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H. F. SCHMIDT

HYDRAULIC REGULATING APPARATUS

Filed March 23, 1925

Fig. 1.

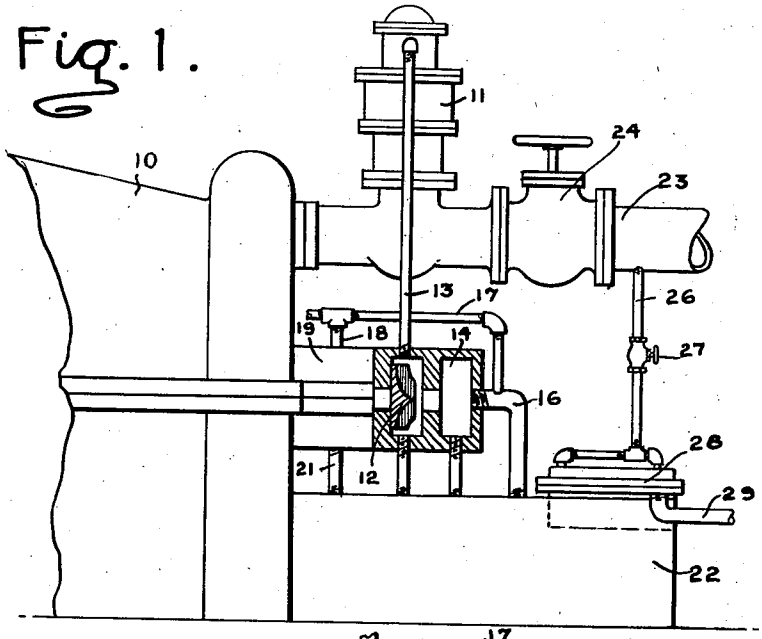
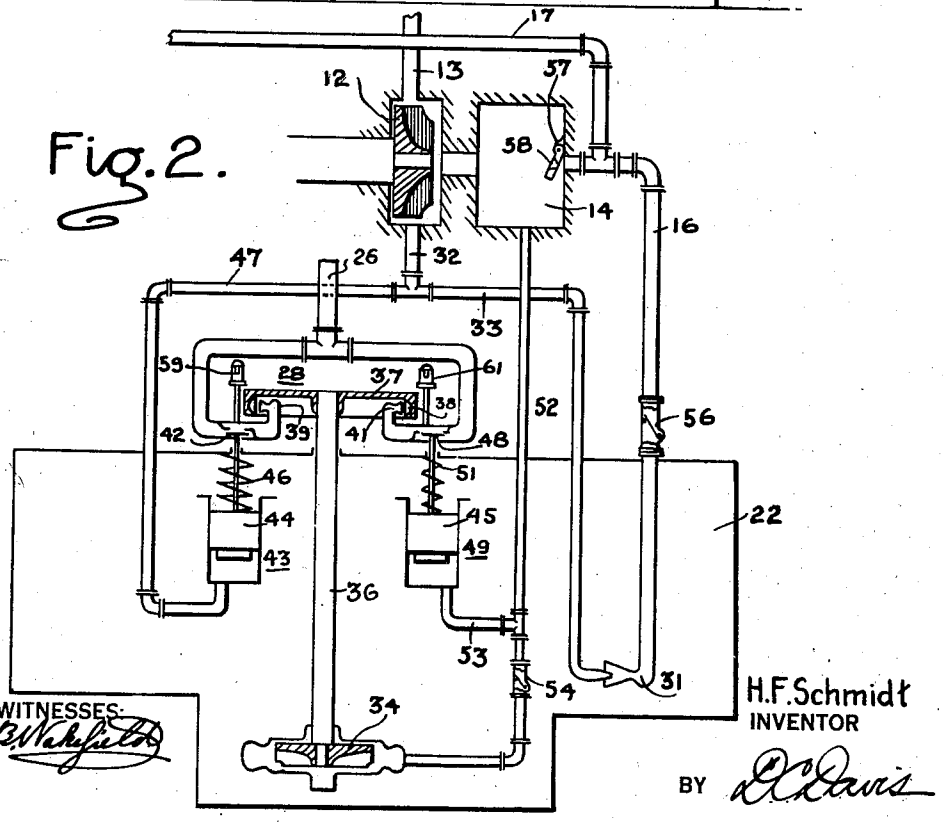


Fig. 2.



WITNESSES:

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UNITED STATES PATENT OFFICE.

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HYDRAULIC REGULATING APPARATUS.

