

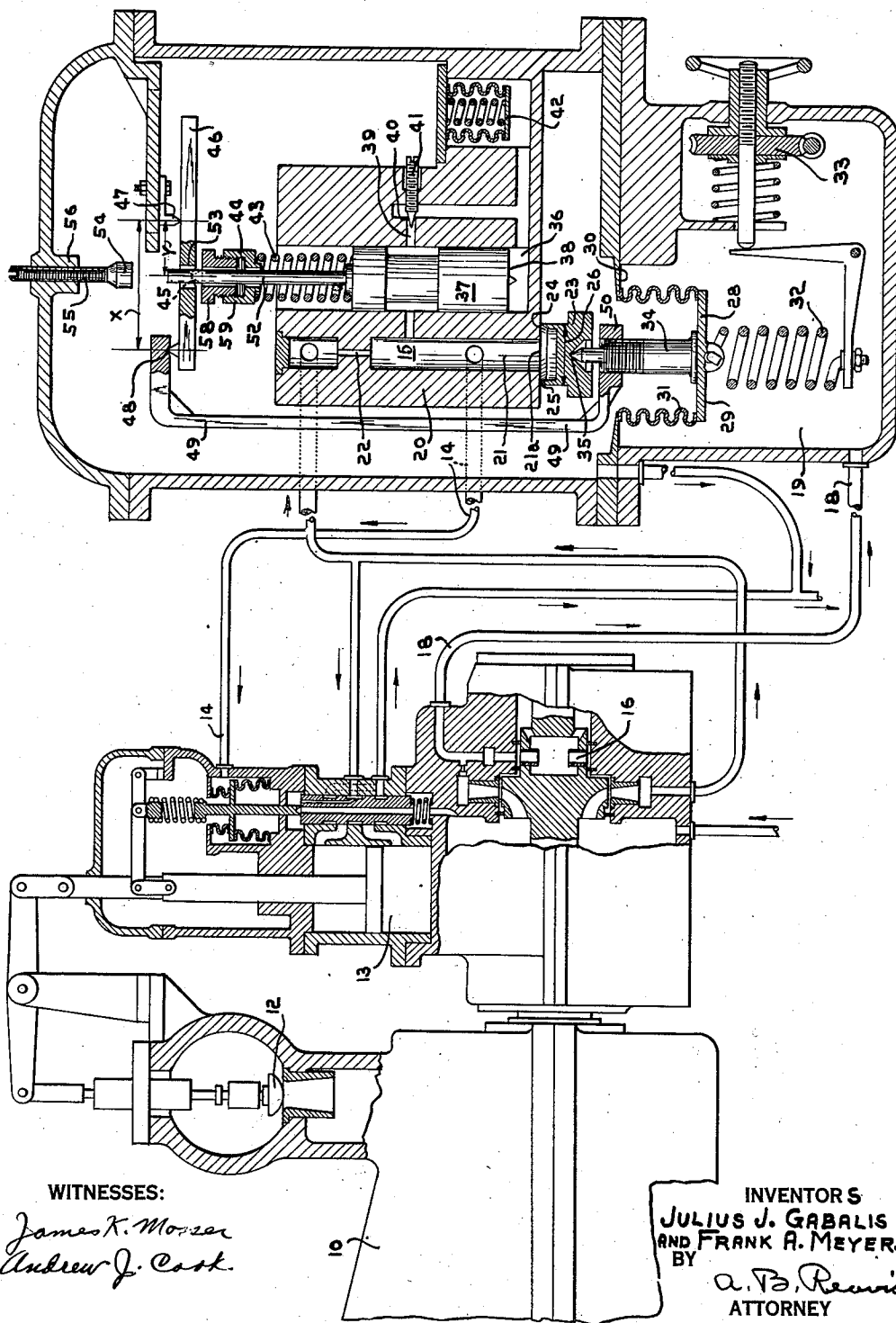
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GOVERNING MECHANISM

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GOVERNING MECHANISM

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The invention relates to governing mechanism and it has for an object to provide therefor an improved compensating device operative to correct speed of the prime mover due to load change.

