

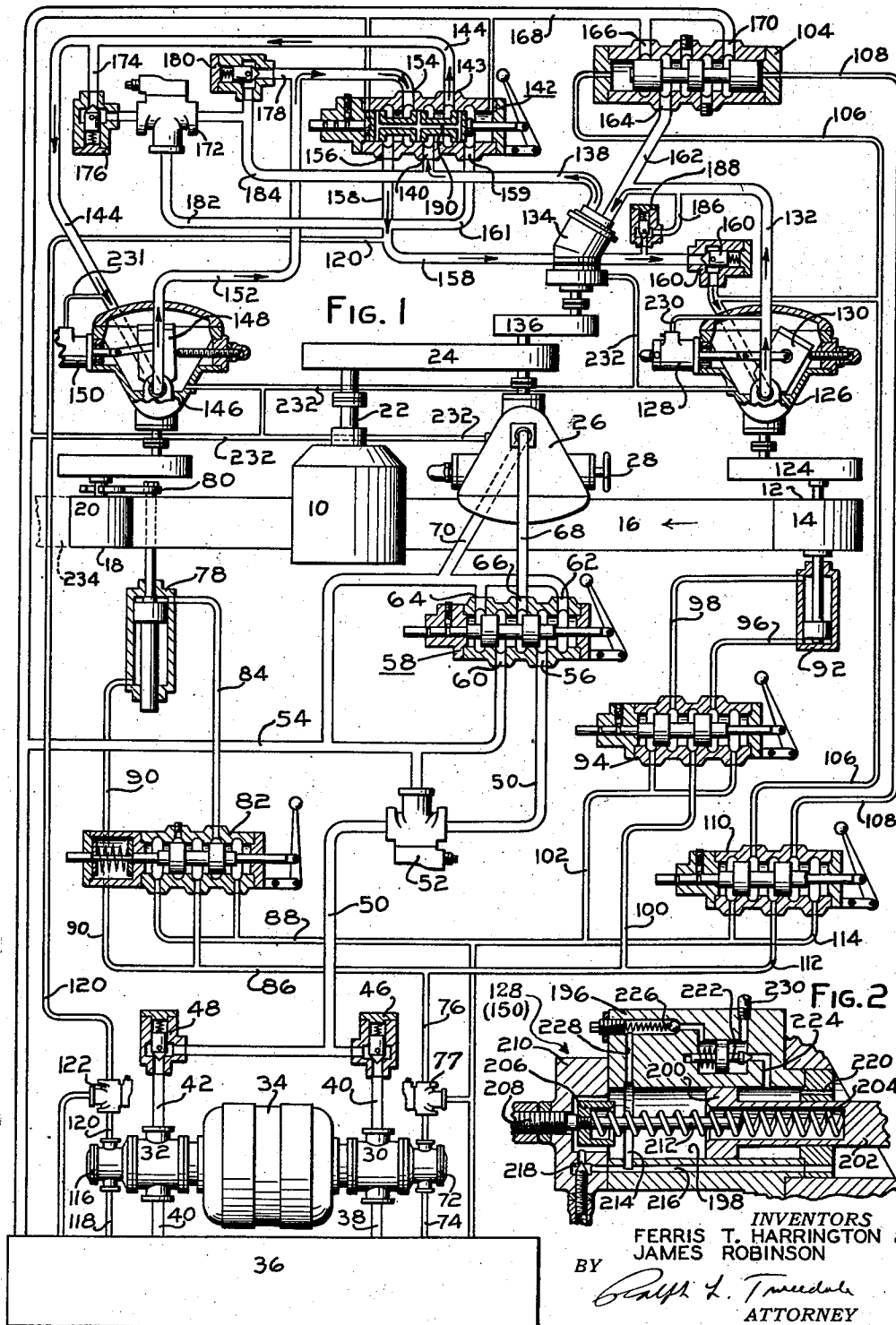
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POWER TRANSMISSION

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POWER TRANSMISSION

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This invention relates to power transmissions, particularly to those of the type comprising two or more fluid pressure energy translating devices one of which may function as a pump and another as a fluid motor.

