Aug. 26, 1941. J. ROBINSON ET AL 2,253,653

POWER TRANSMISSION

Filed March 10, 1938

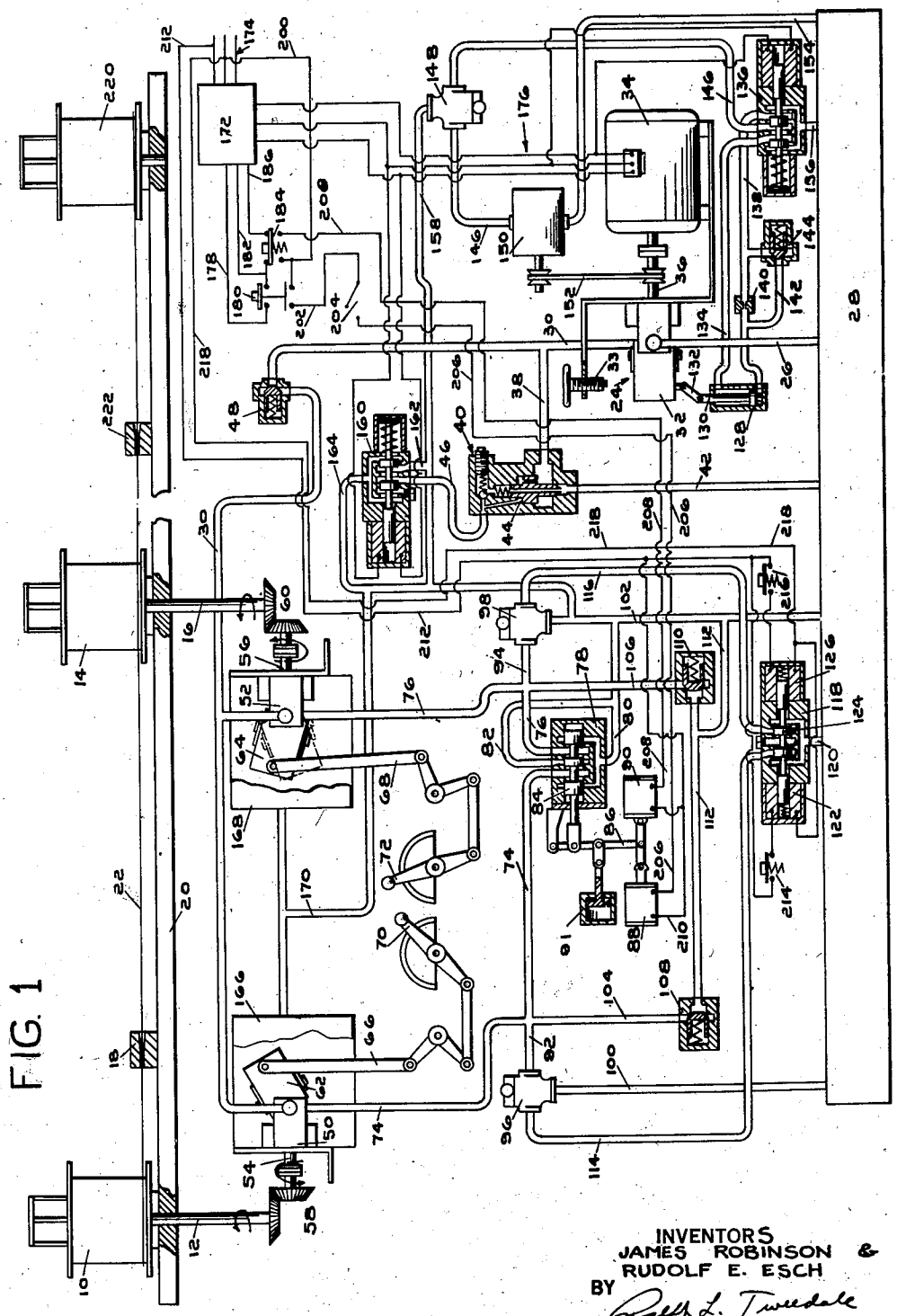


FIG. 1

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Patented Aug. 26, 1941 2,253,653

UNITED STATES PATENT OFFICE

2,253,653

POWER TRANSMISSION

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Application March 10, 1938, Serial No. 195,189

9 Claims. (Cl. 205—14)

This invention relates to power transmissions and more particularly to those of the fluid type wherein a power transmitting fluid, such as oil, and hereinafter referred to as such, is utilized for the transmission of power between one or more pumps and one or more fluid motors.

