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GOVERNING VALVE FOR PRIME MOVERS

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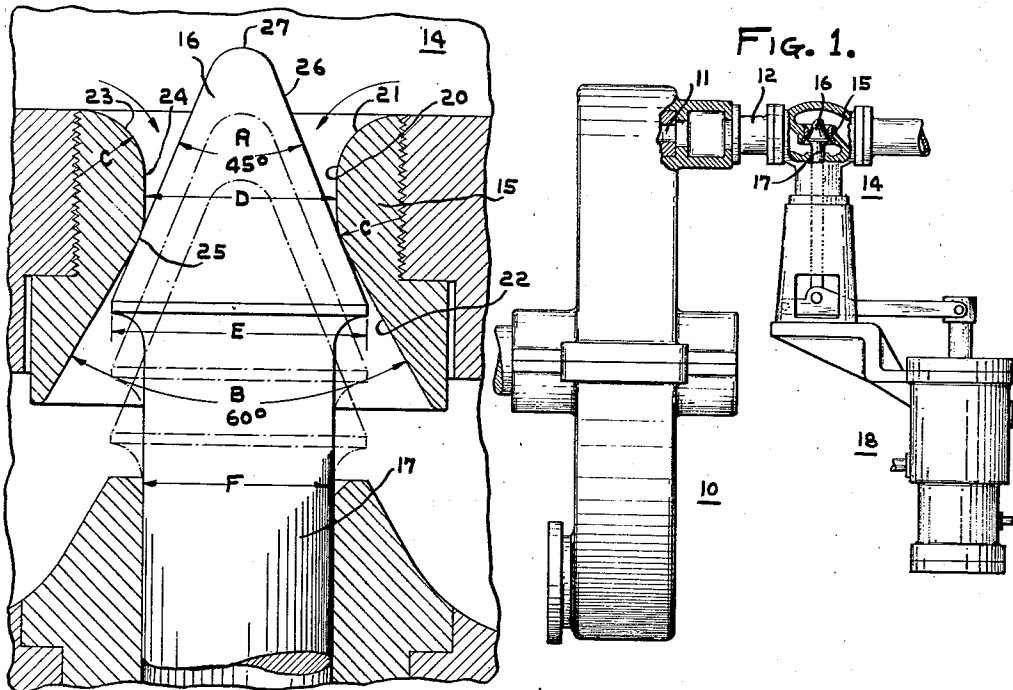


FIG. 2.

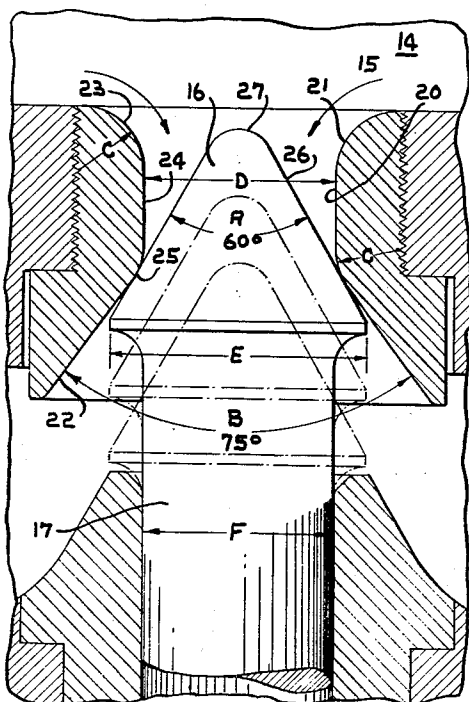


Fig. 3.

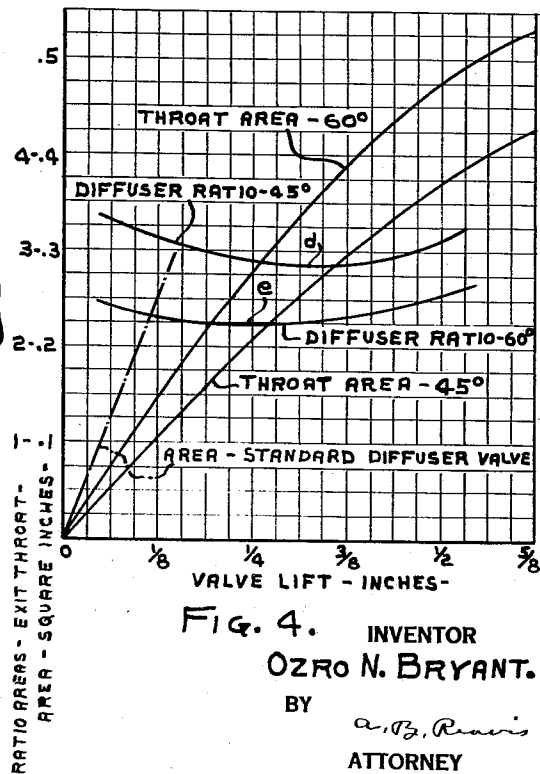


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GOVERNING VALVE FOR PRIME MOVERS

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5 Claims. (Cl. 251—27)

The invention relates to a governor valve for an elastic fluid or steam turbine and it has for an object to provide apparatus of this character capable of covering a relatively wide range of steam or elastic fluid pressures and which will give substantially similar characteristics throughout its entire stroke or lift.