The invention is more particularly concerned with a hydraulic power transmission system adapted for use with a strip material handling device of the type where strip material is reeled or unreled for operation thereon, although many advantages may be derived from use of this system with other machines wherein a load of inversely varying torque and speed is involved. Where strip material is wound in a coil, one layer on top of another, the problem of driving the reel so as to maintain constant linear speed or constant tension in the strip as it is wound or unwound from the reel presents certain difficulties due to the necessity of varying both the torque on the reel shaft and the speed of the reel shaft as the diameter of the reel changes.

In the handling of strip material as, for example, sheet metal, paper, cloth, and similar materials, it is frequently desirable to feed the strip into a treating machine of one sort or another from a supply reel and to again rewind the same strip into a coil by a take-up reel located at the output side of the treating machine. In such machines as heretofore constructed the apparatus provided for driving the take-up reel and the supply reel have been constructed as separate drives entirely independent of one another. In any drive of this character the take-up reel requires positive work to be performed on it while the supply reel performs work as the strip material is unwound from the coil. If the tension in the strip as it leaves the supply reel and as it approaches the take-up reel is the same and if the reel core diameters are the same, it will be seen that the power required to drive the take-up reel is substantially the same as the amount of power generated by the supply reel neglecting losses.

It is an object of the present invention to provide an improved hydraulic power transmission system wherein the drive at the take-up reel is so connected with the power absorbing means at the supply reel as to transfer this energy efficiently from one reel to the other with provisions for supplying any additional energy required to make up losses.

A further object is to provide a power transmission of this character wherein the reels may be operated at different values of tension in the strip while still transferring whatever power is

available at the supply reel to operate the take-up reel.

It is also an object of the present invention to provide an improved means for absorbing power generated at the supply reel independently of whether the strip material to be treated is later rewound on a reel or is utilized in the flat condition.

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:

Figure 1 is a diagrammatic view of a hydraulic power transmission system incorporating a preferred form of the present invention.

Figure 2 is a fragmentary sectional view of part of the mechanism shown in Figure 1.

A sectional machine for operating on continuous strip material is there illustrated, and, by way of example, comprises a roller leveler 10 which constitutes a driving section. The details of the roller leveler form no part of the present invention, it being understood that many other mechanisms for operating on strip stock and at the same time moving it longitudinally from right to left could equally well form the driving section of the machine.

A supply reel is indicated at 12 comprising a coil of strip 14 which, as disclosed, is partly unwound so that a flat section of strip 16 extends through the driving section 10 to a take-up reel 18 where the strip is again reeled into a coil 20. The roller leveler 10 has a drive shaft 22 which is driven by means of a gear box 24 from a fluid motor 26. The latter may be of the variable displacement type provided with a manual control wheel 28 for adjusting the displacement to control the speed of the leveler 10.

For the purpose of supplying fluid to operate the motor 26 there is provided a double set of pumps 30 and 32 driven by an electric motor 34 and withdrawing oil from a tank 36 through suction conduits 38 and 40 and delivering the same through delivery conduits 40 and 42. The latter include check valves 46 and 48 through which fluid is delivered to a single supply conduit 50 having the customary relief valve 52 therein for bypassing oil to the tank through a conduit 54 whenever the pressure in delivery line 50 exceeds a predetermined value.

The supply conduit 50 extends to a port 56 of a manually-controlled stop-go valve 58, the ports 60, 62 and 64 of which are connected to the tank

conduit 54. A fifth port 66 is connected by a conduit 68 with the inlet port of motor 26 while the outlet port thereof is connected to the tank conduit 54 by a conduit 70.

When the valve 58 has its spool shifted to the left-hand position, as illustrated, the port 66 is connected to port 62 so that the entire pump delivery is bypassed to the tank freely, and the motor 34 is thus unloaded. Likewise, both sides of motor 26 are bypassed through ports 60 and 66. When the valve spool is shifted to the right the connections just described are closed, and port 66 is connected to port 66, thus delivering the pressure fluid to the inlet of motor 26 through ports 66 and 66, the exhaust fluid returning from the outlet side of the motor through the conduits 70 and 54 to tank.

