Sept. 17, 1929. R. MARSLAND 1,728,277

FLUID PRESSURE DEVELOPING SYSTEM

Filed May 28, 1925 2 Sheets-Sheet 1

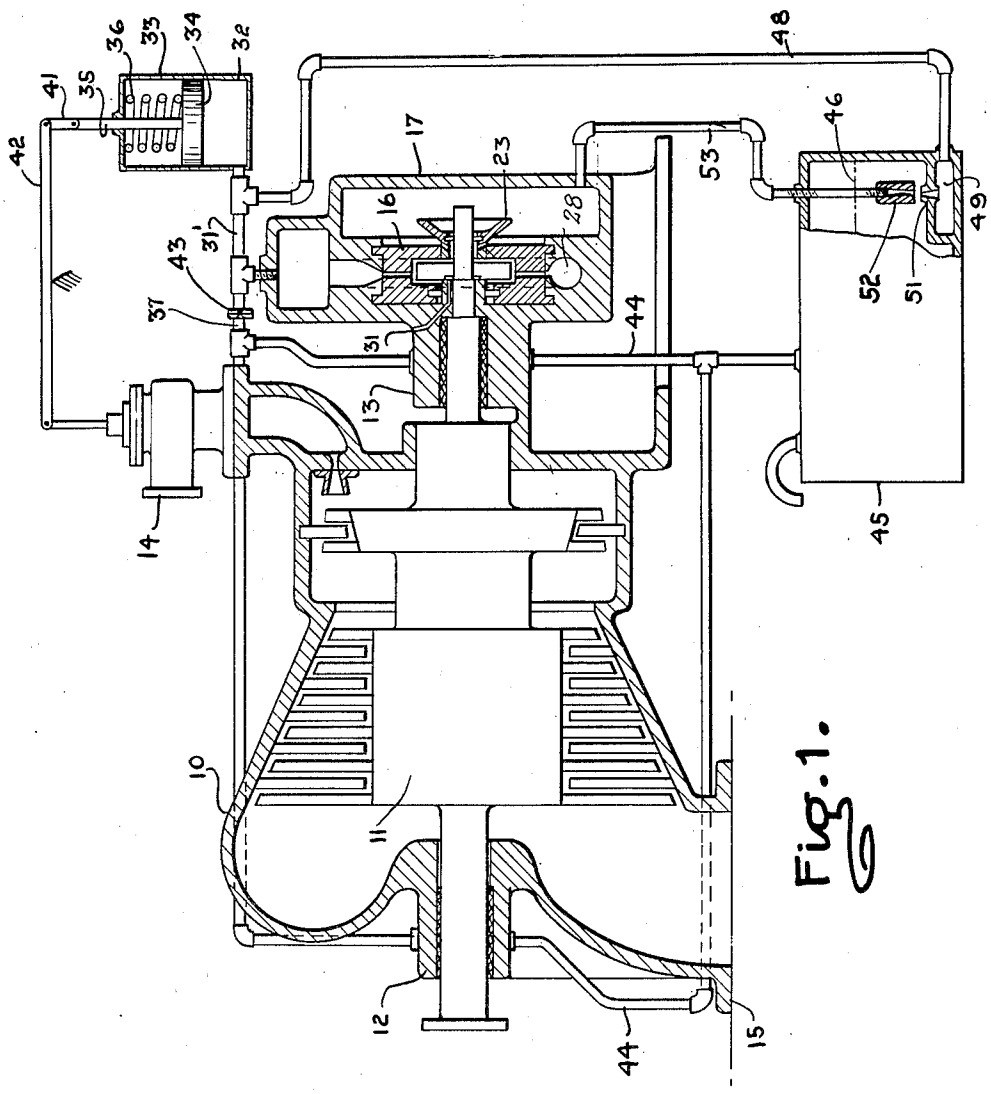


Fig. 1.