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My invention relates to regulating apparatus of the hydraulic type for prime movers and has for its object the provision of apparatus of the character designated which shall be effective to operate without interruption over long periods of time.

More specifically the object of my invention is to provide a primary pump for normally developing fluid pressure for a hydraulic regulating apparatus and to provide an auxiliary pump, normally inactive, and means to automatically operate the same upon a partial or complete failure of the primary pump and when starting to provide pressure until the primary pump has attained its normal speed.

Apparatus embodying features of my invention is illustrated in the accompanying drawings forming a part of this specification in which Fig. 1 is a view of an elastic fluid turbine having my improved regulating apparatus applied thereto; and Fig. 2 is a diagrammatic view illustrating detailed features of my invention.

Regulating apparatus of the hydraulic type for prime movers, as known to me, usually embodies a pump which develops fluid pressure varying with the speed of the prime mover for operating a fluid pressure governor and for supplying fluid under pressure for lubricating the bearings. Inasmuch as the development of fluid under pressure by a pump is dependent upon the pressure supplied to the pump at its inlet, it has been found desirable, in such a system, to provide means for supplying the pump at its inlet with fluid under a positive pressure. A very convenient means for accomplishing this purpose has been provided in a fluid pressure operated ejector as disclosed in my copending application Serial No. 688,292, filed January 24, 1924, and assigned to Westinghouse Electric and Manufacturing Company. While such a system has been found to be very efficient and dependable in operation, there may occur times, due to leakage in conduits or other causes, when the pressure supplied either to the governing apparatus or to the lubricating system fails and the prime mover is subjected to the danger of overspeeding or to the danger of burning out the bearings.

In accordance with my invention I provide, with apparatus such as has just been described, a normally inactive auxiliary pump and provide an auxiliary elastic fluid turbine for driving said pump. Motive fluid for driving the auxiliary turbine is admitted thereto through a primary and a secondary nozzle. When motive fluid is being supplied to the auxiliary turbine through the primary nozzle it operates at a relatively high speed so that the auxiliary pump develops fluid under a pressure slightly less than the pressure developed by the main pump employed with the system. When the auxiliary turbine is being operated by motive fluid supplied through the secondary nozzle it operates at a speed sufficient to cause the auxiliary pump to develop fluid pressure slightly less than the fluid pressure existent at the inlet of the main pump associated with the system. A fluid pressure operated governor is provided for each of the nozzles. The governor controlling the primary nozzle is connected to the outlet side of the main pump and is set to close off the motive fluid supplied to the auxiliary turbine when the pressure in the system is slightly less than the normal pressure developed by the main pump. The governor controlling the secondary nozzle is connected to the inlet side of the main pump and is set to close off the motive fluid to the secondary nozzle when the pressure at the inlet to the main pump is slightly less than the normal inlet pressure. Motive fluid supplied for the auxiliary turbine is so connected to the main motive fluid supply that the auxiliary turbine may be started before the main turbine and develops sufficient pressure for the system before the main turbine is started.

Referring now to the drawing for a more detailed description of my invention, I show in Fig. 1 at 10 an elastic fluid turbine controlled by a fluid pressure operated governing apparatus 11. Fluid for operating the governing apparatus 11 is supplied by a centrifugal pump 12 driven directly by the turbine 10 and is delivered to the governing apparatus through a conduit 13. Associated with the pump 12 is an inlet chamber 14 supplied with fluid under a positive pressure through a conduit 16. Connected to the conduit 16 is a conduit 17 leading to the turbine bearings. A branch conduit 18 is shown leading to a turbine bearing 19. It may be seen that fluid for the turbine bearings is supplied at the same pressure as that

supplied to the inlet of the pump 12. After lubricating the bearings fluid drains therefrom through a conduit 21 to a reservoir 22.

Motive fluid for the turbine 10 is supplied through a conduit 23 having a throttle valve 24 interposed therein. Leading from the conduit 23 is a branch conduit 26 having a control valve 27 interposed therein. The conduit 26 supplies motive fluid to an auxiliary turbine 28 to be described later. When the turbine 28 is in operation motive fluid, after passing through the turbine, is exhausted therefrom through an exhaust connection 29.