It will be seen that the portion of the circuit thus far described constitutes a variable speed hydraulic transmission for operating the driving section 10, this circuit per se forming no part of the present invention.

The motor 34 also drives an auxiliary pump 72 having a suction conduit 74 and a delivery conduit 76 provided with the customary relief valve 77. The pump 72 supplies fluid for certain auxiliary apparatus which includes a stripper cylinder 78 for operating stripper arms 80 for the take-up reel. Cylinder 78 is of the differential piston type and is controlled by a manually-operated, spring-centered, three-way valve 82 which is connected with the upper end of cylinder 78 by a conduit 84. The valve is connected with supply line 76 by a conduit 86 and with the tank 36 by a conduit 88. The lower end of cylinder 78 is also connected with the supply conduit 86 by a branch conduit 90.

The pump 72 also supplies fluid for operating a mandrel expanding cylinder 92 associated with the supply reel 12 and controlled by manually-operable, spring-centered, four-way valve 94. The latter is connected with opposite ends of cylinder 92 by conduits 96 and 98 and with the supply line 76 by a conduit 100 and with the tank 36 by a conduit 102.

The pump 72 also supplies fluid for the pilot shifting of a by-pass valve 104 located in the reel coupling circuit later to be described. For this purpose the opposite end chambers of valve 104 are connected by conduits 106 and 108 with a manually-operated four-way valve 110 which is connected with supply line 76 by a conduit 112 and with tank 36 by a conduit 114.

A second auxiliary pump 116 has a suction conduit 118 and a delivery conduit 120 provided with the usual relief valve 122. The delivery conduit 120 extends directly to the reel coupling circuit, later to be described, for the purpose of replenishing the low pressure side thereof and maintaining pressure therein at a constant value somewhat above atmospheric as determined by the setting of the relief valve 122. Pump 116 also serves to fill the coupling circuit with fluid when the system is being initially charged.

Coming now to the reel coupling circuit, supply reel 12 is connected through a gear box 124 with a variable displacement pump 126 of the pressure regulated type. The latter has a pressure regulator 128, the details of which are disclosed in Figure 2, for the purpose of controlling the position of the swinging yoke 130 by which the displacement of pump 126 is varied. The regulator is arranged to reduce the stroke as the pressure in the delivery conduit 132 of the pump 126 tends

to increase and to thereby maintain such pressure at a substantially constant value.

The conduit 132 extends to the inlet of a fluid pressure energy translating device 134 which is connected by a gear box 136 with the motor 26 and driving section 10. The device 134 is adapted to operate either as a pump or motor depending upon conditions within the circuit and is of the fixed displacement type.

From the outlet of unit 134 a conduit 138 extends to a port 140 of a three-position, manually-controlled, open-center, four-way valve 142. In the position of the valve shown, port 140 is connected with a port 143 thereof from which a conduit 144 extends to the inlet of a pressure-regulated, variable displacement fluid motor 146. The latter may be similar to the pump 126 except that the swinging yoke 148 thereof is connected to the pressure regulator 150 in such a way that the displacement of the motor 146 is increased whenever the pressure in the supply conduit 144 tends to increase. The outlet port of motor 146 connects by a conduit 152 with a port 154 of valve 142 which, in the position of the parts shown, communicates with a port 156 connected by a conduit 158 with the inlet of pump 126. Conduit 158 has a check valve 160 therein for preventing flow from the pump 126 to the valve 142.

The valve 142 is of the three-land spool, open-center type, each of the lands being provided with diametral cross bores connected together by a central longitudinal bore 160. The right-hand port 159 of the valve 142 connects with the left-hand port 156 by a conduit 161.

The circuit thus far described constitutes the main portion of the circuit through which fluid normally flows during operation of the device. This normal flow path is indicated by the arrows applied thereto. This main circuit is provided with certain auxiliary branches which are effective under special conditions. Among them is a branch 162 leading to a port 164 of the valve 104. In the position of the valve spool illustrated, this port is blocked. If the valve spool be shifted to the left, however, port 164 is connected to a port 166 connected by a conduit 168 with the tank 36. A second port 170 is also connected with conduit 168 for the purpose of draining any seepage past the spool of valve 104 either from port 164 or from the righthand pilot end chamber.