For certain steam turbine applications, for example, an auxiliary application such as for driving an auxiliary oil pump, the turbine should be capable of covering a relatively wide range of steam or elastic fluid pressures. The steam pressure may vary from 100 to 1200 pounds per square inch. The turbine nozzle area should be approximately inversely proportional to the steam pressure. It is desirable, for these conditions, to provide a governor valve which will give substantially similar characteristics throughout its entire stroke or lift.

The ordinary plug valve does not have a straight line relation between lift and steam flow when the back pressure rises above 55 to 60 per cent of the supply pressure. As may be seen from Patent No. 2,091,669, issued to the present applicant on August 31, 1937, and assigned to the Westinghouse Electric & Manufacturing Company, it is known that a diffuser valve does have a straight line relation between lift and steam flow even with back pressures as high as 90 to 95 per cent of the supply pressure. Since it is good practice where turbines are used to drive apparatus, such as auxiliary oil pumps, to provide excess nozzle area so that the turbine will run satisfactorily even at reduced steam pressures, the back pressure will not ordinarily exceed 90 per cent of the supply pressure; however, a diffuser valve, such as disclosed in said patent, is not adapted to such extremes of steam flow and pressure, and, for this reason, the diffuser becomes practically useless at small values of steam flow. What is required in a situation of this kind, and which it is the object of this invention to satisfy, is a valve having a diffuser exit area nearly in constant proportion to the valve annulus area and in which the annulus area is nearly proportional to the valve lift. It is also desirable for the lift to be relatively large in relation to the annulus area so as to facilitate control at small steam flows.

A further object of the invention is to provide a governor valve of the diffuser type comprising a diffuser and valve members with such a relation of the diffuser passage and divergency of the valve member in the direction of flow that a small change in ratio of exit area to annulus area

occurs over the whole range of lift of the valve member.

A further object of the invention is to provide, in connection with a governor valve comprising diffuser and valve members, the diffuser member having a diffuser passage including an upper part which is convexly curved in the direction of flow to provide convergent, throat and divergent portions and a lower conical divergent part into which the curved divergent portion merges, the valve member being conically divergent in the direction of flow and cooperating with the convexly-curved divergent portion of the diffuser passage to define an annulus area and with the conically divergent portion of such passage to define an exit area, such relation of diffuser passage and valve member surfaces that a small change in ratio of exit area to annulus area occurs over the entire range of lift of the valve member.

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 diagrammatic view showing a steam turbine having the improved governor valve applied thereto;

Fig. 2 is a sectional view showing the preferred form of governor valve;

Fig. 3 is a view similar to Fig. 2 but showing a modified form of the governor valve; and,

Fig. 4 is a graph showing operating characteristics of the valve.

Referring now to the drawing more in detail, in Fig. 1, there is shown a steam turbine, at 10, having nozzles 11 for supplying steam at high velocity to suitable blading (not shown). Motive steam is supplied to the turbine by means of the conduit or passage 12 provided with the governor valve, at 14.

The governor valve includes diffuser and valve members 15 and 16, the valve member being joined to a stem 17 operatively connected to suitable servo-motor apparatus, at 18. Suitable servo-motor apparatus for controlling the movable valve member is more particularly described in the application of A. F. Schwendner et al., Serial No. 381,804, filed March 5, 1941.

The diffuser member 15 has a diffuser passage 20 comprising a first part 21 and a second part 22. The first, or upper, part includes convergent, throat and divergent portions 23, 24, and 25, respectively, and at least the convergent and divergent portions are convexly curved in the direc-

tion of flow. The second, or lower, part 22 is conically divergent and the divergent portion 25 of the first part merges therein.

The valve member 16 has a conical surface 26 which diverges in the direction of flow. The upper or apical end of the valve member is rounded or faired, as shown at 27. The lower or basal end of the valve member is joined to the valve stem 17, the latter being operatively connected to the servo-motor apparatus, at 18.

The conical surface 26 of the valve member has a small angle of divergence in relation to the conical surface of the second part 22 of the diffuser passage so that there occurs, over the whole range of lift or stroke of the valve member 16 a small change in ratio of exit area, defined between the conical surface 26 of the valve member at the lower or basal end of the latter and the conical surface 22, and the annulus area, defined between the conical surface 26 and the curved divergent portion 25 of the diffuser passage. As shown in Fig. 2, the angle of divergence B of the lower conical part 22 of the diffuser passage is 60° and the angle of divergence A of the valve member surface 26 is 45°, thereby providing an angle of divergence of 15° between the surfaces 26 and 22. Fig. 3 is similar to Fig. 2 except that the angles B and A are larger, B being 75° and A, 60°.

The radius of curvature C of the convexly-curved upper part of the diffuser passage is preferably one-third of the diameter of the throat portion 24, the diameter being indicated at D.