Referring now to Fig. 2, I show the fluid reservoir 22 with the arrangement of my improved apparatus therein shown diagrammatically in relation to the main centrifugal pump 12. The main pump 12 is supplied with fluid under positive pressure developed by an ejector 31 located within the fluid reservoir 22. The ejector 31 is operated by fluid under pressure developed by the pump 12 and delivered to the ejector through a conduit 32 and a branch conduit 33. The pressure developed by the ejector 31 is also sufficient for supplying lubricant to the turbine bearings as previously explained. Inasmuch as the pressure developed by the pump 12 is the pressure due to its rotational velocity plus the pressure existent at its inlet, it follows therefore that should there be a failure of the ejector 31 and a consequent change in the pressure at the pump inlet, there would be a change in the pressure developed by the pump without a change in its rotational velocity. I accordingly provide an auxiliary pump 34 located within the reservoir 22 and connected to the shaft 36 of the turbine 28. The turbine has a well-known form of rotor 37 with a series of blades 38 milled into the inner periphery of an overhanging flange of the rotor. Motive fluid for operating the turbine is directed against the blades 38 by means of two nozzles 39 and 41, hereinafter referred to as primary and secondary nozzles. The primary nozzle 39 is designed to supply sufficient motive fluid to the turbine 28 to drive it at a speed so that the pump 34 develops a pressure corresponding to the normal pressure developed by the pump 12. The secondary nozzle 41 is designed to deliver sufficient motive fluid to the turbine 28 to drive the turbine at a speed so that the pump 34 develops a pressure slightly less than that developed by the ejector 31. Motive fluid is admitted to the primary nozzle 39 through an admission valve 42, said admission valve being controlled by a fluid pressure operated governor 43. The governor 43 is of conventional design and embodies a piston 44 biased downwardly by a spring 46. Fluid under pressure is conveyed to the under side of the piston 44 from the delivery side of the pump 12 through the conduit 32 and a branch conduit 47. The spring 46 is adjusted so that it will force the piston 44 downwardly and open the admission valve 42 when the pressure within the conduit 47 is slightly less than the normal pressure developed by the pump 12. It will be seen therefore that should there be a diminution in the pressure developed by the pump 12, below a predetermined pressure, the spring 46 causes the admission valve 42 to open and admit motive fluid through the nozzle 39.

The turbine 28 then operates at a speed so that the pump 34 develops a pressure corresponding to the pressure normally developed by the pump 12. The secondary nozzle 41 is supplied with motive fluid through an admission valve 48, said admission valve being controlled by a fluid pressure operated governor 49 similar to the governor 43 controlling the primary admission valve 42. The governor 49 is similar to the governor 43 and is provided with a spring 51 designed to open the valve 48 when the pressure beneath its associated piston 45 is slightly less than the pressure developed by the ejector 31. Fluid pressure for operating the governor 49 is conveyed thereto from the inlet chamber 14 of the pump 12 through a conduit 52 and a branch conduit 53. The conduit 52 also connects to the delivery side of the pump 34 so that when the turbine 28 is being operated by motive fluid supplied through the primary nozzle 39 and the pump 34 is developing a relatively high pressure, the governor 49 acts to close off the valve 48 and the secondary nozzle 41 is inoperative. Disposed within the conduit 52 is a check valve 54 which prevents fluid from the inlet chamber 14, normally controlled by the ejector 31, from passing into the pump 34 when it is idle. I similarly provide a check valve 56 within the conduit 16 which prevents fluid under pressure from passing backwardly to the ejector 31 when the ejector 31 is idle and the pump 34 is developing pressure. When the turbine 28 is being operated by motive fluid delivered through the primary nozzle 39 and the pump 34 is being driven at a speed for developing a relatively high pressure of fluid and delivering the same through the conduit 52 to the inlet chamber 14 of the pump 12, the pressure within the inlet chamber 14 is greater than that desired for the lubricating system of the turbine. I consequently provide a check valve 57 having an orifice 58 therein at the juncture of the conduit 16 with the inlet chamber 14. During normal operation, when the ejector 31 is supplying fluid under pressure for the inlet chamber 14 and for the lubricating system, the check valve 57 freely opens, permitting the fluid from the ejector 31 to pass into the chamber 14. When the pump 34

is developing a relatively high pressure, however, the check valve 57 closes and the fluid for the lubricating system is forced to pass through the orifice 58 where it is reduced in pressure. Associated with the nozzle 39 and with the nozzle 41 are two whistles 59 and 61. Either of these whistles blows continuously when its associated nozzle is delivering motive fluid to the rotor 38 and thus serves to warn the operator so that he may remedy the cause of failure of the pump 12 or ejector 31 to deliver the required fluid pressure.