The valve 104 functions as a control to bypass the output of the pump 126 whenever it is desired to stop and turn the reel 12 manually. This valve is disclosed as a conventional pilot-operated, four-way valve for the reason that valves of this character are widely used and low in price as compared to a special valve having only the ports necessary for use in this function. In other words, it is frequently found more economical to utilize a standard four-way valve and plug certain of the ports, thus converting it to a three-way or two-way valve. This expedient is also found in the valve 82.

Since the fluid motor 146 is not self-protected against overload pressures, as is the case with the pump 26, it is desirable to provide overload relief protection by means of a relief valve 172. The pressure side of this valve is connected to the inlet conduit 144 by a branch 174 having a check valve 176 therein and to the outlet conduit 152 by a branch 178 having a check valve 180 therein. The discharge side of the relief valve 172 connects to the conduit 158 by a conduit 182. A conduit 184 extends between branch conduit

178 and conduit 138 and thus provides pressure relief protection to the output side of unit 134 whenever valve 142 is in the center position. For the purpose of initially filling the system with oil, a conduit 186 having a check valve 188 connects between conduit 158 and conduit 132.

Referring now to Figure 2, there is illustrated a pressure regulator particularly adapted for use with the present invention although it will be understood that other types of pressure regulators may be used at 128 and 150. The regulator disclosed comprises a block 196 having a cylinder bore 198 formed therein in which is slidable a piston 200. The latter has a stem 202 to which is connected the swinging yoke of the pump or motor unit to which the regulator is attached. The piston 200 is biased to the right by a relatively light spring 204 the tension of which, however, does not determine the pressure to which the device regulates. A limit stop 206 is adjustably mounted by means of a threaded stem 208 in an end cap 210 which closes the lefthand end of cylinder bore 198. A spring guide pin 212 is also carried by the stem 208. The limit stop 206 serves to determine the minimum displacement position in the regulator 128 and the maximum displacement position in the regulator 150. A circumferential groove 214 is formed near the lefthand end of cylinder bore 198 to intersect a passage 216 communicating with the interior of the casing of the pump or motor unit. This groove is blocked off by the piston 200 as the latter approaches the lefthand end of its stroke so that thereafter communication between the pump casing and the lefthand end of cylinder bore 198 is through needle valve 218, thus cushioning the movement of piston 200 at the lefthand end of its stroke.

The righthand end of cylinder bore 198 is in restricted communication with the interior of the pump casing through a passage 220. It is also in communication with the discharge port of a relief valve 222 through a passage 224. The relief valve 222 operates similarly to that disclosed in the patent to Harry F. Vickers, No. 2,043,453, and is pilot controlled by means of a small pilot relief valve 226 which exhausts to tank 36 through a passage 228 leading to the groove 214 and passage 216. The pressure at which valve 222 opens is governed by the spring adjustment of valve 226. The pressure connections 230 and 231 of relief valve 222 connect respectively with the conduit 132 leading from pump 126 or with conduit 144 leading to motor 146. The interiors of the casings of the three units 126, 146, and 134 are all drained to the tank by a drainage network 232.

In operation, the parts are shown in idle position with the drive section circuit bypassed but with the reel coupling circuit in condition for operation whenever the driving section 10 is started. During idle position the delivery of pumps 30 and 32 is bypassed to tank, as previously described, so long as electric motor 34 operates, while the delivery of pumps 72 and 116 is bypassed to tank through their respective relief valves 78 and 122.

When it is desired to start the entire apparatus the valve 58 may be shifted to the right to connect ports 56 and 56 thus causing motor 26 to operate at a speed determined by the setting of the stroke adjustment 28. The drive section 10 is accordingly operated at a predetermined speed to move the strip section 16 from right to left unwinding the strip from coil 14. This causes the pump 126 to be rotated at a speed which gradually increases as each layer of strip is un-

wound from coil 14 due to the gradual decrease in the diameter thereof.

