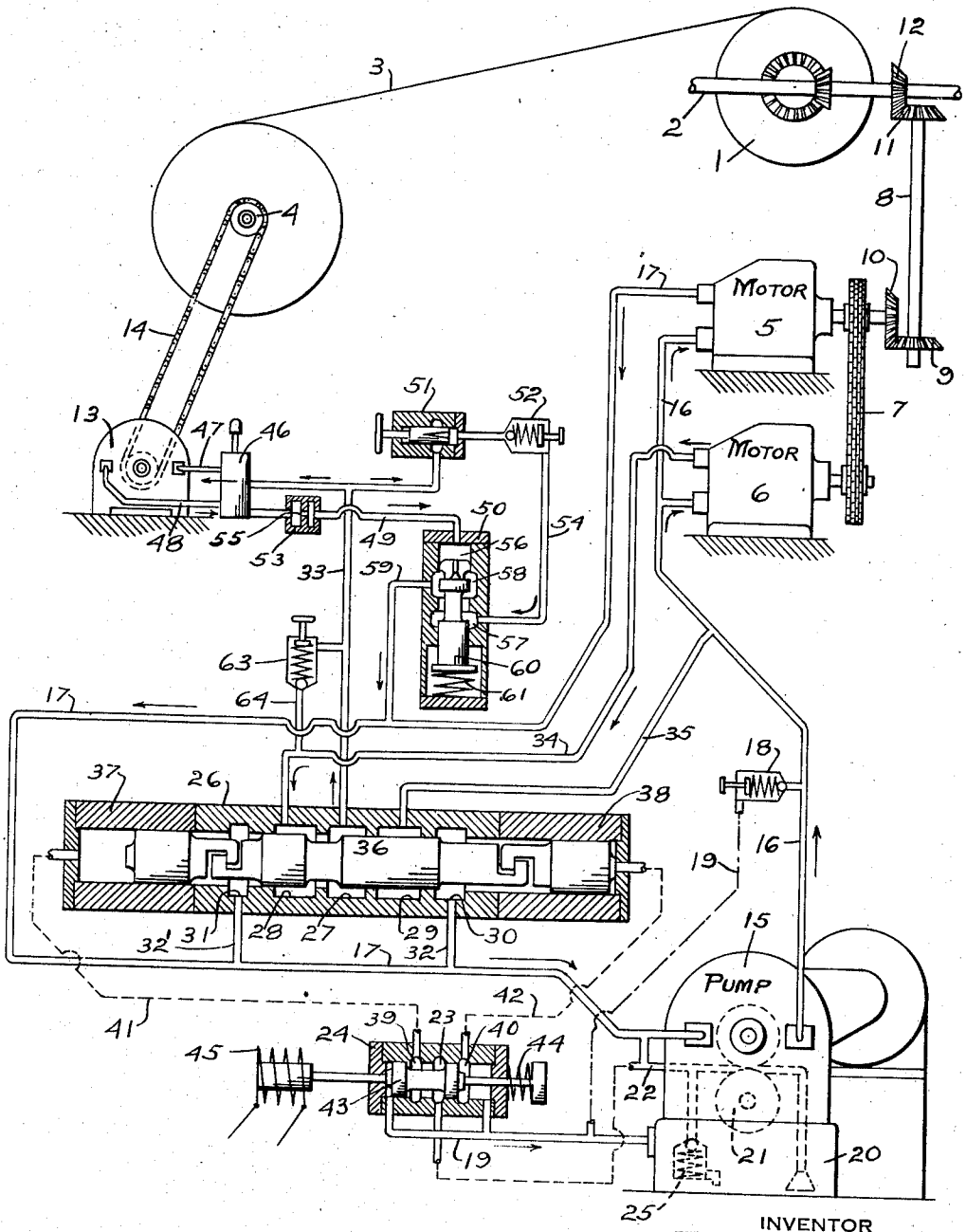
May 4, 1937. E. WIEDMANN 2,079,268

HYDRAULIC TRANSMISSION

Filed April 20, 1935 2 Sheets-Sheet 2

Fig. 2.