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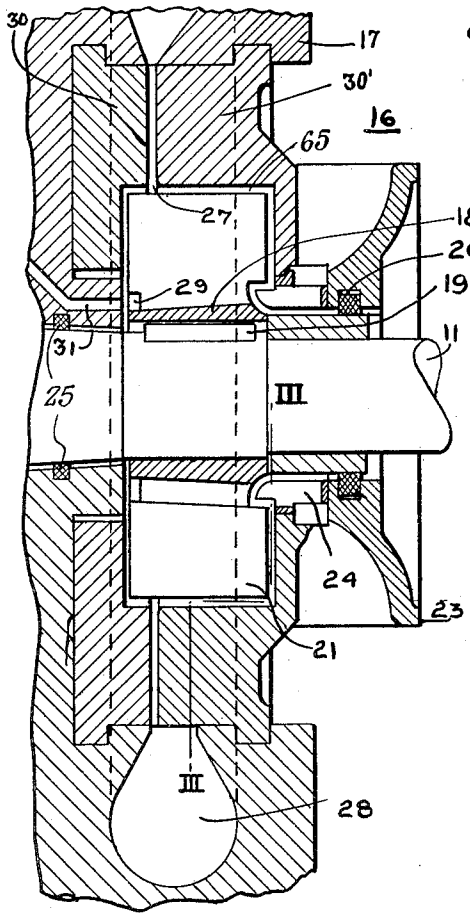


Fig. 2.

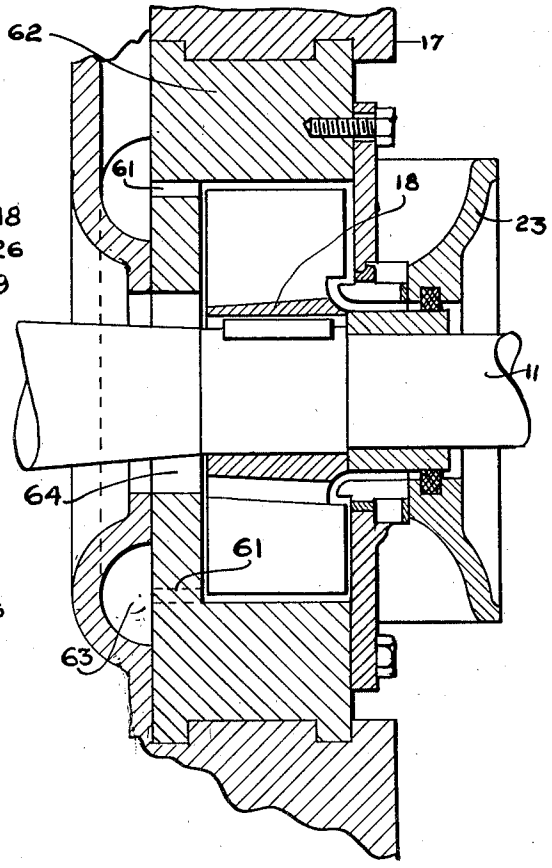


Fig. 4.

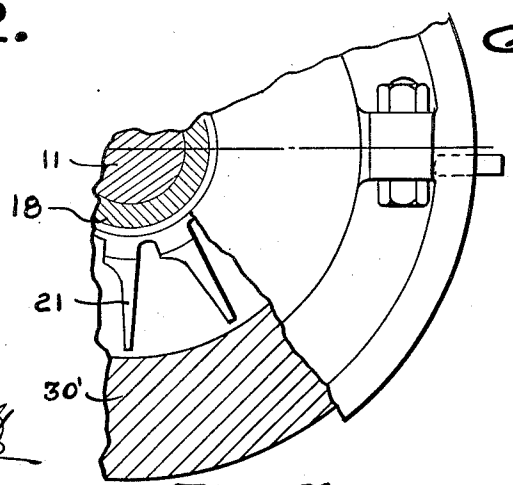


Fig. 3.

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Patented Sept. 17, 1929 1,728,277

UNITED STATES PATENT OFFICE

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FLUID-PRESSURE-DEVELOPING SYSTEM

Application filed May 28, 1925. Serial No. 33,420.

My invention relates to fluid pressure developing systems, particularly to systems for developing a liquid pressure for lubricating or for governing the speed of prime movers, such as steam turbines, or for both lubricating and governing, and it has for an object to provide a system of the character designated in which the pressure developed shall not be affected by the amount of air and non-condensable gases usually entrained in the liquid employed in the system. It has for a further object to provide a system which shall develop a fluid pressure which varies exactly as a function of the speed of the turbine by incorporating in such a system suitable apparatus for de-aerating the fluid.

These and other objects, which will be made apparent throughout the further description of the invention, may be attained by the employment of the apparatus hereinafter described and illustrated in the accompanying drawings in which:

Fig. 1 is a view, in sectional elevation, of one form of my fluid pressure developing system associated with a steam turbine; Fig. 2 is an enlarged view, in sectional elevation, of the fluid translating device employed in Fig. 1; Fig. 3 is a transverse sectional elevation taken on the line III—III of Fig. 2, and Fig. 4 is a view, in sectional elevation, of another form of fluid translating device which I may employ.