Unit 134 is also driven at a fixed speed determined by the speed of driving section 10, and since unit 134 is of fixed displacement, it controls the rate at which fluid can pass from pump 126 to unit 134 through conduit 132. In other words, the quantity of fluid which can pass through this conduit in a given unit of time is maintained invariable by unit 134 at any given speed of driving section 10.

The pressure regulator 128 automatically controls the displacement of pump 126 so that this quantity will be delivered regardless of the speed of supply reel 14. Due to the spring 204 and orifice 220, the piston 200 is under a constant tendency to move to the right and increase the stroke of pump 126. The instant that such stroke tends to increase beyond the value necessary to supply the quantity which unit 134 takes, the pressure in conduit 132 will immediately build up and open relief valve 222 thus admitting oil to the righthand end of cylinder 198 at a faster rate than it can escape through the orifice 220. Accordingly, the piston 200 will be moved back to the left, thus decreasing the stroke of pump 126 and counteracting the tendency for the pressure in conduit 132 to rise.

In actual operation the parts will come to a steady condition in which the relief valve 222 is cracked open sufficiently to pass oil into cylinder 198 at a slightly higher rate than it passes out of cylinder 198 through orifice 220. Thus the piston 200 will move to the left slowly at a speed proportional to the gradual decrease in diameter of coil 14. In this manner the volumetric delivery rate of pump 126 is maintained constant during the gradually increasing speed thereof.

The oil discharged from unit 134 flows through conduit 138, ports 140 and 143 and conduit 144 to the inlet of fluid motor 146. The quantity flowing through this path is also constant due to the constant speed of displacement of unit 134. Accordingly, pressure regulator 150 will act to increase the stroke of motor 146 as is necessary to decrease the speed of reel 18 as the diameter of coil 20 increases. The speed of reel 18 can never exceed that where the linear speed of the strip is equal to the linear speed of the strip through driving section 10 since to do so would stretch, and eventually rupture, the strip. Accordingly, any tendency for motor 146 to drive the reel faster than this speed causes an increase in pressure in line 144 which reacts on the pressure regulator 150 to increase the stroke of motor 146 and thereby decrease the speed of reel 18 restoring the original condition.

In actual operation the piston 200 and pressure regulator 150 will also move slowly to the left to gradually swing yoke 148 at a speed proportional to the gradual increase in diameter of coil 20. Oil discharged from motor 146 returns directly to the inlet of pump 126. This path is through conduit 152, ports 154 and 156, conduit 158 and check valve 160.

It will be noted that under these conditions of operation the speed of the reels 12 and 18 is controlled automatically in such a way that a constant tension is maintained in the strip between the reels and the driving unit 10. This value of tension moreover is not necessarily the same at the right and lefthand sides of the driving section 10. The operation of a reel at constant strip tension or constant linear speed requires constant horsepower operation at the reel shaft. This is

evident from the fact that the torque on the reel shaft, being the product of strip tension and coil diameter, varies directly with the diameter of the coil, while the angular speed, being the quotient of linear strip speed and coil diameter, varies inversely with the coil diameter. Since the horsepower at the reel shaft is the product of torque and speed, the factor of reel diameter disappears as a factor affecting horsepower. Accordingly, since the constant tension reel produces (at the supply reel) or requires (at the take-up reel) a constant horsepower, it follows that any hydraulic drive which requires or produces constant horsepower will automatically and inherently cause constant tension operation at the reel, assuming, of course, that the drive provides both variable speed and variable torque.

Hydraulic horsepower being the product of rate of flow and operating pressure, it follows that unit 126 must operate at constant horsepower because unit 134 maintains a constant rate of flow through unit 126 while the regulator 128 maintains a constant pressure of operation. Likewise at motor 146 a constant horsepower is always produced because of the constant rate of flow determined by unit 134 and the constant operating pressure determined by regulator 150.