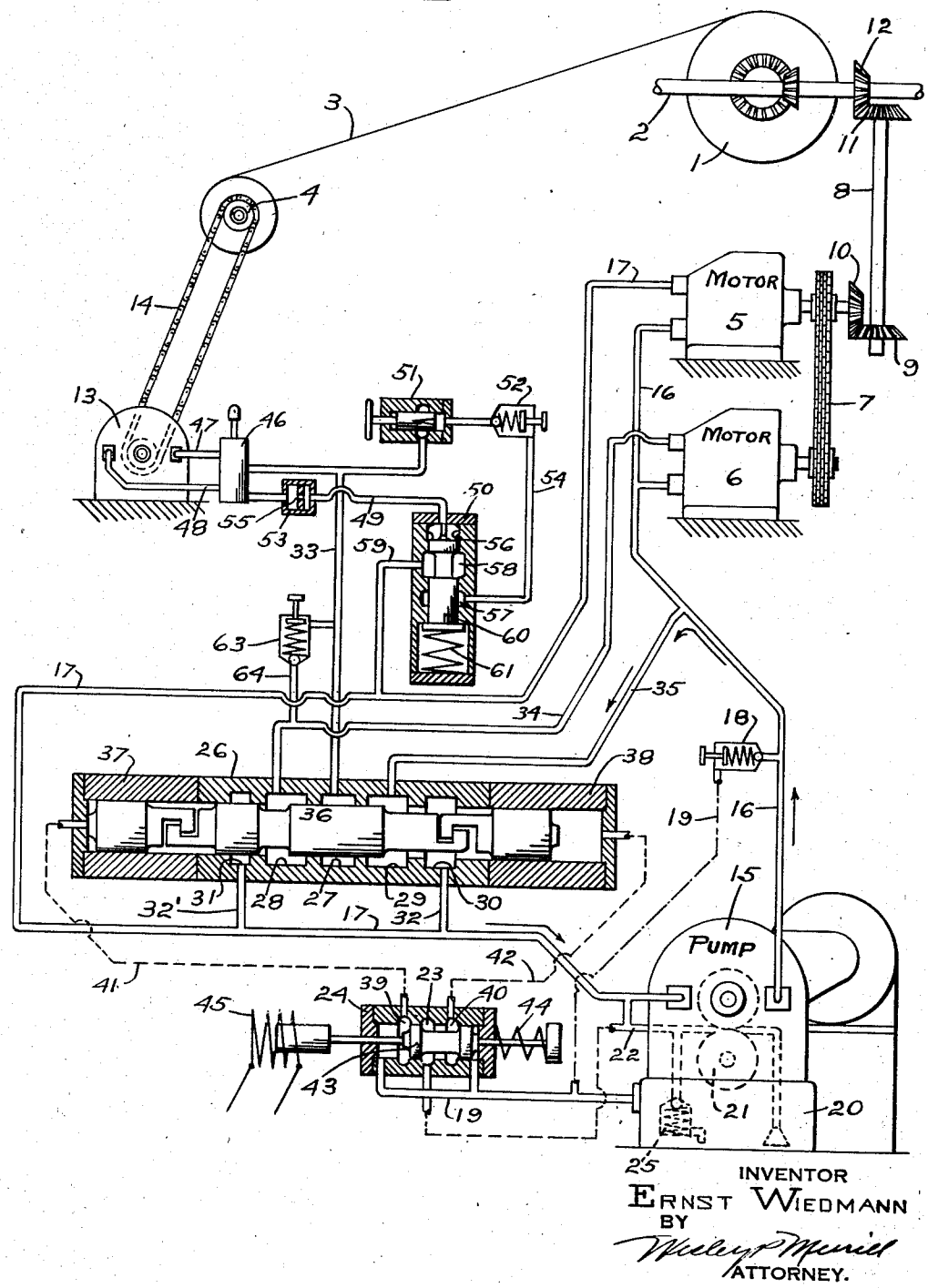
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HYDRAULIC TRANSMISSION

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Fig. 1.



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2,079,268

HYDRAULIC TRANSMISSION

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Application April 20, 1935, Serial No. 17,439

14 Claims. (Cl. 60—53)

This invention relates to hydraulic transmissions of the type employed to drive two or more machines or two or more parts of the same machine in unison but not necessarily in synchronism with each other, such as the transmission disclosed in application Serial No. 688,725, filed September 9, 1933 by Ransom Tyler.