This invention is particularly concerned with a transmission adapted for driving a wire drawing apparatus with improved efficiency and facility. It has been found in the art of wire drawing that improved efficiency and decreased die wear can be achieved by maintaining a back-pull on the large diameter portion of the wire entering the die which back-pull is correctly correlated to the forward pull exerted on the reduced diameter wire leaving the die. In order to obtain the greatest advantage from this method of drawing, it is necessary to be able to regulate the back-pull precisely and it is also desirable that the back-pull be maintained at a predetermined fraction of the forward-pull. Since the forward-pull inherently fluctuates a certain amount, it is difficult to provide a proportional variation in the back-pull by the use of friction brake mechanism, etc. The use of a brake to create the back-pull on the wire is also disadvantageous in that the work done at the brake is completely dissipated.

It is an object of the present invention to provide a power transmission system particularly adapted for drawing wire in this manner and which avoids the difficulties experienced with previous apparatus.

A further object is to provide a power transmission of this character wherein the hold-back tension is always maintained at a predetermined fractional value of the pulling tension regardless of fluctuation in the pulling tension.

A further object is to provide a transmission for operating a wire drawing machine wherein the work done in maintaining the hold-back tension is not dissipated, but is utilized in driving the machine as a whole.

It is also an object of the invention to provide a transmission system for the purposes described, which is simple and automatic in its operation, which may be readily started with gradual pick-up in speed and which may be operated forwardly or backwardly with equal facility and which may be operated intermittently in small steps under complete manual control of the operator.

A further object is to provide a transmission system for this purpose which is readily adjustable to take care of different sizes of wire and different amounts of area reduction at the die.

It is also an object to provide a novel method and apparatus for drawing wire.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred form of the present invention is clearly shown.

In the drawing:

The single figure represents a diagrammatic view of a wire drawing apparatus and its associated power transmission system incorporating a preferred form of the present invention.

The drawing apparatus may comprise a pulling reel 10 having a drive shaft 12 and a holdback reel 14 having a drive shaft 16. Intermediate the two reels a suitable drawing die 18 is mounted on the bed 20 of the machine and the wire to be drawn, indicated at 22, is threaded around the reel 14 through the die 18 and around the reel 10 whereby the wire 22 may be drawn through the die 18.

For the purpose of driving the shafts 12 and 16 in the required manner, a hydraulic power transmission system is provided, comprising a variable displacement pump 24 having a suction conduit 26 communicating with an oil tank 28. The pump 24 delivers oil to a delivery conduit 30 at a rate depending upon the setting of a pivoted yoke 32, movable between the position shown and the position determined by the adjustable stop 33 as is well known in the art. A suitable prime mover, such as an electric motor 34, is connected to the drive shaft 36 of the pump 24 to operate the same at a constant speed. Communicating with the discharge conduit 30, by means of a by-pass conduit 38, is a pilot operated relief valve 40 adapted to discharge oil to the tank through a conduit 42 whenever a predetermined pressure exists in the conduit 30 or whenever the control chamber 44 of the valve 40 is connected to tank through the venting conduit 46. The valve 40 may be similar in construction to that disclosed in the patent to Harry F. Vickers, #2,043,453. The conduit 30 extends through a check valve 48 to the pressure connections of a pair of variable displacement fluid motor units 50 and 52, the drive shafts 54 and 56 of which are connected by beveled gearing 58 and 60 to the shafts 12 and 16.