It should be noted, however, that the horsepower at unit 126 is not identical to that at unit 146 unless both pressure regulators are set to operate at the same pressure. When they are thus set, equal tension will be maintained in the strip on both sides of the drive section 10, and the unit 134 will operate at zero pressure differential, thus neither absorbing nor giving out power from or to the driving section 10. The only function which the unit 134 performs under these conditions is a sort of synchronizing function to prevent "hunting" caused by momentary fluctuations in operating conditions at the pressure regulators 128 and 150.

If the pressure regulator 128 is set for a higher pressure than pressure regulator 150, then the power produced at reel 12 in excess of that required at reel 18 is returned to the driving unit 10 by unit 134 acting as a motor operating at the pressure differential between unit 128 and 150. Conversely, should the reel 12 produce less power than required to operate reel 18 at a given adjustment of the pressure regulators, the unit 134 will make up the deficiency by transferring power from driving unit 10 to the reel 18. It is understood, of course, that the above discussion has neglected losses in the hydraulic circuit and in the mechanical parts of the reel as well as the hysteresis losses in the bending of the sheet material.

Under certain conditions of operation it is sometimes desired to operate the strip handling device without recoiling the material after it has passed through the driving section 10. In other words, the strip is utilized in its flat condition and is carried past the reel 18 as indicated in dotted lines at 234 to be sheared into shorter lengths. For this purpose the valve 142 may be shifted to its middle position in which the motor 146 is hydraulically blocked at the ports 143 and 154. Under these conditions oil discharging from the unit 134 returns directly to the inlet of pump 126 by passing from port 140 through the passage 190 to ports 156 and 159 where it flows to the conduit 158. It will be seen that under these conditions the entire quantity of power generated at the reel 12, neglecting losses, is returned to the

driving section 10 by the unit 134 operating as a motor.

During setting up operations it is necessary to be able to turn the reel 12 without operating the reel coupling circuit, and for this purpose the control valve 110 may be shifted to direct pilot pressure to shift valve 104 and bypass the delivery of pump 126 to tank 38.

Also it is occasionally desirable to reverse the rotation of the reel 18 for attaching the end of a new strip, and for this purpose valve 142 may be shifted to its extreme right-hand position to reverse the direction of flow through motor 146.

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. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled by the pull of the driving section, and means for controlling the tension of the strip between said sections comprising a variable displacement pump mechanically coupled to the reel section in predetermined speed ratio, a hydraulic motor mechanically coupled to the driving section in predetermined speed ratio, a series hydraulic circuit connecting the pump to deliver all its fluid output to the motor, and means responsive to an increase in pressure in said circuit for reducing the pump displacement to maintain said pressure substantially constant.

2. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled by the pull of the driving section, and means for controlling the tension of the strip between said sections comprising a variable displacement pump mechanically coupled to the reel section in predetermined speed ratio, a fixed displacement hydraulic motor mechanically coupled to the driving section in predetermined speed ratio, a series hydraulic circuit connecting the pump to deliver all its fluid output to the motor, and means responsive to an increase in pressure in said circuit for reducing the pump displacement to maintain said pressure substantially constant.

3. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled from a progressively decreasing diameter by the pull of the driving section, and means for controlling the tension of the strip between said sections comprising a variable speed ratio hydraulic power transmission system connected to be driven by the supply reel section and to drive the driving section, and means responsive to operating pressure in said transmission for controlling the speed ratio of said transmission.

4. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply

reel section from which the strip is unreeled from a progressively decreasing diameter by the pull of the driving section, and means for controlling the tension of the strip between said sections comprising a variable speed ratio hydraulic power transmission system connected to be driven by the supply reel section and to drive the driving section and comprising a pair of fluid pressure energy translating devices, one of which is of the variable displacement type, and pressure responsive means for regulating the displacement of said one device.

5. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled by the pull of the driving section, a take-up reel section onto which the strip is reeled after leaving the driving section, and means for controlling the tension of the strip between said three sections comprising a variable displacement pump unit coupled to the supply reel section and having means for controlling its displacement to maintain a substantially constant delivery pressure, a variable displacement motor unit coupled with the take-up reel section and having means for controlling its displacement to maintain a substantially constant inlet pressure, and means mechanically coupled with the driving section and hydraulically connected with said units for metering the quantity of fluid passing through each of said variable displacement units in predetermined ratio to the longitudinal movement of the strip through the driving section.

6. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled by the pull of the driving section, a take-up reel section onto which the strip is reeled after leaving the driving section, and means for controlling the tension of the strip between said three sections comprising a variable displacement pump unit coupled to the supply reel section and having means for controlling its displacement to maintain a substantially constant delivery pressure, a variable displacement motor unit coupled with the take-up reel section and having means for controlling its displacement to maintain a substantially constant inlet pressure, and means mechanically coupled with the driving section and hydraulically connected with said units for metering the quantity of fluid passing through each of said variable displacement units in predetermined ratio to the longitudinal movement of the strip through the driving section, at least one of said units being adjustable to regulate to different pressures whereby the strip tension on one side of the driving section may be varied relative to that on the other side thereof.

7. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled by the pull of the driving section, a take-up reel section onto which the strip is reeled after leaving the driving section, and means for controlling the tension of the strip between said three sections comprising a variable displacement

ment pump unit coupled to the supply reel section and having means for controlling its displacement to maintain a substantially constant delivery pressure, a variable displacement motor unit coupled with the take-up reel section and having means for controlling its displacement to maintain a substantially constant inlet pressure, and means including a fixed displacement fluid pressure energy translating device mechanically coupled with the driving section and hydraulically connected with said units for metering the quantity of fluid passing through each of said variable displacement units in predetermined ratio to the longitudinal movement of the strip through the driving section.

8. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled by the pull of the driving section, a take-up reel section onto which the strip is reeled after leaving the driving section, and means for controlling the tension of the strip between said three sections comprising a variable displacement pump unit coupled to the supply reel section and having means for controlling its displacement to maintain a substantially constant delivery pressure, a variable displacement motor unit coupled with the take-up reel section and having means for controlling its displacement to maintain a substantially constant inlet pressure, and means including a fixed displacement fluid pressure energy translating device mechanically coupled with the driving section and hydraulically connected in a series circuit with both said units for metering the quantity of fluid passing through each of said variable displacement units in predetermined ratio to the longitudinal movement of the strip through the driving section.

9. A strip material handling device comprising a supply reel from which the strip is to be unwound and a take-up reel onto which the same strip is to be wound, a pair of constant pressure, variable volume, hydraulic displacement devices, one connected in driving relation to each reel, a constant volume, variable pressure, hydraulic displacement device, means for driving the last-mentioned device at a controlled speed, and fluid supply and return conduits connecting said three devices in a series circuit.

10. In a sectional machine for operating on strip material the combination of a driving section having means for engaging the strip and moving it longitudinally, power means for driving the driving section at a controlled speed, a supply reel section from which the strip is unreeled by the pull of the driving section, a take-up reel section onto which the strip is reeled after leaving the driving section, and means for controlling the tension of the strip between said three sections comprising a variable displacement pump unit coupled to the supply reel section and having means for controlling its displacement to maintain a substantially constant delivery pressure, a variable displacement motor unit coupled with the take-up reel section and having means for controlling its displacement to maintain a substantially constant inlet pressure, means mechanically coupled with the driving section and hydraulically connected with said units for metering the quantity of fluid passing through each of said variable displacement units in predetermined ratio to the longitudinal movement of the

strip through the driving section, and means including a valve selectively shiftable to disconnect one of said units from said metering means.

11. A strip material handling device comprising a supply reel from which the strip is to be unwound and a take-up reel onto which the same strip is to be wound, a pair of constant pressure, variable volume, hydraulic displacement devices, one connected in driving relation to each reel, a constant volume, variable pressure, hydraulic 10

displacement device, means for driving the last-mentioned device at a controlled speed, fluid supply and return conduits connecting said three devices in a series circuit, and means selectively shiftable to disconnect one of said pair of devices from the last-mentioned device and to connect the remaining two devices in series.

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