The transmission is particularly adapted for driving rotary printing presses, paper mills and the like and, for the purpose of illustration, it will be explained as applied to a printing press but it is to be understood that the invention is applicable to other uses.

A certain type of printing press delivers printed paper in long or substantially continuous strips to a winder roll which should wind it thereon as received and maintain a substantially uniform tension upon the paper irrespective of the speed at which it is delivered by the printing press.

Under ordinary operating conditions, the paper is delivered to the winder roll at a substantially uniform speed but, since the diameter of the roll of paper upon the winder roll increases as the paper is wound thereon, the winder roll must be driven at a relatively high speed when the diameter of the roll of paper thereon is small, and the speed of the roll should be decreased and the torque increased as the diameter increases in order to maintain a uniform tension upon the paper.

The above application discloses two transmissions each of which drives a winder roll and maintains a substantially constant tension upon the paper being wound thereon. In one of these transmissions, the winder roll is driven by a hydraulic motor which is operated by liquid supplied by a pump driven by and in synchronism with the press which delivers paper to the winder roll. This transmission requires a pump in addition to the transmission which drives the press.

In the other transmission, the winder roll is driven by a hydraulic motor connected in series with a hydraulic motor which drives the press. This transmission operates satisfactorily on presses in which the power required to drive the press is not too much in excess of the power required to drive the winder roll of that press.

If the power required to drive the press is greatly in excess of the power required to drive the winder roll, liquid will be discharged from the press motor at a rate in excess of the rate at which liquid can pass through the winder roll motor and through the bypass valves.

The present invention has as an object to provide a hydraulic transmission which is capable of driving a press having a winder roll which requires but a fraction of the power required to drive the press.

Another object is to provide a hydraulic transmission which will drive in unison two parts of the same machine or two separate machines one of which requires but a fraction of the power required to drive the other machine or machine part.

Another object is to provide a transmission of the above character having a main drive, which operates at a substantially uniform speed regardless of variation in load with a consequent variation in power output, and an auxiliary drive which maintains its power output substantially constant by varying the torque inversely to variations in its speed.

Another object is to provide a hydraulic transmission which will drive a main machine and an auxiliary machine or the main part of a machine and an auxiliary part of that machine in unison and exert a high starting torque upon the auxiliary machine or the auxiliary part of the machine.

Another object is to provide a transmission of the above character which is positive and precise in operation.

Another object is to provide a transmission of the above character which is susceptible of close adjustment and control.

Other objects and advantages will appear from the description hereinafter given of a hydraulic transmission in which the invention is embodied.

According to the invention in its general aspect and as ordinarily embodied in practice, the transmission is provided with a plurality of main rotary hydraulic motors which are mechanically connected together to rotate in synchronism and hydraulically connected to each other in parallel, a pump for supplying motive liquid to the motors, an auxiliary rotary motor which is connected in series with one of the main motors, and means for bypassing the pump and simultaneously directing the liquid discharged by one of the main motors to the auxiliary motor through a resistance in order to keep the auxiliary motor running as long as the main motors continue to run and to impose a brake load upon the main motors.

According to the invention in another aspect, the fluid channel which supplies motive liquid to the auxiliary motor has means connected thereto for bypassing liquid around the auxiliary motor at rates varying in accordance with variations in pressure in that channel to thereby enable the auxiliary motor to have a constant power output,

and means are provided to prevent bypassing any liquid until after the auxiliary motor starts to thereby enable the auxiliary motor to exert a high starting torque to overcome the static friction and inertia of the machine or machine part which it drives.

The invention is exemplified by the transmission shown schematically in the accompanying drawings in which the views are as follows:

Fig. 1 is a circuit diagram showing the several valves in the positions occupied when the transmission is idle.

Fig. 2 is a similar view showing the valves in the positions occupied when the transmission is in operation.

The transmission is shown connected to a printing press of which only the delivery roll 1 and the drive shaft 2 are shown for the reason that the press per se is of a well known type and forms no part of the present invention, it being sufficient to state that the press delivers paper in a long or substantially continuous strip 3 to a winder roll 4 which should wind it thereon and maintain a substantially uniform tension upon the paper to prevent it from sagging or breaking between the winder roll 4 and the delivery roll 1.

