Sept. 23, 1941. H. F. SCHMIDT 2,256,963

HYDRAULIC GOVERNING APPARATUS

Filed Nov. 12, 1940

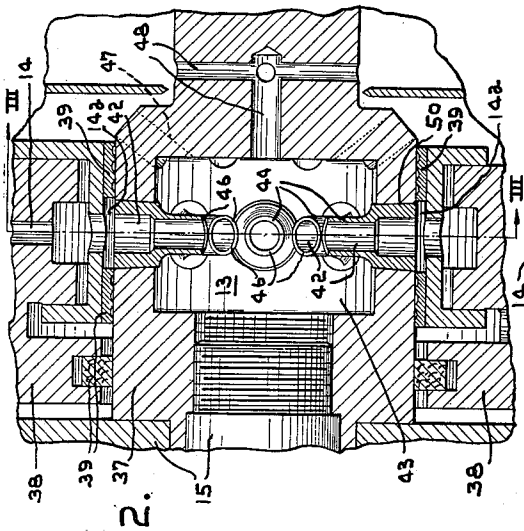


Fig. 2.

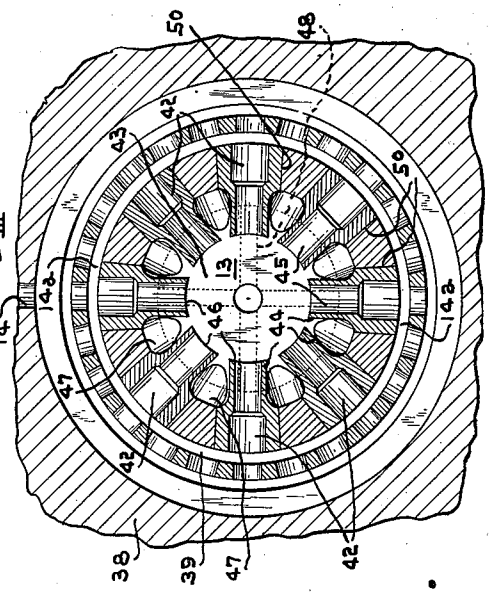


Fig. 3.

