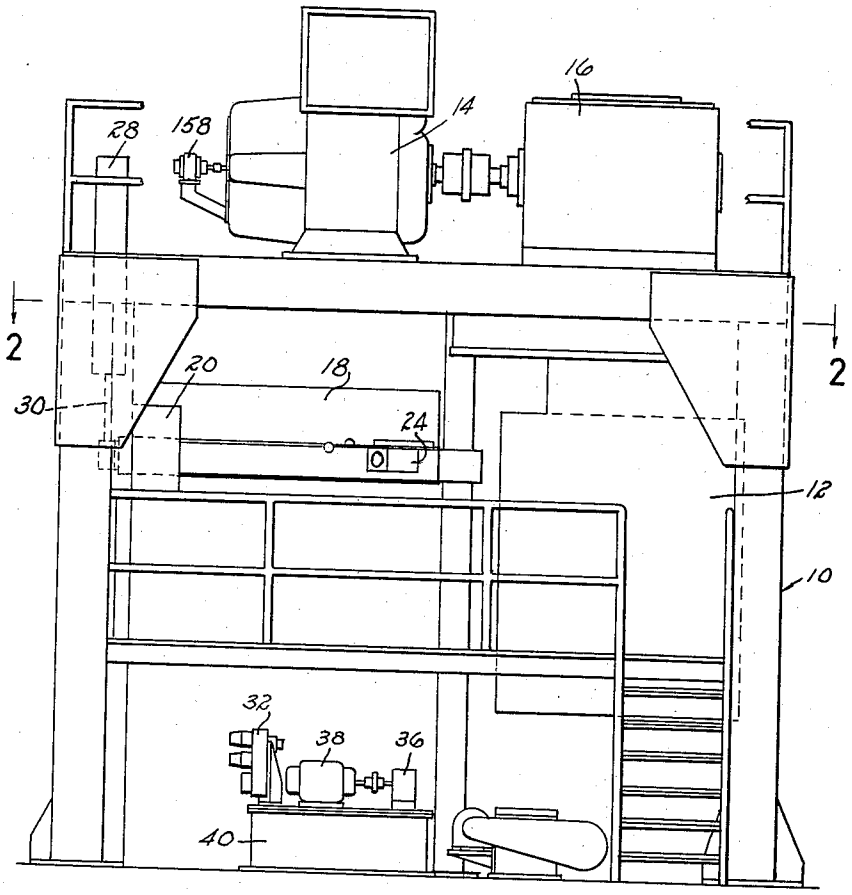
Jan. 19, 1960 J. I. McMARTIN 2,921,671

TUBE DRAWING MACHINE

Filed Aug. 15, 1957

3 Sheets-Sheet 1

FIG. 1



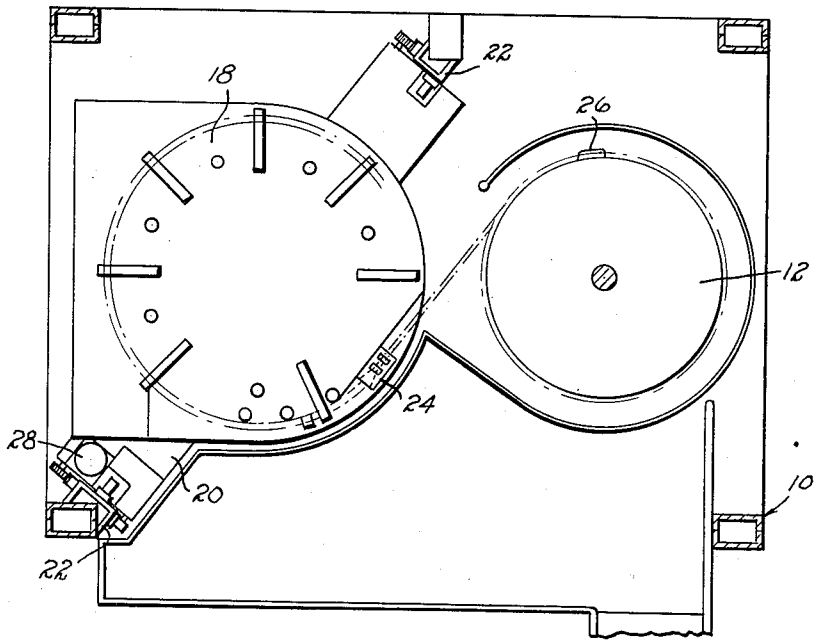
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FIG. 2