A further object of the invention is to provide governing apparatus and a compensator therefor arranged so that, with the compensator ineffective, the governing apparatus operates in an uncompensated manner, together with means for rendering the compensator ineffective at and below any desired load in the load range.

A further object of the invention is to provide governing apparatus and a compensator therefor arranged so that, with the compensator ineffective, the governing apparatus operates in an uncompensated manner, together with means for rendering the compensator ineffective at and above a predetermined load.

A further object of the invention is to provide governor mechanism embracing a transformer for transforming the ranges of a speed-responsive force, impulse or pressure into changes of transformed pressure together with an auxiliary device responsive to transformed pressure change due to speed and load change to effect such further change or adjustment in transformed pressure that the prime mover speed may be corrected to a desired extent, the arrangement being such that the governor mechanism is capable of operating in the normal way irrespective of operativeness or inoperativeness of the auxiliary device.

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

The figure is a diagrammatic view showing the improved governor applied to an elastic-fluid turbine.

In the drawing, the prime mover, for example, a turbine 10, has an admission valve 12 controlled by a pressure-responsive servo-motor, at 13.

Fluid under pressure is supplied by the passage 14 to the pressure-responsive servo-motor, at 13, from the hydraulic governing apparatus including the pressure transformer, at 15, the latter serving to transform changes in governing force or pressure into changes in transformed fluid pressure. While any suitable means providing a force varying as a function of the speed of the prime mover may be utilized by the transformer, preferably, the prime mover or turbine drives an impeller 16 to provide fluid under pressure varying as the square of the speed, the impeller pressure being furnished by the passage 18 to the expansible chamber 19 of the transformer.

By way of example, the transformer, at 15, is shown as comprising a body 20 having a transformed fluid pressure space 21 supplied with liquid through a metering orifice 22 from any suit-

able source. The space 21 has an escape opening 21a and a cup valve 23 is arranged in covering relation with respect to the escape opening, the body 20 having a seat 24 bounding the escape opening and with which cooperates the annular edge 25 of the cup valve 23 to define an annular escape orifice.

It will be apparent that the pressure existing in the space 21 depends upon the escape of fluid therefrom. The pressure in said space acting on the pressure or abutment area of the cup valve 23, this area being bounded by the annular edge 25 and its diameter being indicated at 26, tends to move the cup valve downwardly to increase the flow area of the annular escape orifice and thereby to reduce the pressure in the space 21. This movement is opposed by the means to be now described.

The pressure abutment 28 presents the area 29 to the expansible chamber 19, the abutment being connected to the housing structure 30 by means of the bellows 31.

The force of the fluid pressure supplied from the impeller and applied to the pressure area 29 is opposed by that of the load spring 32. The force of the load spring may be adjusted in the usual way by means of speed changer apparatus, at 33.

The pressure abutment 28 has a stem 34 extending toward the cup valve 23 and the cup valve and the stem are formed to provide a pivot bearing 35 for transmitting thrust from the abutment 28 to the cup valve.

From the apparatus so far described, it will be apparent that the transformed pressure depends upon the flow area of the annular escape orifice defined by the cup valve 23, the pressure decreasing as this flow area increases and vice versa. If the load should decrease, the impeller pressure would increase to act on the pressure area 29 and move the abutment and stem 34 in the direction to decrease the orifice flow area to bring about increase in transformed fluid pressure in the space 21, the transformed fluid pressure being supplied from the latter space by means of the passage 14 to the pressure-responsive servo-motor, at 13, to adjust the admission valve to decrease the admission of elastic fluid to the prime mover or turbine in order to limit the increase in speed of the latter. If the prime mover load should increase, the contrary operation would take place, the transformed pressure decreasing on account of increased orifice flow area and the servo-motor, at 13, being operated to increase the admission of elastic fluid to the prime mover or turbine and to limit decrease in speed of the latter due to increase in load.