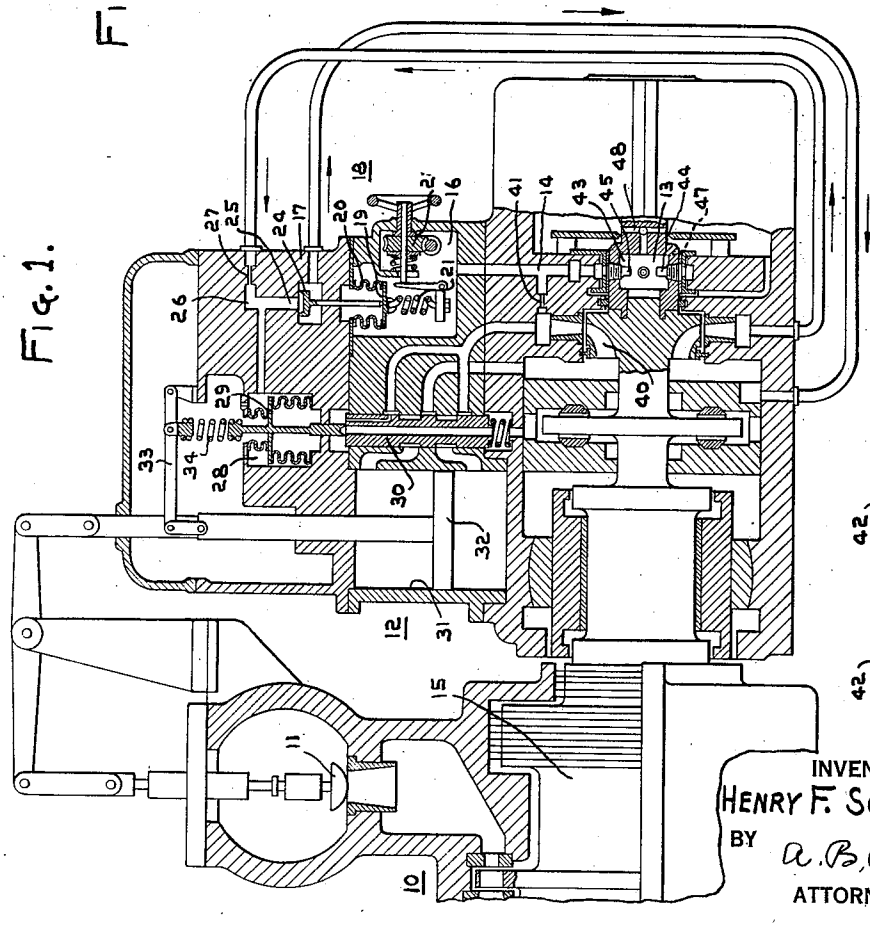


Fig. 1.

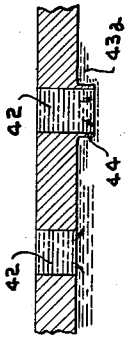


Fig. 4.

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HYDRAULIC GOVERNING APPARATUS

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10 Claims. (Cl. 264—14)

The invention relates to hydraulic governing apparatus and the like and it has for an object to provide therefor improved means for regulating liquid under pressure depending upon speed, such that the pressure variations correspond more accurately to variations in speed and steadier governing pressures are secured.

In the patent of Bryant, No. 2,035,689, granted March 31, 1936, there is disclosed and claimed a reverse flow impeller, or centrifugal device resisting escape of liquid, operating to secure modification of liquid pressure in a space so that the pressure varies as a function of the speed of the impeller. The space is supplied with liquid from a suitable source by means of an orifice, and escape from the space, except for leakage, can occur only through the impeller, with the result that the latter determines the pressure in the space so that such pressure may be used for governing purposes. This arrangement is sometimes subject to the objection of pressure fluctuations or variations due to variations in the length of column of liquid in the passage centrifugally resisting escape. If there is a change in leakage, this would tend to reduce the space pressure, resulting in operation of the governor to change the speed of the turbine until equilibrium conditions are restored. To minimize this effect of leakage variation, the flow should be made large in relation to any anticipated leakage; however, with the single passage shown in the patent, increased flow can be had only with variation in the effective radial length of the column centrifugally resisting escape, and this introduces a variation in the pressure and speed relation. To overcome this objection, I provide an impeller wherein the flow may be so large in comparison to the leakage that any variation in the latter will not affect the pressure, and large variations in flow may occur with only negligible change in effective radial length of the column resisting escape. More particularly, I provide an impeller body having an axial bore and a plurality of passages connecting the space thereabout with the bore. Also, each passage preferably has its discharge end bounded by a ridge so that, as liquid flows over the latter, centrifugal force immediately effects outward movement of such escaping liquid toward the wall of the bore, the body having adequate escape openings to prevent liquid accumulating in the bore and affecting in any way the character of discharge from the tubular portions; and, as the aggregate ridge peripheral extent is relatively large, very substantial variations in flow can occur without any appreciable change in the thickness of the overflowing crest layer, with the result that the flow can change over a wide range without changing the radial column length of liquid setting up centrifugal resistance to escape and, therefore, without change in pressure on account of column length variation.

A further object of the invention is to provide a centrifugal fluid relief device for a hydraulic governor comprising a rotary member having a discharge bore and a plurality of relief passages discharging thereinto and distributed circumferentially of the member.

Another object of the invention is to provide a centrifugal relief device for liquid and including one or more passages formed in a rotary member so that the discharge end of each passage is nearer to the axis of the member than its outlet end and is located between the latter and the axis together with a ridge bounding the discharge end of each passage to provide for liquid issuing from the discharge end assuming a crest formation to minimize the thickness of the discharging or overflowing liquid layer.

These and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawing, forming a part of this application, in which:

Fig. 1 is a longitudinal sectional view of a turbine equipped with a hydraulic governing system which is provided with the improved impeller;

Fig. 2 is a detail axial sectional view of the impeller;

Fig. 3 is a sectional view taken along the line III—III of Fig. 2; and,

Fig. 4 is a diagrammatic view illustrative of a principle of the invention.

Referring now to the drawing more in detail, there is shown a prime mover or turbine, at 10, having an admission valve 11 operated by means of a servo-motor, at 12, under control of the hydraulic governor.