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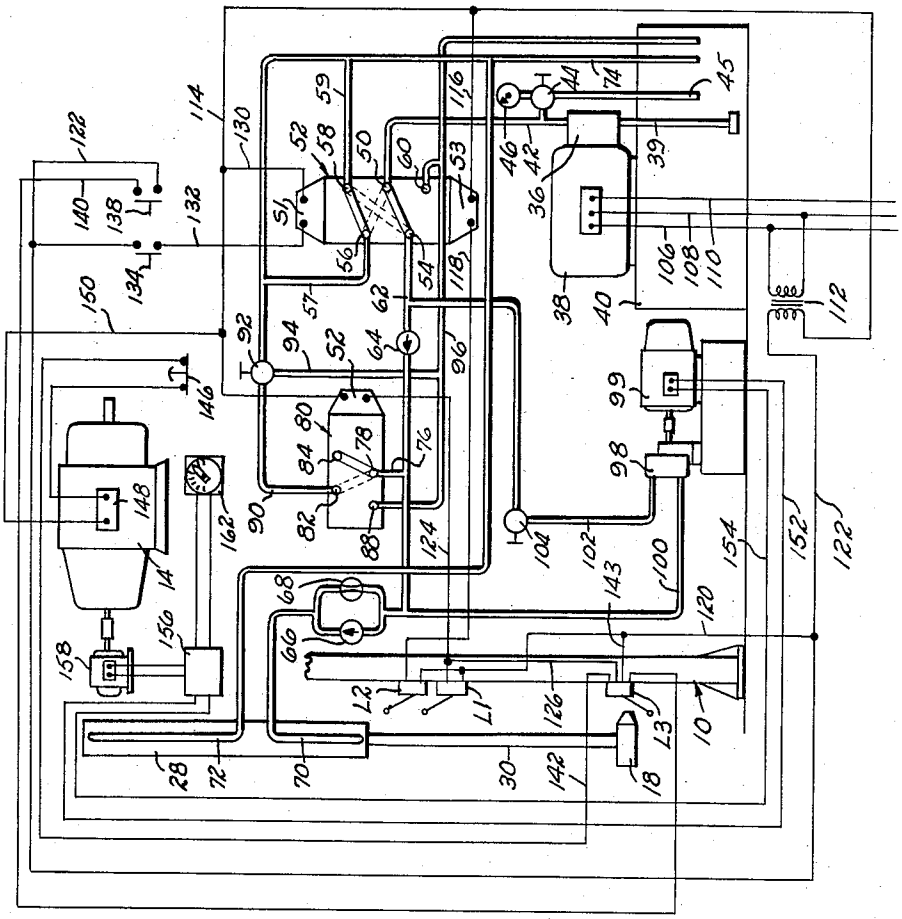


FIG. 3

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2,921,671

TUBE DRAWING MACHINE

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7 Claims. (Cl. 205—3)

This invention is concerned with tube drawing machines of the type comprising a table or swift, on which is supported the tubing to be drawn, and a rotatable cylinder, commonly referred to as a block, to which is engaged one end of the tubing carried by the swift, so that, as the block is rotated, the tubing will be drawn through dies, fixed relative to the swift, to reduce the tubing and wind it upon the block. It is usual in machines of this type to provide axial displacement or traverse of the swift relative to the block during the reducing operation in order to coil the tubing in a helix upon the block.

It is the object of this invention to provide a tube drawing machine of the type described having a novel and improved traverse control to regulate the rate of relative axial displacement of the block and swift during a drawing operation in direct relation to the speed of rotation of the block.

Other objects will be in part obvious, and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In the drawings:

Fig. 1 is a front elevational view of a tube drawing machine of a type with which this invention is concerned;

Fig. 2 is a fragmentary cross sectional view substantially along the line 2—2 of Fig. 1; and

Fig. 3 is a diagrammatic view of an electro-hydraulic traverse control, for the machine of Fig. 1, constructed in accordance with the invention.