The motors 50 and 52 have adjustable yokes 62 and 64 for varying the displaceemnt of the units independently. Suitable linkage systems 66 and 68 are connected with control levers 70 and 72 for manually adjusting the displacement of the motor units 50 and 52. The tank connections of the motor units connect by conduits 74 and 76 with the cylinder ports of a solenoid operated, closed center, four-way valve 78. The pressure and tank ports of the valve 78 connect to the tank 28 by conduits 80 and 82. The spool 84 of the valve 78 is connected by a lever 86 to a pair of solenoids 88 and 90. The solenoid 88 when energized shifts the lever 86 to the left, opening both conduits 74 and 76 to communication with the tank. When the solenoid 90 is en-

ergized the lever 86 is shifted back to the position shown in the drawing, wherein all ports in the valve 78 are blocked. A dashpot 91 may be provided for retarding movements of the valve spool 84.

Branch conduits 92 and 94 connect the conduits 74 and 76 with relief valves 96 and 98 adapted to discharge oil to the tank through conduits 100 and 102 whenever a predetermined pressure is exceeded in the conduits 92 and 94. Branch conduits 104 and 106 also communicate with the conduits 74 and 76 and connect through the check valves 108 and 110 with a conduit 112 leading to the tank conduit 102. The check valves 108 and 110 open to free flow of oil from the tank into the conduit 104 and the conduit 106 respectively.

In open communication with the branch conduits 92 and 94, through the pressure chambers of the relief valves 96 and 98 are a pair of conduits 114 and 116 leading to the cylinder ports of a closed center, spring centered, solenoid operated, four-way valve 118. The pressure port of the valve 118 is plugged while the tank ports thereof connect to the tank 28 by a conduit 120. A solenoid 122 is adapted to shift the spool 124 of the valve 118 to the left when energized and thus connect the conduit 116 to the conduit 120 leaving the conduit 114 blocked by its communication with the blocked pressure port. A solenoid 126 is adapted, when energized, to shift the spool 124 to the right making the opposite connections.

For the purpose of controlling the position of the yoke 32 of the pump 24, a control cylinder 128 has a piston 130 connected by a link 132 to the yoke 32. The upper end of the cylinder 128 communicates by a conduit 134 with the left hand cylinder port of a solenoid operated, spring offset, closed center, four-way valve 136. The lower end of the cylinder 128 communicates by a conduit 138 with the right hand cylinder port of the valve 136. Interposed in the conduit 138 is a restriction 140 around which a by-pass 142, controlled by a check valve 144, permits free flow of oil out of the lower end of the cylinder 128. The pressure port of the valve 136 connects by a conduit 146 through a relief valve 148 to the delivery port of a small fixed displacement pump 150 driven from the motor 34 by a belt 152. The suction port of the pump 150 and the tank port of the valve 136 are connected to tank by conduits 154 and 156. The relief valve 148 is adapted to discharge oil to the tank through a conduit 158 whenever a predetermined pressure is exceeded in the conduit 146.

The vent conduit 46 of the valve 40 is under the control of a spring offset, solenoid operated, closed center, four-way valve 160 to the pressure port of which the conduit 46 connects. One cylinder port of the valve 160 is plugged while the other connects to the tank conduit 158 by a branch 162. The tank port of the valve 160 connects to tank conduit 102 by a branch 164. The fluid motor units 50 and 52 may be enclosed in suitable casings 166 and 168 which are connected to the branch conduit 164 by a conduit 170.

For the purpose of controlling the various solenoid operated valves, an electric circuit is provided as follows:

A suitable magnetic starting contactor 172 connects to a three-phase alternating current supply line 174 and controls the supply of current to the motor 34 through the load line 176. A conductor 178 leads to starting switch 180 adapted, when depressed, to connect the conductor 178 with a conductor 182, leading to the contactor 172 and forming the starting circuit therefor in the well known manner. The customary stopping circuit includes the conductor 182 and a normally closed stop switch 184, which connects by a conductor 186 with the contactor 172. The starting and stopping switches 180 and 184 each have auxiliary contacts adapted to be closed when their respective push buttons are depressed, the auxiliary circuits for both switches being connected to one leg of the supply line 174 by a conductor 200. The auxiliary circuit for the switch 180 connects by a conductor 202 and manual switch 204 with a conductor 206 leading to the solenoid 88. The auxiliary circuit for the switch 184 connects by a conductor 208 with the solenoid 90. The opposite sides of the solenoids 88 and 90 are connected by a conductor 210 with a conductor 212 leading to another leg of the supply line 174. The conductor 212 extends to a pair of normally opened inching switches 214 and 216, the opposite sides of which connect to the solenoids 122 and 126 respectively. The other sides of the solenoids connect by a conductor 218 with the supply line 174 at the conductor 200. The solenoids of the valves 136 and 160 are connected directly across two legs of the load line 176 for energization concurrently with energization of the motor 34.