The hydraulic governor includes an impeller, at 13, operating to provide, in the enclosed space 14, liquid under pressure varying substantially as the square of the speed of the turbine rotor 15 to which the impeller is attached.

The space 14 includes the primary pressure chamber 16 formed in the structure 17 of the transformer governor, at 18. A pressure abutment 19 is disposed within the pressure chamber, it being connected to the structure 17 by means

of a bellows or sylphon element 20, and a spring 21 exerts its force on the abutment 19 in a direction opposite to that of the fluid pressure force, one end of the spring being connected to suitable speed changer mechanism 22. The abutment 19 is associated with any suitable means effective to amplify changes in impeller pressure.

By way of example, the amplifying or transforming means associated with the pressure abutment 19 may comprise a cup valve 24 arranged in covering relation with respect to the ecape port 25 of the pressure space 26 supplied with liquid under pressure by means of the orifice 27 from any suitable source of pressure. The pressure space 26 also includes the pressure chamber or space 28 of a pressure-responsive device, at 29, of the servo-motor, changes in pressure in the space 26 resulting in operation of the pressure-responsive device, at 29, to bring about operation of the pilot valve 30 of the servo-motor to control the admission and exhaust of motive fluid to the operating cylinder 31 to secure movement of the operating piston 32 to adjust the admission valve, movement of the operating piston being transmitted through the follow-up mechanism, at 33, to change the force on the spring 34 incident to such movement of the operating piston so that movement of the latter may be terminated when equilibrium is again restored on the pressure-responsive device, at 29, with the pilot valve in neutral cut-off position.

The impeller, at 13, is comprised, for example, by a cylindrical body 37 attached to the rotor 15. A housing structure 38 has spaced annular seals 39 fitting the periphery of the body 37 so as to provide an annular portion 14*a* of said space 14. Any suitable means may be used to supply liquid to the space 14 so that the liquid pressure therein may depend upon the resistance of the centrifugal escape means hereinafter described. For example, there is provided, adjacent to the body 37, a centrifugal pump, at 40, driven by the rotor 15 and providing a suitable source of oil under pressure for any desired purpose, this source being connected by means of an orifice 41 to the space 14.

Resistance to escape from the space 14*a* is provided by a plurality of passages 42 formed in the body 37 and affording communication between the encompassing space 14*a* and the interior bore 43 having a wall 43*a*. The inner end of each passage 42 is bounded by a ridge 44 extending from the bore wall to provide for discharge of liquid from each passage in crest formation. Preferably the passages 42 and the ridges 44 are provided by tubular members 45.

The inner ends 46 of the ridge portions 44 are formed so that the discharge edges are included in a cylindrical surface which is coaxial with the cylindrical periphery of the body 37. Liquid is discharged from the bore by means of suitably located passages 47. Also, maintenance of atmospheric pressure in the bore is assured by means of the vent passages 48.

The ridge portion 44 of each passage 42 provides for liquid issuing from the latter taking a crest formation, with the result that a minimum thickness of the discharging layer will be maintained. If, as diagrammatically shown at the left in Fig. 4, the passage did not have its discharge end bounded by a ridge, then fluid after discharge would tend to accumulate and introduce considerable variation in thickness of the liquid layer at the discharge end of the passage. This objection is avoided by means of the ridge 44 bounding the discharge end of the passage, as will be seen from the passage at the right of Fig. 4. Just as soon as liquid passes over the crest of the ridge, centrifugal force is then effective to move such liquid outwardly radially, with the result that any tendency of liquid to accumulate on the wall 43*a* would not cause variations in thickness of the crest layer. Thus, by providing a ridge to give a crest formation to the liquid issuing from the centrifugal relief passage, the discharging liquid layer is kept very thin and minimum variations in thickness thereof occur with variations in flow with the result that the radial length of the column of liquid giving centrifugal resistance to escape is kept substantially constant and pressure pulsations due to column length variations are avoided.