The printing press is driven by two rotary hydraulic motors 5 and 6 which are mechanically connected to each other and to the press. As shown, the motors are connected to each other by a chain and sprocket connection 7 which causes the motors to rotate in synchronism, the motor 5 has its shaft connected to a shaft 8 by a pair of intermeshing beveled gears 9 and 10, and the shaft 8 is connected to the drive shaft 2 by a pair of intermeshing gears 11 and 12.

The winder roll 4 is driven by a rotary hydraulic motor 13 which is hydraulically connected in series with the motor 6 and mechanically connected to the roll 4 by any suitable means such as a chain and sprocket drive 14.

The motors 5, 6 and 13 are driven by liquid supplied by a pump 15 which has not been illustrated in detail as any suitable pump will suffice, it being sufficient to state that it discharges liquid into a high pressure supply pipe 16 at a rate dependent upon pump adjustment and has liquid returned to it through a return pipe 17. A suitable pump is disclosed in Patent No. 1,998,984 issued April 23, 1935, to Walter Ferris.

The supply pipe 16 is connected to the inlet of both of the motors 5 and 6 and the return pipe 17 is connected to the outlet of the motor 5. The arrangement is such that the liquid discharged from the motor 5 is returned direct to the pump 15 and the liquid discharged from the motor 6 is employed to drive the winder motor 13 as will be presently explained.

Pressure created by the pump 15 is limited by a high pressure relief valve 18 which is ordinarily arranged within the pump casing but which is shown connected between the supply pipe 16 and a drain pipe 19 which discharges into a reservoir 20 formed in the lower part of the pump casing and containing a supply of motive liquid such as oil.

The transmission is also provided with an auxiliary pump or gear pump 21 which is ordinarily driven in unison with the pump 15 and arranged in the casing thereof as shown in the above patent. The gear pump 21 operates continuously and delivers liquid from the reservoir 20 into a low pressure supply pipe 22 which is connected to the return pipe 17 and to the admission port 23 of a pilot valve 24 to enable the gear pump to supercharge the pump 15 and to provide liquid for control purposes. All liquid delivered by the gear pump in excess of these requirements is exhausted through a low pressure relief valve 25 which enables the gear pump to maintain a predetermined low pressure in the pipe 22 and at the intake of the pump 15.

Operation of the transmission is controlled primarily by a control valve 26 which has its casing provided with a central port 27, two ports 28 and 29 arranged upon opposite sides of the port 27, and two end ports 30 and 31 which are connected to the return pipe 17 by pipes 32 and 32' respectively. The port 27 is connected to a pipe 33 through which liquid is delivered to the motor 13, the port 28 is connected by a pipe 34 to the outlet of the motor 6, and the port 29 is connected by a pipe 35 to the supply pipe 16 intermediate the ends thereof.

Flow of liquid through the valve 26 is controlled by a plunger 36 which has pistons formed thereon and closely fitted in the bore of the valve casing to control communication between the several ports.

The plunger 36 is shifted between two positions by two servo-motors 37 and 38 which are arranged upon opposite ends of the valve casing and have the pistons thereof mechanically connected to the valve plunger 36. The servo-motors 37 and 38 are operated by liquid supplied thereto from the gear pump 21 under the control of the pilot valve 24 which is ordinarily arranged in the casing of the control valve and operated magnetically but which, for the purpose of illustration, has been shown provided with a separate casing having two ports 39 and 40 formed therein upon opposite sides of the admission port 23 and connected, respectively, to the servo-motors 37 and 38 by two pipes 41 and 42.

The flow of liquid through the pilot valve is controlled by its plunger 43 which has spaced apart pistons formed thereon and closely fitted in the bore of the valve casing to control communication between the several ports. As shown, the plunger 43 is moved in one direction by a helical compression spring 44 arranged around its stem between one end of the valve casing and an abutment fastened to the stem. The plunger 43 is moved in the opposite direction by a solenoid 45 connected to its stem and arranged at the other end of the valve casing. The solenoid is controlled by a switch (not shown) which is ordinarily arranged at a remote point. Both ends of the pilot valve casing are connected to the drain pipe 19 in order to permit the plunger 43 to reciprocate in the casing.