Governors of the fluid pressure type are generally recognized as providing a very effective, reliable and sensitive form of mechanism for controlling the speed of prime movers such, for example, as steam turbines. In this form of governing mechanism, the motive fluid admission valve of the prime mover is actuated by a fluid motor, the movements of which are responsive to fluid pressure generated in accordance with the speed of the prime mover. One form of fluid pressure developing means which may be employed is a pump of the centrifugal type driven by the rotor of the turbine and developing a pressure which varies as the square of its speed. Oil is the fluid which is frequently utilized in the fluid pressure developing means inasmuch as such a fluid may be employed to lubricate the turbine bearings in addition to actuating the pressure-responsive device of the governor mechanism.

A difficulty which has heretofore been encountered with governors of the fluid pressure type is that the lubricating oil, in its passage through the system, has entrained therein variable quantities of non-condensable gases, such as air, which affect the discharge pressure developed by the pump. As these changes in discharge pressure do not result from any changes in the speed of the turbine, it is apparent that the action of the governing mechanism is somewhat influenced by the amount of air entrained in the lubricating oil.

I have therefore devised a fluid pressure developing system which may be employed in various ways but which is especially adapted for use with governing mechanisms, inasmuch as I have incorporated therein means for de-aerating the fluid in its passage through the system. More particularly, I have developed a pump which is of the centrifugal type and which is of such large pumping capacity with respect to the outlet capacity that the liquid is acted upon by the impeller for an abnormal period of time. I have so associated the impeller with the pump casing that centrifugal force performs what might be termed gravitational separation, that is, the heavier particles of liquid which are possessed of greater kinetic energy are thrown outwardly to the periphery of the casing, thereby forcing the lighter particles of air inwardly to the axis of the pump. By venting off the air accumulating about the axis, the main body of the liquid contained in the pump is freed of any entrained air and the pressure generated is solely dependent upon the speed of the impeller.

Referring to the drawings for a more detailed description of my invention, I show in Fig. 1 a turbine 10 having a rotor 11 supported in bearings 12 and 13. The turbine 10 is provided with a motive fluid admission valve 14 and an exhaust connection 15. Attached to the rotor 11 is a fluid pressure de-

veloping apparatus or pump 16 which is housed within a casing 17. As shown in Figs. 2 and 3, the pump 16 comprises an impeller 18 which is secured to the rotor 11 by a key 19 and a housing 65 enclosing the impeller. The impeller 18 is provided with a plurality of impelling vanes 21 which are of sufficient radial length to develop the required fluid pressure and which are of such a longitudinal length that the flow of the liquid passing radially outward is comparatively slow, this slow flow being secured by employing a restricted outlet as will hereinafter more fully appear.

Formed with the casing 17 is a converging inlet 23 for supplying low pressure aerated liquid to the inner periphery of the impeller 18. The inlet 23 is provided with a plurality of radially disposed guide vanes 24 which project longitudinally within the entrant portion of the impeller 18 for avoiding any eddying of the fluid entering the impeller vanes. Liquid discharged from the impeller 18 is conveyed through a radial outlet 27, of limited flow area, formed by two rings 30 and 30′, fixed in the casing 17, to an annular chamber 28 provided in the casing 17. Interposed at suitable points between the casing 17 and the rotor 11 are sealing rings 25 and 26 for preventing leakage of the liquid between the rotating and stationary members of the pumping mechanism. Air and other non-condensable gases separated out by the pump are removed and vented to the atmosphere through an annular clearance space 29 provided near the inner periphery of the impeller 18 which communicates with a conduit 31.

The liquid discharged by the pump under pressure is conveyed from the annular chamber 28 to a conduit 31′ and thence to a pressure-responsive mechanism 32. The pressure-responsive mechanism 32 may assume any one of a number of mechanical forms. I have illustrated, for example, a cylinder 33 having disposed therein a piston 34 which is connected to a rod 35. A compression spring 36 is interposed between one end of the cylinder 33 and one face of the piston 34 for biasing the same to one end of the cylinder. Liquid is conveyed by the conduit 31′ to one end of the cylinder and acts upon the piston 34 in opposition to the force exerted by the spring 36. The rod 35 connects through a link 41 with a lever 42 for actuating the motive fluid admission valve 14, in a manner well understood in the art.