With reference to the drawings, and particularly Figs. 1 and 2, a drawing machine of a type suitable for drawing wire, tubing and the like, with which this invention is concerned, comprises a frame 10 on which is rotatably supported a vertically disposed block 12. The block is driven by an electric motor 14 through suitable reduction gearing 16. A swift 18 is supported on a base 20 slidably mounted on the frame as at 22 for vertical movement of the swift relative to the block 12 in a direction parallel to the rotational axis of the block. Drawing dies 24 are carried by the swift and a clamping fixture 26 is mounted on the block 12 for engagement with one end of tubing carried by the swift to draw the tubing through the dies in response to rotation of the block.

A hydraulic cylinder 28 is supported in a vertical position on the frame 10. A piston rod 30 of a piston (not shown) in the cylinder 28 is connected to the swift base 20 for vertical movement therewith. Positive stops (not shown) are provided to limit vertical movement of the swift in either direction. As will be hereinafter explained in detail, means are provided to introduce hydraulic fluid beneath the piston in the cylinder 28 to raise the swift and subsequently to bleed the hydraulic fluid from beneath the piston in direct relation to the

speed of rotation of the block 12 in order that the swift will descend by reason of its own weight but in a controlled manner to provide the desired relative speed. The control of the flow of fluid to and from the cylinder 28 is accomplished by an electro-hydraulic control system, the major components of which are conveniently mounted on a control panel 32 at the base of the machine.

Turning now to Fig. 3, wherein is diagrammatically shown a control system constructed in accordance with the invention, the hydraulic portion of the system comprises a constant delivery hydraulic pump 36 driven by an electric motor 38. The intake of the pump 36 is connected by a conduit 39 to a tank 40 containing a supply of hydraulic fluid. The exhaust of the pump 36 is connected to a conduit 42 having a branch passage connected to a relief valve 44 and a pressure gage 46. The valve 44 is manually adjusted and is connected through a conduit 45 back to the tank 40.

The conduit 42 is connected to a port 50 of a four-way valve 52 having additional ports 54, 56 and 58 as well as a drain port 60. The valve 52 is shiftable in one direction by a solenoid S1 to form a fluid connection between the ports 50 and 54 and also between the ports 56 and 58, as shown in solid lines, in response to energizing of the solenoid . A solenoid S3 is operable to shift the valve in the opposite direction to connect the ports 54 and 58 and the ports 56 and 50, as shown in dotted lines. The ports 56 and 58 are connected by conduits 57 and 59 respectively to a conduit 74 leading to the supply tank 40. The port 54 is connected by a conduit 62, through a one-way valve 64, to a second one-way valve 66 and a metering orifice 68 disposed in parallel relation. The one-way valve 66 and metering orifice 68 are connected by a conduit 70 to the bottom of the cylinder 28. A conduit 72 is connected at one end to the top of the cylinder 28 above the piston therein and at the other end to the conduit 74 leading to the supply tank 40.

A branch passage 76 is connected from the conduit 62 to the port 78 of a valve 80 having additionally an outlet port 82, and a plugged port 84, as well as a drain port 88. The valve 80 is constructed so that upon movement in one direction, the ports 78 and 82 will be connected, as shown in dotted lines, and upon movement in the other direction, the ports 78 and 84 will be connected, as shown in solid lines. A solenoid S2 is operable to shift the valve in said one direction to connect the ports 78 and 82 and a return spring (not shown) is provided to shift the valve in said other direction to connect the ports 78 and 84. The port 82 is connected by means of a conduit 90 to a manually operable flow control valve 92 connected to the conduit 74 leading to the supply tank 40. A conduit 94 is connected at one end to the valve 92 for drainage. The conduit 94 is connected at its other end to a conduit 96 leading to the supply tank 40 and also connected to the drainage ports 60 and 88 of the valves 52 and 80, respectively.