In operation, with the wire 22 wrapped around the reels 10 and 14 and threaded through the die 18, and with the yokes 62 and 64 adjusted to positions, as illustrated, with the yoke 64 at a smaller displacement than the yoke 62, the motor 34 may be started by depressing starting switch 180. Previous to this the solenoid valve 136 was deenergized and lies in the position shown, and the yoke 32 was moved to neutral position, illustrated, by the piston 130. Closure of the starting circuit 178—182 causes the contactor 172 to energize the load lines 176 starting the motor 34 and energizing the solenoid valves 136 and 160. At the same time the second circuit of the starting switch 180 closes a circuit to the solenoid 88 extending from the supply line 174 through conductor 200, switch 180, conductor 202, switch 204, which should be closed for normal operation, conductor 206, solenoid 88 and conductors 210 and 212 to the line 174. The valve spool 84 is accordingly shifted to the left connecting conduit 74 to conduit 80 and connecting conduit 76 to conduit 82. As the motor starts the pumps 24 and 150 are caused to operate and the solenoid valves 136 and 160 shift to the right and left respectively. Shifting of the former causes fluid delivered from the pump 150 through conduit 146 to be directed to the conduit 138 and through restrictor 140 to the bottom end of cylinder 128. The yoke 32 is thus moved upwardly by the piston 130 at a speed determined by the restriction 140. Shifting of the valve 160 closes the vent line 46 thus permitting relief valve 40 to close and causing pressure oil, delivered by the pump 24, to continue on through the conduit 30, and check valve 48 to the motors 50 and 52. The rate of delivery of oil by the pump 24 increases gradually as the yoke 32 moves upwardly until it abuts the adjustable stop 33.

It will be noted that the motors 50 and 52, when their yokes are adjusted, as shown in the drawing, are connected for operation in opposite directions, that is, if the wire 22 were not connecting the reels 10 and 14, the shafts 12 and 54 would rotate in the directions shown by the arrows while the shafts 16 and 56 would rotate

in the opposite direction to that of the arrows shown on the drawing. Since the wire 22 connects the two reels together for substantially synchronous operation and since the yoke 64 is adjusted to a lesser angle than the yoke 62 the backward torque available at the shaft 56 with a given pressure in the conduit 30, is less than the forward torque available at the shaft 54. Accordingly, the motor 50 is able to drive the reel 10 forwardly, pulling the wire 22 through the die and also pulling the reel 14 forwardly, overcoming the backward torque of the motor 52 and driving the same so that it operates as a pump delivering oil into the pressure line 30 against the pressure head existing therein. The motor 52 withdraws oil for this purpose from the tank through conduit 102, conduit 82, valve 78 and conduit 76. Oil delivered by both pump 24 and motor 52 into the pressure line 30 passes through the motor 50 and discharges through conduit 74, valve 78 and conduits 80 and 102 to the tank.

There is thus produced a hold-back tension on the wire 22 between the die 18 and the reel 14. The relative values of the tension in the wire on either side of the die 18 depends upon the relative settings of the yokes 62 and 64, and may be freely varied as desired and as determined by experience under various drawing conditions. If the angle of the yoke 64 be increased relative to that of 62, the hold-back tension will be increased relative to the pulling tension. With any given setting of the yokes 62 and 64, however, it will be noted that a constant ratio is maintained between the tension in the wire entering the die and that in the wire leaving the die. This ratio is maintained even though the resistance at the die 18 varies from moment to moment as may occur due to variations in lubrication at the die or due to variations in the characteristics of the metal along the length of a given piece of wire.