The operation of apparatus made in accordance with my invention is as follows:

When it is desired to start up the main turbine 10, the valve 27 leading to the auxiliary turbine 28 is first opened and the auxiliary turbine begins to operate and drive the auxiliary pump 34. So long as the pressure developed by the pump 34 is slightly less than the normal pressure developed by the pump 12, when in operation, the turbine 28 will be under the control of the governor 43 associated with the primary nozzle 39. Fluid under pressure developed by the pump 34 is delivered through the conduit 52 to the inlet chamber 14 of the pump 12 from whence it passes through the pump 12 and conduit 13 to the governing apparatus 11 and also passes through the orifice 58 into the conduit 16 and from thence through the conduit 17 to the lubricating system. The throttle 24 to the main turbine 10 is next opened and the main turbine is started. As soon as the main turbine 10 has acquired its normal operating speed, the pump 12 develops a pressure slightly greater than that required to operate the governor 43. The governor 43 then closes off the primary valve 42 and the turbine 28 stops. Should there now be a diminution in the fluid under pressure supplied to the inlet chamber of the pump 14 by the ejector 31, the governor 49 operates to open the admission valve 48 controlling the secondary nozzle 41. The turbine 28 is now caused to operate at a speed so that the pump 34 develops a pressure for the inlet of the pump 12 at a pressure corresponding to that normally developed by the ejector 31. Should there be a diminution in the pressure developed by the pump 12, the governor 43 operates to open the admission valve 42 associated with the primary nozzle 39. The turbine 28, now operates at a speed so that the pump 34 develops a pressure corresponding to the pressure developed by the pump 12 when running at a normal speed. At the same time fluid for the lubricating system is supplied at a reduced pressure through the orifice 58.

From the foregoing it will be apparent that I have invented an improved apparatus of the hydraulic type embodying an auxiliary pump with means for driving the same and automatic means operable upon failure of pressure within the system for starting and operating the driving means.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The combination with an elastic fluid turbine having a fluid-pressure operated governor, of a primary pump for developing fluid-pressure varying with the speed of the turbine for operating the governor, a normally inactive auxiliary pump, and means for automatically starting the auxiliary pump and operable upon failure of the primary pump to develop a predetermined fluid-pressure.

2. The combination with an elastic fluid turbine having a fluid-pressure operated governor, of a primary pump for developing fluid-pressure varying with the speed of the turbine for operating the governor, means for supplying the primary pump at its inlet with fluid at a positive pressure, a normally inactive auxiliary pump, and means operable upon failure of the fluid supplying means of the primary pump for automatically starting the auxiliary pump.

3. The combination with an elastic fluid turbine having a fluid-pressure operated governor, of a primary pump for developing a relatively high fluid pressure for operating the governor, means for supplying the primary pump at its inlet with fluid at a relatively low positive pressure, a normally inactive auxiliary pump effective to develop fluid pressure proportional to its speed, motor means for driving the auxiliary pump, means for starting and operating the motor means at a speed effective for developing fluid pressure corresponding to that of the primary pump and operable upon failure of the primary pump to develop fluid under a predetermined pressure and means for starting and operating the motor means at a speed effective for developing fluid pressure corresponding to that of the pump inlet pressure and operable upon a diminution in pump inlet pressure.

4. The combination with an elastic fluid turbine having a fluid pressure operated governor and a forced feed lubricating system, of a primary pump driven by the turbine for developing a relatively high pressure of fluid varying proportionally to the speed of the turbine for operating the governor, an ejector operated by fluid under pressure from the primary pump for supplying

a relatively low pressure of fluid for the inlet of the pump and for the lubricating system, an auxiliary pump effective for developing fluid pressure proportionate to its speed, an auxiliary turbine for driving the auxiliary pump, means for admitting motive fluid to the auxiliary turbine to operate it at a speed effective for developing a pressure of fluid corresponding to the normal operating pressure of the governor, additional means for admitting motive fluid to the auxiliary turbine to operate it at a speed effective for developing a pressure of fluid corresponding to the normal primary pump inlet pressure, and means effective upon a predetermined diminution of the pressure delivered by either the primary pump or by the ejector for automatically operating the corresponding motive fluid admission means to the auxiliary turbine.