In accordance with the invention, a pump 98, such as a gear pump, having a capacity directly proportional to the speed of operation thereof, is connected at its inlet through a conduit 100 to the conduit 62 on the down stream side of the one-way valve 64 so that on operation of the pump 98, fluid will be drawn from the bottom of the cylinder 28 through the metering orifice 68. The pump 98 is drivingly connected to a variable speed direct current motor 99 for operation thereof. The outlet of the pump 98 is connected by a conduit 102 through an adjustable relief valve 104 and to the conduit 62 on the up stream side of the one-way valve 64.

The motor 38 for the constant delivery hydraulic

pump 36 is connected to a source of power through lines 106, 108 and 110 and a suitable motor control (not shown). A transformer 112 has its primary connected to the lines 106 and 108. A line 114 leads from one side of the secondary of the transformer 112 to a line 116 which is connected to one side of the solenoid S3. The other side of the solenoid S3 is connected by a line 118 to one side of a single pole, single throw, normally open limit switch L2. The limit switch L2 is positioned relative to the swift for actuation thereby to close the switch as the swift reaches its upper limit of travel. The other side of the limit switch L2 is connected by a line 120 to one side of a single pole, single throw, normally open limit switch L1 and line 120 is also connected to a line 122 leading to the other side of the secondary of the transformer 112. The limit switch L1 is positioned relative to the swift for momentary actuation thereby to close the switch during upward movement only of the swift and preferably just prior to actuation of the limit switch L2. The other side of the limit switch L1 is connected by a line 124 to one side of the solenoid S2. The other side of the solenoid S2 is connected to line 114 leading to the transformer 112. The line 124 is connected by a line 126 and a line 140 through an associated pair of poles of a double pole, single throw, normally closed limit switch L3. The limit switch L3 is positioned relative to the swift for actuation thereby to open the switch as the swift moves into its lower limit of travel.

The solenoid S1 is connected at one side by a line 130 to the line 114. The other side of the solenoid S1 is connected by line 132 and a normally open switch 134 to line 122 which is also connected to one side of a normally open switch 138. The other side of the switch 138 is connected to line 140 leading to the limit switch L3. The remaining pair of poles of the limit switch L3 is connected between line 120 connected to the power line 122 and a line 142 leading to one side of a normally closed switch 146, the other side of which is connected to an emergency stop control 148 on the block motor 14. The other side of the stop control 148 is connected through line 150 to line 114 leading to the transformer 112. The control 148 is adapted to de-energize the motor 14 in response to disconnection of the control from the power line 122.

In accordance with the invention, the armature of the motor 99 for the pump 98 is connected by lines 152 and 154 to an electronic variable speed motor control 156 connected to a tachometer generator 158 for its source of power. The tachometer generator 158 is drivingly connected to the block motor 14. A potentiometer 162 connected to the variable speed motor control 156 permits adjustment by the operator of the ratio of the speed of the direct current motor 99 to the speed of the block motor 14 for any given speed of the block motor.

During the operation of the tube drawing machine incorporating a swift traverse control constructed in accordance with the invention, when it is desired to raise the swift from the down position, preparatory to a drawing operation, the motor 38 being energized, the switch 134 is closed to energize the solenoid S1 and connect the ports 50, 54, 56 and 58 of the valve 52 as shown in solid lines. Hydraulic fluid will thus flow from the tank 40 through the pump 36, conduit 42, ports 50 and 54 of the valve 52, conduit 62, and one-way valve 64 and through the one-way valve 66 and metering orifice 68 to conduit 70 connected to the bottom of the cylinder 28 beneath the piston therein. During raising of the swift, the fluid displaced from the top of the cylinder 28 will flow through conduit 72 to conduit 74 and into the tank 40. Upon sufficient raising of the swift, and as heretofore mentioned preferably just prior to the swift reaching its upper limit of travel, the limit switch L1 will be momentarily closed so as to energize the solenoid S2 to shift the valve 80 and connect the ports 78 and 82. Hydrulic fluid will thus be bled from the line 62, through

the line 76, valve 80 and line 90, and through the flow control valve 92 back into the tank 40. The rate at which fluid is bled from the line 62 is controlled by the setting of the adjustable flow control valve 92 and should be selected to be sufficient to substantially reduce the rate of upward movement of the swift in order to cushion its engagement with the upper limit stops.