When it is desired to stop the machine the stop switch 184 may be depressed, opening the stopping circuit 182—186 and causing the contactor 172 to deenergize the load line 176. The solenoid valves 136 and 160 shift to the left and right under their spring bias and the motor 34 coasts to a stop. Sufficient oil will be delivered by the pump 150 before the motor 34 comes to a stop to move the yoke 32 to neutral position by delivering oil to the conduit 146, valve 136 and conduit 134 to the upper end of cylinder 128. Oil returning from the lower end of cylinder 128 passes freely through the conduits 138 and 142, check valve 144, and valve 136 to the tank conduit 156. Shifting of the valve 160 again vents the relief valve 40, relieving pressure in the conduit 30.

The depression of the stop switch 184 also energizes the solenoid 90 through conductor 200, switch 184, conductor 208, solenoid 90 and conductors 210 and 212 to the line 174. The valve spool 84 is accordingly returned to the position shown in the drawing blocking the tank lines 74 and 76 for the motors 50 and 52. The inertia of the reel 10 tends to drive the motor 50 as a pump, delivering oil to the conduit 74. This conduit is blocked from the tank, however, at the valve 84. Conduit 104 is blocked at the check valve 108 so that the only path for oil to discharge from the conduit 74 is through the relief valve 96 and conduit 100. This creates a strong braking effect causing the machine to slow down and come to a stop in a reasonably short period. The inertia of the reel 14 tends to drive the motor 52 in the same direction in which it has been previously driven and thus causes it to continue to act as a pump, delivering oil into the conduit 30. This oil passes to the motor 50 through the conduit 30 and is prevented from by-passing to tank through conduit 38 and relief valve 40 by the check valve 48. The motor 52 may withdraw oil from the tank under these conditions through conduit 112, check valve 110 and conduits 106 and 76.

The machine may be operated to draw wire in the opposite direction by using an oppositely facing die 18 and by adjusting the yoke 64 to a greater angle than the yoke 62. Under these conditions the functions and operation of the motors 50 and 52 are reversed. During stopping the action is similar except that relief valve 98 acts as a brake for the motor 52 while check valve 108 supplies oil to the motor 50.

If it is desired to operate the machine in small increments for "inching," the switch 204 may be opened and the starting switch 180 depressed to start the motor as before, except that the valve spool 84 remains in its blocking position. Under these conditions the motors 50 and 52 remain stationary and the oil delivered by the pump 24 passes through the relief valve 40 to the tank, pressure being maintained in the conduit 30, however. Thereafter by depressing the switch 214, the solenoid 122, may be energized to shift spool 122 to the left, opening communication between conduits 114 and 120. The motor 50 is thus permitted to discharge oil to the tank through conduits 74, 92 and 114 and the reel operates in the normal manner so long as the switch 14 is closed. If the yokes 62 and 64 are adjusted for operation in the reverse direction the switch 214 is operated for "inching" movement to produce the safe effect by exercising control on the discharge line 116 from the motor 52.

The transmission system of the present invention may also be utilized for drawing machines where there are more than two reels in series, and where it is desired to operate one or more intermediate reels, the reel 14 for example, as a hold-back reel for the wire leaving the reel and as a pulling reel for the wire approaching the reel. An example of such an arrangement is illustrated by the additional reel 220 which feeds wire to the die 222 ahead of the reel 14. The reel 220 may be either freely rotatable or may be provided with suitable brake mechanism such as a friction brake or a hold-back motor similar to the motor 52 and connected in parallel therewith. All that is necessary to operate the apparatus in this manner is to shift the yoke 64 downwardly to the dotted line position thus causing the motor 52 to operate as a motor for driving the reel 14 forwardly in the direction of the arrows. Since the motor 52 is adjusted to a smaller displacement than the motor 50 the former will produce less torque, the additional torque being made up by the tension exerted in the wire 22 between die 18 and reel 14 which tension is created by the excess torque at the reel 10.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A drive system for a wire drawing machine

of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels comprising in combination with a source of power, fluid pressure energy translating devices connected to operate each reel, and a circuit connecting said translating devices in parallel with the source of power, whereby the drawing reel will be driven by its translating device and the hold-back reel will be driven from the drawing reel through the medium of the wire being drawn, the translating device at the hold-back reel serving to cause a predetermined back-pull on the wire entering the die.

2. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels comprising in combination with a source of power, a fluid pressure energy translating device connected to operate the drawing reel, a circuit connecting the translating device with the source, and means for causing a predetermined back-pull on the wire entering the die comprising a second fluid pressure energy translating device mechanically connected to the hold-back reel and connected into said circuit in a manner to return the energy of the hold-back reel to the circuit.

3. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels and a drawing die beyond the hold-back reel comprising in combination with a source of power, fluid pressure energy translating devices connected to operate each reel, and a circuit connecting said translating devices in parallel with the source of power, whereby the drawing reel will be driven by its translating device and the hold-back reel will be driven from the drawing reel through the medium of the wire being drawn, the translating device at the hold-back reel serving to apply a portion of the required torque to the hold-back reel whereby a predetermined back-pull from the second mentioned die is transmitted to the wire entering the first mentioned die.

4. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels comprising in combination with a pump, fluid pressure energy translating devices connected to operate each reel, and a circuit connecting said translating devices in parallel with the pump, whereby the drawing reel will be driven by its translating device and the hold-back reel will be driven from the drawing reel through the medium of the wire being drawn, the translating device at the hold-back reel serving to cause a predetermined back-pull on the wire entering the die and means controlling the rate of fluid delivery to the translating devices.

5. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels comprising in combination with a pump, fluid pressure energy translating devices connected to operate each reel, and a circuit connecting said translating devices in parallel with the pump, whereby the drawing reel will be driven by its translating device and the hold-back reel will be driven from the drawing reel through the medium of the wire being drawn, the translating device at the hold-back reel serving to cause a predetermined back-pull on the wire entering the die, and means controlling the rate of fluid delivery to the translating devices, said means including a movable member and means for moving said member at a predetermined slow rate to start the machine with a gradual acceleration.

6. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels comprising in combination with a source of power, fluid pressure energy translating devices connected to operate each reel, one of said devices being of the variable displacement type, and a circuit connecting said translating devices in parallel with the source of power, whereby the drawing reel will be driven by its translating device and the hold-back reel will be driven from the drawing reel through the medium of the wire being drawn, the translating device at the hold-back reel serving to cause a predetermined back-pull on the wire entering the die and means for adjusting the displacement of said one device.

7. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels comprising in combination with a source of power, a fluid pressure energy translating device connected to operate the drawing reel, a circuit connecting the translating device with the source, and means for causing a predetermined back-pull on the wire entering the die comprising a second fluid pressure energy translating device of the variable displacement type and mechanically connected to the hold-back reel and connected into said circuit in a manner to return the energy of the hold-back reel to the circuit.

8. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels and a drawing die beyond the hold-back reel comprising in combination with a source of power, fluid pressure energy translating devices connected to operate each reel, and a circuit connecting said translating devices in parallel with the source of power, whereby the drawing reel will be driven by its translating device and the hold-back reel will be driven from the drawing reel through the medium of the wire being drawn, the translating device at the hold-back reel serving to apply a portion of the required driving torque to the hold-back reel whereby a predetermined back-pull from the second mentioned die is transmitted to the wire entering the first mentioned die and means for varying the displacement of one of said translating devices.

9. A drive system for a wire drawing machine of the type having a drawing reel and a hold-back reel and a drawing die intermediate the reels comprising in combination with a source of power, translating devices connected to operate each reel and a circuit connecting said translating devices in parallel with the source of power, whereby the drawing reel will be driven by its translating device and the hold-back reel will be driven from the drawing reel through the medium of the wire being drawn, the translating device at the hold-back reel serving to cause a predetermined back-pull on the wire entering the die and means preventing the hold-back reel from overrunning the drawing reel due to inertia when the drawing reel drive is discontinued.

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