5. The combination with an elastic fluid turbine having a fluid pressure operated governor and forced feed lubricating system, of a primary pump driven by the turbine for developing a relatively high pressure of fluid varying proportionally to the speed of the turbine for operating the governor, an ejector operated by fluid under pressure for the primary pump for supplying a relatively low pressure fluid for the inlet of the pump and for the lubricating system, an auxiliary pump effective for developing fluid pressure proportionate to its speed, an auxiliary turbine for driving the auxiliary pump, means for admitting motive fluid to the auxiliary turbine to operate it at a speed effective for developing a pressure of fluid corresponding to the normal operating pressure of the governor, additional means for admitting motive fluid to the auxiliary turbine to operate it at a speed effective for developing a pressure of fluid corresponding to the normal primary pump inlet pressure, means effective upon a predetermined diminution of the pressure delivered by either the primary pump or by the ejector for automatically operating the corresponding motive fluid admission means to the auxiliary turbine, and means operable when the auxiliary pump is developing a relatively high fluid pressure for reducing the pressure for the lubricating system.

6. The combination with an elastic fluid turbine having a fluid pressure operated governor and a forced feed lubricating system, of a primary pump driven by the turbine for developing a relatively high pressure of fluid varying proportionally to the speed of the turbine for operating the governor, an ejector operated by fluid under pressure from the primary pump for supplying a relatively low pressure fluid for the inlet of the primary pump and for the lubricating system, an auxiliary pump effective for developing fluid pressure proportionate to its speed, an auxiliary turbine for driving the auxiliary pump, primary motive fluid admission means for the auxiliary turbine effective to cause it to rotate at a relatively high speed, secondary motive fluid admission means for the auxiliary turbine effective to cause it to rotate at a lesser speed, corresponding fluid-pressure operated controlling means for the respective admission means, said fluid-pressure operated controlling means being set to operate the admission means at a pressure slightly less than the normal pressure delivered by the primary pump and the normal pressure delivered by the ejector respectively, a conduit connecting the delivery side of the primary pump to the primary controlling means, and a conduit connecting the inlet side of the primary pump with the secondary controlling means, whereby during normal operation of the primary pump the auxiliary turbine and the auxiliary pump are idle and upon failure of either the delivery or the inlet pressure of the primary pump, the auxiliary turbine and the auxiliary pump are operated.

7. The combination with an elastic fluid turbine having a variable fluid pressure operated governor and a forced feed lubricating system, of a fluid reservoir, a primary centrifugal pump driven by the turbine for supplying a relatively high fluid pressure for operating the governor, a delivery conduit for the primary pump, an ejector disposed within the fluid reservoir for supplying the primary pump at its inlet with fluid at a relatively low positive pressure and for supplying the lubricating system, a delivery conduit for the ejector, a normally inactive auxiliary centrifugal pump located in the fluid reservoir, means operable upon a predetermined diminution in pressure in either of the conduits for starting the auxiliary pump and operating it at a speed for developing a pressure corresponding to the normal pressure in said conduit.

8. The combination with a main elastic fluid turbine having a variable fluid pressure operated governor and a forced feed lubricating system, of a primary centrifugal pump driven by the main turbine for developing a relatively high fluid pressure for the governor during normal operation, a fluid reservoir, an ejector located in the fluid reservoir and operated by pressure developed by the primary pump for supplying the lubricating system with fluid at a relatively low pressure during normal operation, an auxiliary centrifugal pump arranged to deliver fluid under pressure to the governor and to the lubricating system, an auxiliary turbine for driving the auxiliary pump, fluid pressure operated means communicating both with the auxiliary

pump and the primary pump for controlling the admission of motive fluid to the auxiliary turbine, said fluid-pressure operated means being set to close off the supply of motive fluid when acted upon by pressure slightly below the normal pressure developed by the primary pump, a throttle valve for the main turbine, and motive fluid conduit means between the throttle valve and the main turbine leading to the auxiliary turbine.

9. The combination with a main elastic fluid turbine having a variable fluid pressure operated governor and a forced feed lubricating system, of a primary centrifugal pump driven by the main turbine for developing a relatively high fluid pressure for the governor during normal operation, a fluid reservoir, an ejector located in the fluid reservoir and operated by pressure developed by the primary pump for supplying the lubricating system with fluid at a relatively low pressure during normal operation, an auxiliary centrifugal pump arranged to deliver fluid under pressure to the governor and to the lubricating system, an orifice valve between the auxiliary pump and the lubricating system for reducing the fluid pressure developed by the auxiliary pump for said system, an auxiliary turbine for driving the auxiliary pump, fluid pressure operated means communicating both with the auxiliary pump and the primary pump for controlling the admission of motive fluid to the auxiliary turbine, said fluid pressure operated means being set to close off the supply of motive fluid when acted upon by pressure slightly below the normal pressure developed by the primary pump.

In testimony whereof, I have hereunto subscribed my name this twentieth day of March, 1925.

HENRY F. SCHMIDT.