To provide the necessary force range essential for governing from no load to full load, some change in speed or regulation is necessary, this

change in speed being represented by the change in scale of the spring 32 due to change in position of the abutment 29 from no load to full load. Ordinarily the percentage of regulation is around four per cent.

The present invention has for an object to provide a compensating device which responds to speed change due to load change to effect a desired extent of correction in speed, that is, the governor mechanism operates in the normal way to provide change in transformed fluid pressure in response to change in speed and the compensator functions to correct to a desired extent the speed change due to load change.

The compensator comprises an expansible chamber 36 provided in the body 20 and a movable abutment 37 and presents a pressure or piston area 38 to the chamber.

A passage 39 connects the transformed pressure space 21 with the expansible chamber 36. An orifice 40, preferably adjustable, as by means of the screw 41, is arranged in the passage, and an air bell or accumulator 42 communicates with the passage between the orifice 40 and the chamber 36.

A spring 43 is arranged between the abutment 37 and a seating ring 44 having knife edge pivots 45 engaging the lever 46 between the adjustable fulcrum 47 and the pivotal connection 48 with respect to the link 49 connected, by means of the threaded collar 50, to the stem 34.

In operation, if there is a change in load of the prime mover, the speed changes sufficiently to operate the governor to adjust the admission of motive fluid suitably to the load change, this operation involving a change in transformed fluid pressure. Temporarily, due to the orifice 40 and the accumulator 42, there exists a pressure differential as between the pressure in the space 21 and that in the space 36, and this differential is effective to apply force to the cup valve 23 to effect further change in transformed fluid pressure and adjustment of the admission of motive fluid to the prime mover for adjustment of the speed of the latter to a desired extent.

If the load should decrease, the prime mover would increase in speed sufficiently to operate the governing mechanism in the ordinary or uncompensated manner to restrict the admission of motive fluid thereto, and the effect of the compensator is to further restrict the admission of motive fluid in order to tend to restore the speed of the prime mover to that existing before the change in load. Temporarily, the pressure in the chamber 21 preponderates over that in the chamber 36 with the result that the force of transformed pressure acting downwardly on the cup valve 23 becomes larger in relation to the force applied upwardly thereto by the link 49; however, as pressure equilibrium is gradually restored in the chambers 21 and 36, the force applied by the link 49 to the cup valve 23 increases to restrict further the escape of liquid from the transformed pressure space 21 to cause such further increase in the transformed pressure as to reduce somewhat further the increase in turbine or prime mover speed to effect the desired speed correction.

If the load should increase, the contrary operation would occur. The pressure in the accumulator expansible chamber 36 would be higher temporarily than that in the chamber 21 and the ensuing process of restoration of pressure equilibrium in the chambers 36 and 21 results in gradual decrease in pressure in the expansible chamber 36 and a gradual decrease in force applied to

the cup valve 23, but, as the latter force is decreased, the force of transformed fluid pressure causes wider opening of the annular escape orifice to increase further the escape of liquid from the transformed pressure space 21 to cause such further decrease in the transformed pressure that the resulting increase in speed of the turbine effects speed correction to the extent determined by the ratio of leverage mechanism hereinafter described.

The amount of compensation may be varied by adjustment of the fulcrum 47 to vary the relationship of the lever arms Y and X. The amount of upward force applied by the link 49 to the cup valve 23 is proportional to the piston or abutment area 38 times the pressure in the chamber 36 multiplied by the leverage ratio Y/X. Assuming that a change in impeller pressure of 5 lbs. per sq. in. is required to produce a change in transformed fluid pressure of 25 lbs. per sq. in. in the chamber 21 without the compensator and the compensator was so adjusted as to give the equivalent upward force on the stem 24 of 4 lbs. per sq. in., then only 1 lb. per sq. in. pressure change acting on the pressure area 29 would be necessary when the compensator is employed and the governor regulation would be only $\frac{1}{5}$ of uncompensated regulation. By adjustment of the fulcrum, the ratio Y/X is changed and, therefore, the amount of compensation is changed.