As the swift reaches its upper limit of travel, the limit switch L2 will be closed to energize the solenoid S3 and shift the valve 52 to connect the ports 54 and 58 and ports 50 and 56 thereof, as shown in dotted lines. Fluid from pump 36 will, thus, now be directed through ports 50 and 56 to conduit 74 leading to tank 40. The one-way valve 64 will prevent back flow from the underside of the cylinder 28 through the conduit 62 to the port 54 of the valve 52. The relief valve 104 in conduit 102 is adjusted relative to the weight of the piston in the cylinder 28 and the components movable therewith to prevent fluid flow from the underside of the cylinder 28 through the conduit 102 unless the pump 98 is being driven by the motor 99. Thus, the swift is now maintained in its upper limit of travel.

The tubing carried by the swift may now be threaded through the dies and clamped on the block 12. By a suitable motor control (not shown) the block motor 14 is then energized, which, through the tachometer generator 158 and motor control 156, results in energizing of the armature of the motor 99 to effect operation of the constant displacement pump 98. The pump 98 will draw hydraulic fluid from the underside of the cylinder 28 through the passage 70, metering orifice 68, and passage 100 and exhaust fluid through line 102, relief valve 104, conduit 62, and ports 54 and 58 of the valve 52 to the tank 40. The size of the metering orifice 68 is preferably sufficiently large so as not to interfere with the normal control of the rate of descent of the swift as effected by the pump 98. It is, however, preferably sufficiently small so that if a failure occurs in the system, it will prevent the swift from falling freely.

During the descent of the piston under the control of the pump 98, it is, of course, desired that the ratio of the rate of descent of the piston relative to the rotative speed of the block be lower for a given block speed when relatively small diameter tubing is to be drawn, than when relatively large diameter tubing is to be drawn. The potentiometer 162 provides the machine operator with a means for initially adjusting the rate of traverse of the swift relative to block speed for any particular size tubing. When the swift reaches its lower limit of travel, limit switch L3 will be actuated to open the connection between lines 120 and 142 to actuate the block motor control 148 and de-energize the block motor. De-energizing of the block motor will, of course, result in the de-energizing of the armature of the pump motor 99 to halt operation of the pump 98.

If it is desired to lower the swift from the raised position independently of the pump 98, the normally open switch 138 is closed to connect the power line 122 to line 126 connected to line 124 leading to the solenoid S2 to actuate the solenoid and shift the valve 80 and connect the ports 78 and 82 thereof. The underside of the cylinder 28 will thus be connected to conduit 90 and through the metering valve 92 to the tank 40, whereupon, the swift will descend under the control of the valve 92.

A tube drawing machine of the type described and incorporating the electro-hydraulic control system described will provide coiling of the drawn tubing on the block in a tight helix regardless of the size of the tubing or the speed of block rotation. The use of a constant displacement hydraulic pump driven by a variable speed electric motor responsive to the speed of rotation of the block provides a very sensitive and accurate, yet easily adjusted traverse control. The electro-hydraulic control system of the invention will provide long and trouble-

free service with a minimum of maintenance, thus assuring the applicability of the machine to mass production operation.

I claim:

1. In a tube drawing machine, a frame, a block rotatably supported on the frame, a motor drivingly connected to said block, a swift supported on the frame for movement relative to the block in a direction parallel to the rotational axis of the block, a hydraulic cylinder supported on the frame, a piston in said cylinder connected to the swift for movement therewith, and means for controlling the rate of movement of the piston relative to the block comprising a hydraulic pump having a capacity directly related to the speed of operation thereof connected to said cylinder on one side of said piston, and electrical means responsive to the speed of rotation of the block drivingly connected to the pump.

2. In a tube drawing machine, a frame, a block rotatably supported on the frame, a motor on the frame drivingly connected to the block, a swift supported on the frame for movement relative to the block in a direction parallel to the block rotational axis, a hydraulic cylinder on the frame, a piston in said cylinder connected to said swift for movement therewith, and means for controlling the rate of movement of the piston comprising a hydraulic pump with a capacity directly related to the speed of operation thereof connected to said hydraulic cylinder on one side of said piston, a variable speed electric motor drivingly connected to the pump, and electrical control means for energizing the variable speed motor in response to the rate of rotation of the block.