Due to the provision of a plurality of passages 42 distributed circumferentially about the body 37, it is assured that any variations in pressure in the space encompassing the body will be averaged, thereby making operation of the device more uniform. Furthermore, by the use of a suitable number of distributed passages, it becomes possible to provide for such relatively large flow that variations in leakage are relatively small in comparison thereto, the wide variations in flow taking place without any appreciable variation in radial length of the column of liquid in the passages resisting centrifugally the escape of fluid. Fluid escaping from the inner or ridge ends of the tubular portions 45 overflows the discharge edges 46 in a very thin crest layer for the reason that the aggregate or peripheral extent of all of the edges 46 is relatively large in comparison to flow, so that very large changes in flow may occur without any appreciable variation in thickness of the crest layer and consequently variation in effective length of the hydraulic column resisting escape centrifugally.

As shown, the escape passages 47 are distributed about the body 37 and communicate with the bore adjacent to the peripheral bore wall, and these passages in the aggregate have a flow area substantially larger than that of the passages 42 so that liquid may escape from the bore as rapidly as it enters, thereby preventing any accumulation or tendency thereof to disturb the pressure conditions created by the passages 42.

While the passages 42 may be formed in any suitable manner, I prefer to have the body 37 provided with a circumferential series of radial openings 50 for the reception of the tubular elements 45 which provide the passages 42 as well as the inner tubular extensions or ridges 44.

While the invention has been shown 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 it is desired, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What is claimed is:

1. In a hydraulic governor for controlling the speed of a rotary member, means for maintaining a pulsation-free pressure dependent upon speed of the rotary member and including a centrifugal fluid relief passage formed in the latter, said passage having its discharge end disposed nearer to the axis of the rotary member than its inlet end and located between the latter and the axis, and a ridge carried by the

rotary member and bounding the discharge end of the passage.

2. The combination as claimed in claim 1, wherein the crest of the ridge is located in a cylindrical surface coaxial with the rotary member.

3. In a hydraulic governor for controlling the speed of a rotary member, means for maintaining a pulsation-free pressure dependent upon speed of the rotary member and including a plurality of centrifugal fluid relief passages formed in the latter, said passages being distributed circumferentially about the rotary member and each passage having its discharge end disposed nearer to the axis of the rotary member than its inlet end and located between the latter and the axis, and ridges carried by the rotary member and bounding the respective discharge ends of the passages.

4. The combination as claimed in claim 3, wherein the crests of the ridges are located in a cylindrical surface coaxial with the rotary member.

5. The combination with a rotary member having a cylindrical portion, of apparatus providing liquid under pressure dependent upon speed of the member and comprising means, including the cylindrical portion of the rotary member, defining a space for the liquid under pressure; said space having an annular portion whose inner boundary wall is provided by said cylindrical portion of the rotary member; means providing for escape of liquid from said space and including a bore formed in the cylindrical portion and a plurality of passages formed in the latter with their outer ends communicating with the annular portion of said space and with their inner ends communicating with said bore; ridges carried by the rotary member within the bore and bounding the discharge ends of the passages; and means for supplying liquid to said space so that the pressure therein depends upon the escape resistance provided by said escape means.

6. The combination as claimed in claim 5, wherein the passages are distributed circumferentially about the rotary member.

7. The combination as claimed in claim 5, wherein the passages extend radially of the rotary member and are distributed circumferentially thereof.

8. The combination as claimed in claim 5, wherein the crests of the ridges are in a cylindrical surface coaxial with the rotary member.

9. The combination as claimed in claim 5, wherein the passages extend radially of the rotary member and are distributed circumferentially thereof and wherein the crests of the ridges are in a cylindrical surface which is coaxial with the rotary member.

10. The combination with a rotary member having a cylindrical portion, of apparatus for developing liquid under pressure dependent upon speed of the member and comprising means including the cylindrical portion of the rotary member providing a space for the liquid under pressure; said space having an annular portion whose inner boundary wall is provided by said cylindrical portion of the rotary member; means for including an orifice for supplying liquid from a pressure source to said space; means providing for escape of liquid from said space including a bore formed in the cylindrical portion, a plurality of passages formed in the latter with their outer ends communicating with the annular portion of said space and with their inner ends communicating with said bore, and escape openings formed in the cylindrical portion and communicating with the bore adjacent to the peripheral bore wall; said last-named means including ridges carried by the cylindrical portion and bounding the discharge ends of said passages and all of the crest portions of the ridges being in a cylindrical surface which is coaxial with the cylindrical portion; and a passage formed in the rotary member and affording communication between the bore and the atmosphere.

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