The conduit 31′ is provided with a branch 37 for conveying lubricant to the bearings 12 and 13. An orifice 43 is provided in the conduit 37 for reducing the pressure of the oil. The oil discharged from the bearings 12 and 13 is conveyed by means of conduits 44 to a drain tank 45 which maintains therein a level of lubricant as indicated at 46. The lubricant contained in the drain tank 45 may be returned to the reservoir formed by casing 17 in the manner disclosed in patent to Henry F. Schmidt, No. 1,627,750, dated May 10, 1927, assigned to the Westinghouse Electric and Manufacturing Company and entitled Lubricating system. In accordance with this system, a conduit 48 is provided which connects with the discharge conduit 31′ and with a fluid-tight pressure reservoir 49 provided in the lower portion of the drain tank 45. The pressure reservoir 49 has provided therein an injector nozzle 51 which is so arranged as to receive a quantity of the oil discharged by the pumping mechanism 16. Disposed within the drain tank 45, in axial alignment with the nozzle 51 and below the liquid level 46, is a diffuser 52. The diffuser 52 is adapted to receive as motive fluid the lubricant under pressure which is discharged by the injector nozzle 51. By means of a conduit 53 the lubricant discharged by the injector apparatus is pumped upwardly to the casing 17.

The operation of the above apparatus is as follows: The casing 17 is substantially filled and the drain tank 45 is filled to the level indicated with a lubricating oil. When the turbine is in operation, the rotor 11 rotates the impeller 18 and lubricant is drawn inwardly through the converging inlet 23 to the inner portion of the impelling vanes 21. The lubricant is then pumped by centrifugal force through the radial outlet 27 to the annular chamber 28. The area or pumping capacity of the impelling vanes 21 in proportion to the flow area of the radial outlet 27 is such that the outward movement of the lubricant is comparatively slow, in other words, the lubricant is subjected to the impelling action of the pump for an abnormal period of time. This action results in increasing the temperature of the lubricant and facilitating removal of the entrained air. The pump is so designed that the aerated liquid is thrown outwardly, thereby effecting what might be termed centrifugal separation, that is, the heavier particles of lubricant move outwardly, thereby forcing the lighter particles of air inwardly to the axis of the pump where they are vented off or liberated to the atmosphere through the space 29 and the conduit 31. Lubricant entering the pump housing 65 is confined therein by means of the sealing rings 25 and 26.

The de-aerated lubricant at a relatively high pressure is discharged through the conduit 31′ and acts upon the piston 34 to overcome the force exerted by the spring 36. The movements of the piston are transmitted by the lever 42 to the motive fluid admission valve 14 for opening and closing the same. A pump of the centrifugal type develops, if the entrained air is removed from the liquid, a fluid pressure which varies directly as the square of its speed and hence, in the present arrangement, the admission of motive fluid to

the turbine is dependent solely upon the speed of the turbine. In this manner, very accurate governing is effected and the permissible speed variation is reduced to a minimum.

A quantity of the de-aerated lubricant discharged through the outlet 27 may, if desired, be conveyed through the conduit 37 and the orifice 43 to the bearings 12 and 13, from whence it is drained by the conduits 44 to the drain tank 45. While I may employ the de-aerated lubricant for only actuating the governing mechanism, nevertheless, I have found that liquid so treated has superior lubricating qualities and I therefore prefer to convey the de-aerated lubricant to the bearings. Lubricant is returned from the drain tank to the casing by means of the nozzle 51 and the diffuser 52 which employs, as motive fluid, a small quantity of the lubricant discharged by the pumping mechanism. The lubricant discharged through the nozzle 51 entrains the required quantity of oil in the drain tank 45 and it is discharged upwardly through the conduit 53 to the reservoir provided by the casing 17, whereupon it may be again circulated through the system. It is apparent that the lubricant, in its passage through the system, may subsequently entrain some air. However, my pumping mechanism 16 is so arranged that the oil is de-aerated each time it passes through the cycle and any additional entrained air is readily removed.

In Fig. 4 I show another form of pump which I may employ and which is similar to that shown in Fig. 2 with the exception that the pressure developed by the pump is conveyed through a plurality of holes 61 disposed in an axial direction in a housing 62. The holes 61 communicate with an annular chamber 63 for the discharge of the fluid. The aggregate area of the holes 61 with respect to the area or pumping capacity of the impeller 18 is such as to thoroughly de-aerate the liquid in the manner heretofore described. In this embodiment, the air and non-condensable gases are liberated through the annular clearance 64 provided between the rotor 11 and the bore of the housing 62.