So long as the movable member 37 is held immovable, compensation does not occur. This result may be accomplished by means positively limiting motion of such member and it may be effected by adjustment of the spring 43.

Referring to the means for holding the member 37 against movement in one direction, such member has a stem 52 extending through the ring 44 and an opening 53 in the lever 46, the stem having a normal clearance space with respect to the lower end of the adjustable stem or abutment 54 having a threaded connection at 55 with respect to a fixed part 56 of the apparatus. Assuming that the stem 52 abuts the stem 54 at no load, when maximum pressure exists in the space 36, the compensator will be maintained ineffective and ineffectiveness will continue until the stem 52 separates from the stem 54. Thus, the use of the adjustable stem 54, the load point at and below which the compensator is maintained ineffective may be varied.

As the pressure in the space 36 is a minimum at full load, the spring 43 may serve to hold the movable member in its lowermost position until the pressure is increased, due to reduction in load, to a point where it is sufficient to overcome the spring and thereby render the compensator effective. The load point at and above which the compensator is rendered ineffective may be varied by adjusting the initial compression of the spring. Spring adjustment may be accomplished, for example, by having the ring 44 comprised by relatively adjustable parts 58 and 59.

The adjustable stem 54 provides means for rendering the compensator ineffective without disturbing the setting of the latter, this being particularly desirable when synchronizing.

As the compensator is structurally and functionally independent of the main governor, it will be apparent that inoperativeness due to sticking or binding thereof results in nothing more serious than the lack of proper compensation and the governor can be operated in the usual way until the trouble is corrected. As already pointed out,

the amount of compensation may be varied by

adjustment of the fulcrum 47, that is, with proper adjustment of the fulcrum, the governor may be compensated more and more in the direction of becoming isochronous. Adjustment of the amount of time delay by adjusting the screw 41 defining the orifice 40 does not change the amount of compensation. Also, changes in oil temperature, density, etc., do not affect the amount of compensation. With respect to the speed changer, the compensator does not affect its power to operate except that, in rendering the compensator effective, it is necessary to adjust the speed changer to maintain a constant speed or load in any position other than full load.

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 control system for a prime mover, means providing a force dependent upon prime mover speed, a transformer including a pressure-controlling element responsive to said force to provide fluid under transformed pressure, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, a compensator for adjusting the speed change of the prime mover due to load change, said compensator comprising means acting in a delayed manner to provide force changes dependent upon transformed fluid pressure changes in consequence of prime mover speed changes due to load changes and means for transmitting force changes from the last-named means to said pressure-controlling element of the transformer, and means providing for uncompensated operation of the control system comprising apparatus for interrupting the transmission of force changes to the pressure-controlling element.

2. The combination as claimed in claim 1 with means providing for adjustment of the interrupting apparatus so that the compensator may be rendered ineffective at and below any desired load within the prime mover load range.

3. The combination as claimed in claim 1 with means providing for adjustment of the interrupting apparatus so that the compensator may be rendered ineffective at and below a desired load and ineffective at and above a desired higher load.

4. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means providing a pressure chamber, a movable member having a pressure area exposed to pressure in said chamber, means providing for fluid pressure in said chamber which changes in a lagging manner with respect to changes in transformed fluid pressure, and mechanism for transmitting forces between the movable member and the controlling element of the transformer and including means providing for relative movement of the movable member.

5. The combination as claimed in claim 4 with an adjustable stop for limiting motion of the movable member.

6. The combination as claimed in claim 4

wherein the mechanism includes a force-transmitting spring together with means providing for adjustment of the spring.

7. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means providing a pressure chamber, a movable member having a pressure area exposed to pressure in said chamber, means providing for fluid pressure in said chamber which changes in a lagging manner with respect to changes in transformed fluid pressure, and force-transmitting mechanism between the movable member and the pressure-controlling element of the transformer and including means for varying the ratio of the force applied to the controlling element to that exerted by the displacement member.

8. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising an expansible chamber, a movable member presenting a pressure area to the chamber, a passage connecting said transformer space to said chamber, means providing an orifice for the passage, an accumulator connected to the passage between the orifice and the expansible chamber, and force-transmitting mechanism between the movable member and the transformer pressure-controlling element and including means providing for the application to the pressure-controlling element of a force which is proportionate to but smaller than that applied by the movable member.

9. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means including a movable member providing an expansible chamber, a passage connecting said transformer space to said chamber, means providing an orifice for the passage, an accumulator connected to the passage between the orifice and the expansible chamber, and force-transmitting means between the movable member and the transformer controlling element and including a spring.

10. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due

to load change; said compensator comprising means including a movable member providing an expansible chamber, a passage connecting said transformer space to said chamber, means providing an orifice for the passage, an accumulator connected to the passage between the orifice and the expansible chamber, force-transmitting means between the movable member and the transformer controlling element and including a spring, and means providing for adjustment of the last-named spring.

11. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means including a movable member providing an expansible chamber, a passage connecting said transformer space to said chamber, means providing an orifice for the passage, an accumulator connected to the passage between the orifice and the expansible chamber, force-transmitting means between the movable member and the pressure-controlling element of the transformer and including a spring, adjustable means for limiting movement of the movable member, and means providing for adjustment of said spring.

12. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means providing a pressure chamber, a movable member having a pressure area exposed to pressure in said chamber, means providing for fluid pressure in said chamber which changes in a lagging manner with respect to changes in transformed fluid pressure, and means for transmitting force from said movable member to the transformer pressure-controlling element; said force-transmitting means including a link operatively connected to the pressure-controlling element, a lever having one end pivotally connected to the link, a fulcrum for the lever, an abutment member engaging the lever, and a spring between the movable and abutment members.

13. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means including a movable member providing an expansible chamber, a passage connecting said transformer space to said chamber, means providing an orifice for the passage, an accumulator connected to the passage between the orifice and

the expansible chamber, means for transmitting force from said movable member to the transformer pressure-controlling element; said force-transmitting means including a link operatively connected to the pressure-controlling element, a lever having one end pivotally connected to the link, a fulcrum for the other end of the lever, an abutment member engaging the lever between its pivotal connection and the fulcrum, and a spring between the movable and abutment members.

14. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means providing a pressure chamber, a movable member having a pressure area exposed to pressure in said chamber, means providing for fluid pressure in said chamber which changes in a lagging manner with respect to changes in transformed fluid pressure, and means for transmitting force from said movable member to the transformer pressure-controlling element; said force-transmitting means including a link operatively connected to the pressure-controlling element, a lever having one end pivotally connected to the link, a fulcrum for the other end of the lever, an abutment member engaging the lever between its pivotal connection to the link and the fulcrum, a spring between the movable and abutment members, and means providing for adjustment of the fulcrum to vary the ratio of lever arms.

15. In a prime mover, means providing a force dependent upon prime mover speed, a transformer having a space and including a pressure-controlling element responsive to said force to provide fluid under transformed pressure in the space, means responsive to fluid under transformed pressure to control the admission of motive fluid to the prime mover, and a compensator for adjusting the prime mover speed change due to load change; said compensator comprising means providing a pressure chamber, a movable member having a pressure area exposed to pressure in said chamber, means providing for fluid pressure in said chamber which changes in a lagging manner with respect to changes in transformed fluid pressure, and means for transmitting force from said movable member to the transformer pressure-controlling element; said force-transmitting means including a link operatively connected to the pressure-controlling element, a lever having one end pivotally connected to the link, a fulcrum for the other end of the lever, an abutment member engaging the lever between its pivotal connection to the link and the fulcrum, a spring between the movable and abutment members, means providing for adjustment of the fulcrum to vary the ratio of lever arms; means for limiting movement of the movable member; and means providing for adjustment of said spring.

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