3. In a tube drawing machine, a frame, a block supported on the frame for rotation, a motor on the frame drivingly connected to the block, a swift supported on the frame for movement relative to the block in a direction parallel to the block rotational axis, a hydraulic cylinder on the frame, a piston in said cylinder connected to said swift for movement therewith, and means for controlling the rate of movement of said piston comprising a hydraulic pump with a capacity directly related to the speed of operation thereof connected to said hydraulic cylinder at one side of said piston, a variable speed electric motor drivingly connected to the pump, a generator connected to the block motor for operation thereby, and electrical control means connected between said generator and variable speed motor to vary the speed of said variable speed motor in response to the output of said generator.

4. In a tube drawing machine, a frame, a block rotatably supported on the frame, a motor on the frame drivingly connected to the block, a swift supported on the frame for movement relative to the block, a hydraulic cylinder on the frame, a piston in said cylinder connected to said swift for movement therewith, and means for controlling the rate of movement of said piston comprising a constant displacement pump having a capacity directly related to the speed of operation thereof connected to said cylinder on one side of said piston, a variable speed electric motor drivingly connected to said pump, a generator connected to the block motor for operation thereby, and electrical control means connected between said generator and variable speed motor for varying the speed of the variable speed motor in response to output of the generator and including manually operable proportioning means for adjusting the ratio of the speed of the variable speed motor to the speed of the block motor.

5. In a tube drawing machine, a frame, a vertically disposed block rotatably supported on the frame, a motor drivingly connected to said block, a vertically disposed swift supported on the frame for vertical movement relative to the block, a vertically disposed hydraulic cylinder supported on the frame, a piston in said cylinder connected to the swift for vertical movement therewith, a pump having a capacity directly proportional to the speed of operation thereof, means connecting the inlet of said pump to said cylinder beneath said piston, a relief valve in series with the outlet of said pump, a variable speed electric motor drivingly connected to said pump, and electrical control means responsive to operation of the block motor connected to said electric motor to regulate the speed thereof in direct relation to the speed of rotation of the block.

6. In a tube drawing machine, a frame, a vertically disposed block rotatably supported on the frame, a motor drivingly connected to said block for rotation thereof, a vertically disposed swift supported on the frame for limited vertical movement relative to the block, a vertically disposed hydraulic cylinder supported on the frame, a piston in said cylinder connected to the swift for vertical movement therewith, a source of hydraulic fluid under pressure, means to connect said source of fluid to said cylinder beneath said piston to raise said swift including means to disconnect said source from said cylinder in response to movement of said swift into its upper limit of travel, a pump having a capacity directly proportional to the speed of operation thereof connected to said cylinder to draw fluid from beneath said piston, an adjustable relief valve in series with the outlet of said pump, and electrical means responsive to operation of the block motor to operate said pump at a speed directly related to the speed of rotation of said block.

7. In a tube drawing machine, a frame, a vertically disposed block rotatably supported on the frame, a motor drivingly connected to said block, a vertically disposed swift supported on the frame for limited vertical movement relative to the block, a vertically disposed hydraulic cylinder supported on the frame, a piston in said cylinder connected to the swift for vertical movement therewith, a one-way valve connected at its upstream side to said cylinder beneath said piston, a metering orifice connected in parallel with said one-way valve, a source of fluid under pressure, a valve connected between said source and the down-stream side of said one-way valve operable to connect and disconnect said one-way valve and source, means to operate said valve to connect said source and one-way valve to raise said swift, means to momentarily reduce the effective flow of fluid from said source and into said cylinder beneath said piston in response to upward movement of the swift into a predetermined position, means to operate said valve to disconnect said one-way valve and source in response to upward movement of said swift into a second predetermined position, a hydraulic pump having a capacity directly proportional to its speed of operation connected to said cylinder to draw fluid from beneath said piston, a relief valve in series with the outlet of said pump having a pressure setting corresponding to the weight of said piston and the elements vertically movable therewith, and electrical means responsive to operation of the block motor to drive said pump at a speed directly related to the speed of rotation of the block.

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