While I have described my invention as employing a pumping mechanism of the centrifugal type, it is to be understood that my invention is not confined to the arrangement illustrated but that I may associate de-aerating facilities in the novel manner disclosed with pumps of various types and thereby secure more accurate governing of prime movers and at the same time more effective lubrication.

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 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. In a governing system of the type utilizing the pressure of liquid as the governing or controlling force for controlling the speed of a machine, the combination of a pressure chamber, an element operable by the pressure in said chamber, means controlled by said element for controlling the speed of the machine, means for supplying a liquid governing pressure to said pressure chamber and including a chamber and an impeller disposed in the last-named chamber and driven by the machine, and means providing for the impeller giving for each speed thereof a pressure which is substantially uniform and constant and including leak-off means associated with the pressure-developing means for removing gaseous media from the liquid acted upon by said pressure-developing means.

2. In a governing system of the type utilizing the pressure of liquid as the governing or controlling force for controlling the speed of a machine, the combination of a pressure chamber, an element operable by the pressure in said chamber, means controlled by said element for controlling the speed of the machine, means for supplying a liquid governing pressure to said pressure chamber and including a chamber and an impeller disposed in the last-named chamber and driven by the machine, and means providing for the impeller giving for each speed thereof a pressure which is substantially uniform and constant and including a leak-off passage for gaseous media extending into said impeller chamber and having its inlet end located adjacent to the inner portion of the impeller.

3. In a governing system of the type utilizing the pressure of liquid as the governing or controlling force for controlling the speed of a machine, the combination of a pressure chamber, an element operable by the pressure in said chamber, means controlled by said element for controlling the speed of the machine, means for supplying a liquid governing pressure to said pressure chamber and including a chamber and an impeller disposed in the last-named chamber and driven by the machine, and means providing for the impeller giving for each speed thereof a pressure which is substantially uniform and constant and including outlet means for the impeller chamber of limited flow area compared to the pumping capacity of the impeller and a leak-off passage for gaseous media located adjacent to the inner portion of the impeller.

4. In a governing system of the type utilizing the pressure of liquid as the governing or controlling force for controlling the speed of a machine, the combination of a pressure chamber, an element operable by the pressure in said chamber, means controlled by said element for controlling the speed of the

machine, means for supplying a liquid governing pressure to said pressure chamber and including a cylindrical chamber and an impeller disposed in the last-named chamber and driven by the machine, and means providing for the impeller giving for each speed thereof a pressure which is substantially uniform and constant and including a restricted peripheral outlet passage for said cylindrical chamber and having a flow area which is limited compared to the pumping capacity of the impeller and leak-off means for gaseous media communicating with said chamber at the side thereof opposite to the inlet.

5. In a governing system of the type utilizing the pressure of liquid as the governing or controlling force for controlling the speed of a machine, the combination of a pressure chamber; an element operable by the pressure in said chamber; means controlled by said element for controlling the speed of the machine; means for supplying a liquid governing pressure to said pressure chamber and including an annular supply chamber communicating with said pressure chamber, a cylindrical impeller chamber arranged inwardly of said annular supply chamber, and an impeller disposed in the cylindrical chamber and driven by the machine; and means providing for the impeller giving for each speed thereof a governing pressure which is substantially uniform and constant and including a passage disposed peripherally of the cylindrical chamber and communicating with the supply chamber, the flow area of the passage being relatively small compared to the pumping capacity of the impeller, and a leak-off passage for gaseous media having its inlet located adjacent to the inner portion of the impeller.

6. In a governing system of the type utilizing the pressure of liquid as the governing or controlling force for controlling the speed of a machine, the combination of a pressure chamber, an element operable by the pressure in said chamber, means controlled by said element for controlling the speed of the machine, means for supplying a liquid governing pressure to said pressure chamber and including a chamber having a centrally-disposed inlet at one side and an impeller disposed in the last-named chamber and driven by the machine, and means providing for the impeller giving for each speed thereof a governing pressure which is substantially uniform and constant and including outlet means of limited flow area compared to the pumping capacity of the impeller, guide vanes arranged in said inlet, and a leak-off passage for gaseous media having its inlet located adjacent to the inner portion of the impeller.

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

ROLAND MARSLAND.