When the valve plungers 36 and 43 are in the positions shown in Fig. 1 and the pumps 15 and 21 are in operation, the liquid discharged by the pump 15 flows freely through the pipes 16 and 35, the valve 26 and the pipes 32 and 17 back to the pump, whereby no pressure is created and the motors are idle, and the entire output of the gear pump 21 is exhausted through the relief valve 25 and the pressure created thereby holds the piston of the servo-motor 38 and the plunger 36 of the control valve 26 in the positions shown.

When the solenoid 45 is energized, it will shift the pilot valve plunger 43 to the position shown in Fig. 2 and the gear pump liquid will flow through the pilot valve 24 and the pipe 41 to the servo-motor 37 which will shift the control valve plunger 36 to the position shown in Fig. 2, thereby blocking port 29 and opening port 27 to port 28. The gear pump will deliver enough liquid

into the return pipe 17 to make up for leakage losses in the main circuit, and all liquid delivered by it in excess of requirements will be discharged through the relief valve 25 which enables the gear pump to maintain a low pressure in the return pipe 17.

The pump 15 will now deliver its entire output direct to the motors 5 and 6 and, since these motors are mechanically connected to each other and hydraulically connected in parallel, the output of the pump 15 will be divided between them in proportion to their displacements and they will be driven in synchronism.

The liquid discharged from the motor 5 will be returned direct to the pump 15 through the return pipe 17 and the liquid discharged from the motor 6 will flow through the pipe 34, the control valve 26 and the pipe 33 to the winder motor 13 which is driven thereby.

In order that the motor 13 may be reversed if and when desired, the pipe 33 is ordinarily connected to the inlet of the motor 13 through a manually operated reversing valve 46 and a pipe 47, and the outlet of the motor 13 is connected through a pipe 48 and the reversing valve 46 to a discharge pipe 49.

The motor 13 must have its speed decreased and its torque increased as the diameter of the roll of paper on the winder roll 4 increases if a substantially constant tension is to be maintained on the strip of paper 3, and it must have a high starting torque in order to overcome the static friction and inertia of the movable parts. In order to accomplish these results, the discharge pipe 49 is connected to the return pipe 17 through an automatic starting valve 50, an adjustable choke 51 and a resistance valve 52 are connected to the pipe 33 in series with each other and discharge into the return pipe 17 through the valve 50, and a resistance or choke 53 is connected in series with the motor 13.

The choke 51 has its inlet connected to the pipe 33 and its outlet connected to the inlet of the resistance valve 52 which has its outlet connected to the valve 50 by a pipe 54.

Since the flow of liquid through a choke varies in accordance with the difference in pressure between its inlet and its outlet, and since the resistance of the valve 52 remains constant after being adjusted, the volume of liquid bypassed through the choke 51 and the resistance valve 52 will vary in accordance with the variation in the pressure prevailing in the pipe 33.

The choke 53 may be connected into the discharge pipe 49 as shown or into the supply pipe 33 as disclosed in the Tyler application referred to above. In either case, the entire volume of liquid passing through the motor 13 must also pass an orifice 55 formed in the choke.

The resistance offered by an orifice to the flow of liquid therethrough varies in accordance with the velocity of the liquid, and the orifice 55 is so adjusted or proportioned that its resistance added to the resistance of the motor 13 is sufficient to cause the diversion through the choke 51 and the resistance valve 52 of all liquid discharged by the motor 6 into the pipe 33 in excess of the volume required to enable the motor 13 to drive the winder roll at a rotary speed equal to the linear speed at which the strip 3 is delivered by the press and to maintain a given tension upon the strip.

The starting valve 50 is provided with an axial bore 56 and has two ports 57 and 58 formed in the wall of the bore. One end of the bore 56 has the pipe 49 connected thereto, the port 57 has the pipe 54 connected thereto, and the port 58 is connected by a pipe 59 to the return pipe 17. Flow of liquid through the valve 50 is controlled by its plunger 60 which is fitted in the bore 56 and urged by a helical compression spring 61 toward that end of the bore 56 to which the pipe 49 is connected.

When the transmission stops, the plunger 60 is moved by the spring 61 to the position shown in Fig. 1, it being found in practice that the small volume of liquid displaced by movement of the plunger 60 can be forced into the pipe 49 due to clearances in the motor 13 and slight leaks in the circuit. In this position, the plunger 60 closes the port 57 and prevents any liquid from being bypassed through the choke 51 and the resistance valve 52. The full pressure in the pipe 33 is then available to enable the motor 13 to exert a high torque to start its load.