The diameter F of the stem 17 is preferably made equal to the throat diameter D so that a practically constant steam unbalance may be imposed on the valve member for the entire range of travel of the latter.

A valve, such as described, is advantageous in that a high, uniform diffuser area ratio occurs over the entire range and this makes possible a substantially constant relation as between lift and steam flow regardless of back pressure. Furthermore, the improved valve provides for relatively greater lift, for a given steam flow and for a very high flow coefficient at all lifts. These advantageous relations will be apparent from a consideration of Fig. 4. In Fig. 4, the curve d shows that the diffuser area ratio, that is, the ratio of exit area to annulus area for Fig. 2 changes through the small amount of from 2.75 to 3.25 over the whole range of lift. Similarly, the curve e of Fig. 4 shows that this ratio changes through the small amount of 2.2 to 2.6 over the whole valve lift range of the valve of Fig. 3.

While the invention has been shown in several forms, 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 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 governor valve for an elastic fluid turbine, means providing an elastic fluid chamber: means for conducting elastic fluid from the chamber to the turbine and including a diffuser member: said diffuser member having a diffuser passage comprising first and second parts and the first part converging in the direction of flow to a throat and then diverging: said convergent and divergent portions of the first part of the diffuser passage being convexly curved in the direction of flow: said second part of the diffuser passage being conically divergent and merging

into said curved divergent portion of the first part: and a valve member including a conical head and a stem joined to the basal end of the latter: said head diverging in the direction of flow, defining, with said second part of the diffuser passage an exit area, and defining, with said curved divergent portion an annulus area; and the angle of divergence of the head being sufficiently less than the angle of divergence of said second part of the diffuser passage to provide for a substantially constant ratio of exit area to annulus area over the whole range of lift of the valve member in order that the relation between flow and lift may remain substantially uniform.

2. In a governor valve for an elastic fluid turbine, means providing an elastic fluid chamber: means providing a passage for conducting elastic fluid from the chamber to the turbine and including a diffuser member: said diffuser member having a diffuser passage comprising first and second parts and the first part converging in the direction of flow to a throat and then diverging: said convergent and divergent portions of the first part of the diffuser passage being convexly curved in the direction of flow: said second part of the diffuser passage being conically divergent and merging into said curved divergent portion of the first part: and a valve member including a conical head and a stem joined to the basal end of the latter: said head diverging in the direction of flow, defining, with said second part of the diffuser passage, an exit area, and defining, with said curved divergent portion of the first part of the diffuser passage, an annulus area; said stem having a diameter equal to the throat diameter of the diffuser passage; and the angle of divergence of the head being sufficiently smaller than the angle of divergence of said second part of the diffuser passage to provide for a substantially constant ratio of exit area to annulus area over the whole range of lift of the valve member in order that the relation between flow and lift may remain substantially uniform.

3. In a governor valve for an elastic fluid turbine, means providing an elastic fluid chamber: means providing a passage for conducting elastic fluid from the chamber to the turbine and including a diffuser member: said diffuser member having a diffuser passage comprising first and second parts and the first part converging in the direction of flow to a throat and then diverging: said convergent and divergent portions of the diffuser passage being convexly curved in the direction of flow about a radius of curvature of the order of one-third of the throat diameter: said second part of the diffuser passage being conically divergent and merging into the curved divergent portion of the first part: and a valve member including a conical head and a stem joined to the basal end of the latter: said head diverging in the direction of flow, defining, with said second part of the diffuser passage, an exit area, and defining, with said curved divergent portion of the first part of the diffuser passage, an annulus area; said stem having a diameter equal to the throat diameter of the diffuser passage; and the conical divergent surface of the second part of the diffuser passage having an angle of divergence in the direction of flow of the order of 15° to provide for a substantially constant ratio of exit area to annulus area over the whole range of lift of the valve member in order that the relation between flow and lift may remain substantially uniform.

4. The combination as claimed in claim 3 wherein the angle of divergence of the divergent conical surface of the second part diffuser passage is 75° and the angle of divergence of the valve member conical surface is 60° .

5. In a diffuser valve for an elastic-fluid turbine, a diffuser having a passage including a first part followed in the direction of fluid flow by a second part: said first part including convergent, throat and divergent portions and the convergent and divergent portions being curved convexly in the direction of flow about a radius equal approximately to $\frac{1}{3}$ of the throat diameter: said second part being conically divergent and the convexly-curved divergent portion of the first part merging into the latter: and a valve including a conical head and a stem joined to the

5 basal end of the latter: said head diverging in the direction of flow at an angle sufficiently less than the angle of divergence of said conically divergent second part of the diffuser passage to provide a small change in ratio of exit area, defined between the basal end of the conical head and the diffuser passage conical surface, to annulus area, defined between the convexly-curved divergent portion of the first part of the diffuser passage and the conical head, over the whole range of valve lift in order that the relation between flow and lift may remain substantially uniform; and said conical head and the stem having a diameter approximately equal to that of said throat.

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