As soon as the motor 13 starts, the liquid discharged therefrom enters the bore 56 and forces the plunger 60 to the position shown in Fig. 2, thereby opening the pipe 54 to the pipe 49 and permitting liquid to be bypassed around the motor 13. After the valve 50 opens, the flow of liquid through the motor 13 gradually increases and is at first so slow that the choke 53 offers substantially no resistance to the flow of liquid therethrough. Consequently, substantially the full pressure in the pipe 33 is available to enable the motor 13 to accelerate the winder roll.

After the winder roll has been started, it must rotate at a relatively high speed in order to wind up the strip as fast as it is delivered by the press, but only a low torque is required to maintain a given tension upon the strip.

The orifice 55, the choke 51 and the resistance valve 52 are so proportioned or adjusted that the resistance of the motor 13 at the low torque and the resistance of the orifice 55 at the relatively high velocity of the liquid will cause the diversion through the choke 51 and the resistance valve 52 of all liquid discharged by the motor 6 into the pipe 33 in excess of the volume required to drive the motor 13 at the relatively high speed required to wind the strip upon the winder roll as fast as it is delivered thereto.

As the apparatus continues to operate, the roll of paper upon the winder roll gradually and continually increases in diameter and tends to wind up the strip at progressively faster rates, thereby requiring a progressively greater motor torque to maintain a uniform tension upon the strip.

This increase in torque causes a progressive rise in pressure in the pipe 33 with a resultant progressive increase in the rate at which liquid is bypassed through the choke 51 and the resistance valve 52, thereby progressively decelerating the motor 13 in proportion to the increase in the diameter of the roll of paper upon the winder roll.

After the press has been operating and the solenoid 45 is deenergized to stop the press, the control valve plunger 36 will be shifted to bypass the pump 15, as previously explained, but the inertia of the moving press parts will cause the press to coast and drive the motors 5 and 6 which will then function as pumps.

In order to quickly and smoothly decelerate the press to a complete stop, a resistance valve 63 has its inlet connected to the pipe 34 by a pipe 64 and its outlet connected to the pipe 33. After the control valve plunger 36 has been

shifted to close the pipe 34 to the pipe 33, the liquid exhausted from the motor 6 is forced through the valve 63 which offers considerable resistance to the passage of liquid therethrough and thus acts as a brake to gradually decelerate the press to a full stop.

The liquid forced through the resistance valve 63 passes through the motor 13 and keeps it in operation until the press stops, thereby maintaining tension upon the strip of paper 3 at all times.

The invention herein set forth is susceptible of various modifications and adaptations without departing from the scope thereof, as hereafter claimed.

The invention is hereby claimed as follows:

1. A hydraulic transmission, comprising a pump, a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected to said pump in parallel with each other, an auxiliary fluid motor connected in series with one of said main motors to be operated by liquid discharged therefrom, a resistance valve, and means for controlling the delivery of liquid to said main motors including a control valve for short circuiting said pump and simultaneously directing the liquid discharged from at least one of said main motors through said resistance valve to cause it to function as a brake upon said main motors.

2. A hydraulic transmission, comprising a pump, a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected to said pump in parallel with each other, an auxiliary fluid motor connected in series with one of said main motors to be operated by liquid discharged therefrom, a resistance valve, means for controlling the delivery of liquid to said main motors including a control valve for short circuiting said pump and simultaneously directing the liquid discharged from at least one of said main motors through said resistance valve to cause it to function as a brake upon said main motors, and means for varying the speed and torque of said auxiliary motor independently of the speed of said main motors.

3. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means for controlling the delivery of liquid to said main motors, and means responsive to variations in the load upon said auxiliary motor for automatically varying the speed thereof.

4. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means for controlling the delivery of liquid to said main motors, means for diverting from said auxiliary motor a part of the liquid discharged from the main motor with which said auxiliary motor is connected in series, and means responsive to variations in the pressure at the inlet of said auxiliary motor for varying the rate at which liquid is diverted.

5. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means for controlling the delivery of liquid to said main motors, and means responsive to variations in the pressure required to drive said auxiliary motor for automatically varying the speed of said auxiliary motor inversely to the torque thereof and at a rate to maintain the power output of said auxiliary motor substantially constant.

6. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means for controlling the delivery of liquid to said main motors, means responsive to variations in the load upon said auxiliary motor for automatically varying the speed thereof, and means responsive to liquid flow through said auxiliary motor for automatically preventing said last named means from functioning until after said auxiliary motor has started.

7. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means for controlling the delivery of liquid to said main motors, means for diverting from said auxiliary motor a part of the liquid discharged from the main motor with which said auxiliary motor is connected in series, means responsive to variations in the pressure at the inlet of said auxiliary motor for varying the rate at which liquid is diverted, and means responsive to liquid flow through said auxiliary motor for preventing said diversion of liquid until after said auxiliary motor has started.

8. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means for controlling the delivery of liquid to said main motors, means responsive to variations in the pressure required to drive said auxiliary motor for automatically varying the speed of said auxiliary motor inversely to the torque thereof and at a rate to maintain the power output of said auxiliary motor substantially constant, and means responsive to liquid flow through said auxiliary motor for automatically preventing said last named means from functioning until after said auxiliary motor has started.

9. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, a resistance valve having its outlet connected to the inlet of said auxiliary motor, and a control valve for controlling the delivery of liquid from said pump to said main motors and for directing through said resistance valve to said auxiliary motor the liquid discharged from the main motor to which said auxiliary motor is connected to thereby cause

said resistance valve to function as a brake upon said main motors.

10. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, a resistance valve having its outlet connected to the inlet of said auxiliary motor, a control valve for controlling the delivery of liquid from said pump to said main motors and for directing through said resistance valve to said auxiliary motor the liquid discharged from the main motor to which said auxiliary motor is connected to thereby cause said resistance valve to function as a brake upon said main motors, and means for varying the speed and torque of said auxiliary motor independently of the speed of said main motors.

11. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, a resistance valve having its outlet connected to the inlet of said auxiliary motor, a control valve for controlling the delivery of liquid from said pump to said main motors and for directing through said resistance valve to said auxiliary motor the liquid discharged from the main motor to which said auxiliary motor is connected to thereby cause said resistance valve to function as a brake upon said main motors, means for diverting from said auxliary motor a part of the liquid discharged from the main motor with which said auxiliary motor is connected in series, and means responsive to variations in the pressure at the inlet of said auxiliary motor for varying the rate at which liquid is diverted.

12. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, a resistance valve having its outlet connected to the inlet of said auxiliary motor, a control valve for controlling the delivery of liquid from said pump to said main motors and for directing through said resistance valve to said auxiliary motor the liquid discharged from the main motor to which said auxiliary motor is connected to thereby cause said resistance valve to function as a brake upon said main motors, and means responsive to variations in the pressure required to drive said auxiliary motor for automatically varying the speed of said auxiliary motor inversely to the torque thereof and at a rate to maintain the power output of said auxiliary motor substantially constant.

13. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means responsive to variations in the load upon said auxiliary motor for automatically varying the speed thereof, means responsive to liquid flow through said auxiliary motor for automatically preventing the aforesaid means from functioning until after said auxiliary motor has started, a resistance valve having its outlet connected to the inlet of said auxiliary motor, and a control valve for controlling the delivery of liquid from said pump to said main motors and for directing through said resistance valve to said auxiliary motor the liquid discharged from the main motor to which said auxiliary motor is connected to thereby cause said resistance valve to function as a brake upon said main motors.

14. A hydraulic transmission, comprising a plurality of main fluid motors mechanically synchronized with each other and hydraulically connected in parallel, an auxiliary fluid motor connected in series with one of said main motors, a pump for supplying liquid to said motors to drive the same in unison, means for diverting from said auxiliary motor a part of the liquid discharged from the main motor with which said auxiliary motor is connected in series, means responsive to variations in the pressure at the inlet of said auxiliary motor for varying the rate at which liquid is diverted, means responsive to liquid flow through said auxiliary motor for preventing said diversion of liquid until after said auxiliary motor has started, a resistance valve having its outlet connected to the inlet of said auxiliary motor, and a control valve for controlling the delivery of liquid from said pump to said main motors and for directing through said resistance valve to said auxiliary motor the liquid discharged from the main motor to which said auxiliary motor is connected to thereby cause said resistance valve to function as a brake upon said main motors.

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