July 3, 1928.

1,675,477

J. B. WILSON

GOVERNOR

Filed Nov. 19, 1925

2 Sheets-Sheet 1

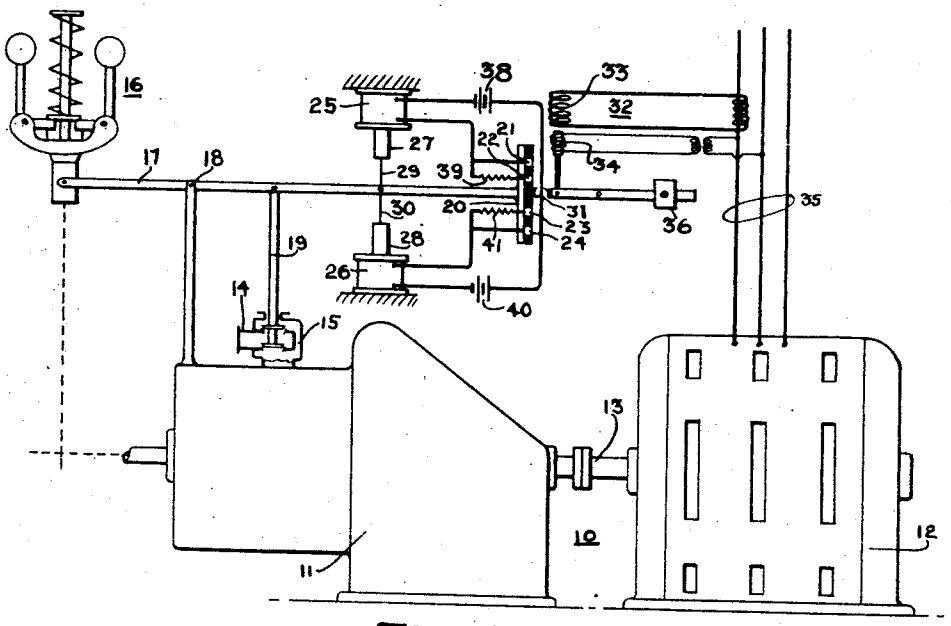


Fig. 1.

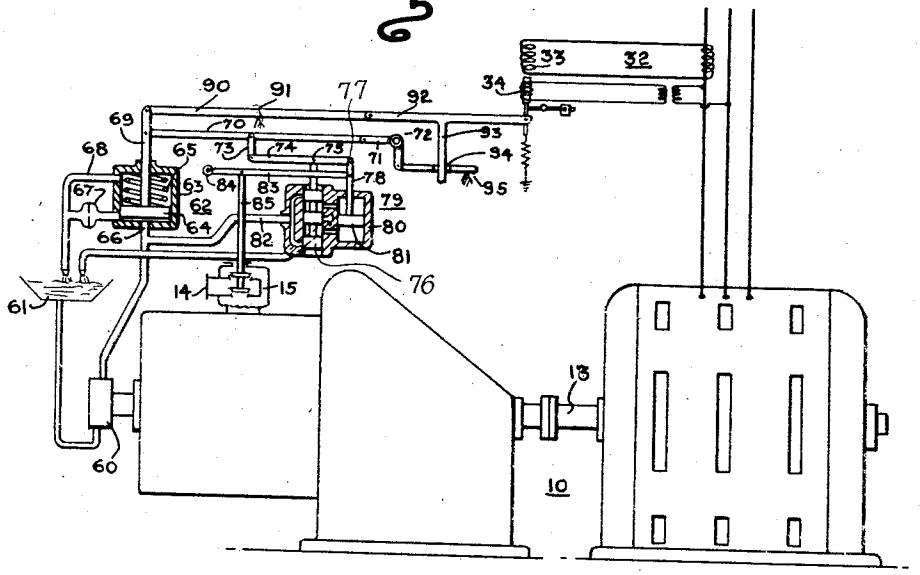


Fig. 3.

WITNESSES:

J.B. Wilson
INVENTOR

BY D.C. Davis

ATTORNEY

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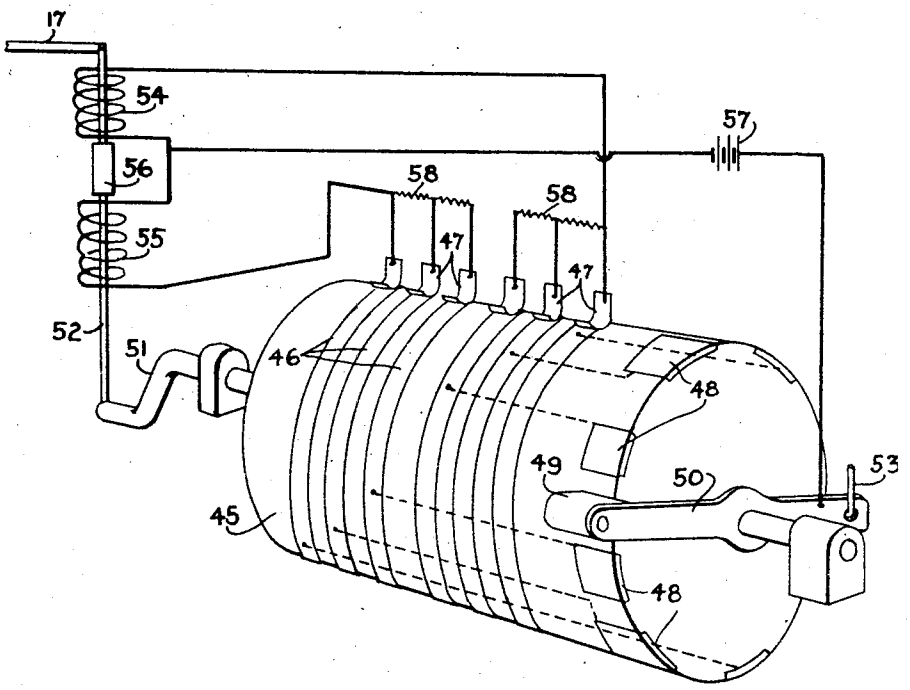


Fig. 2.

WITNESSES:

J.B.Wilson
INVENTOR

BY D.C.Davis

ATTORNEY

Patented July 3, 1928. 1,675,477

UNITED STATES PATENT OFFICE.

JOSEPH BANCROFT WILSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

GOVERNOR.

Application filed November 19, 1925. Serial No. 70,171.

My invention relates to governing systems and it has for its object to provide apparatus of the character designated which shall be effective to govern a turbo-generator set within close limits where the load imposed upon said turbo-generator set is subject to rapid and extreme fluctuations.

In the accompanying drawing, Figure 1, is a side view, partially diagrammatic and partially in elevation, of a turbo-generator set employing a preferred form of my invention; Figure 2 is a detail view illustrating a modification of a portion of the control elements in the system of Figure 1 and Figure 3 is a view similar to Figure 1 and illustrates a modification in the control system.

In the operation of turbo-generator sets it is usual to employ a speed-operated governor for the control of the fluid-admitting valve and governing systems of this type have proven highly satisfactory where the load changes imposed on the generator are gradual in nature. When, however, a turbo-generator set is employed for the energization of certain types of circuits, such as steel mill drives and mine hoists, it has been found that the load changes imposed on the generator are so rapid and so violent that a governor controlled entirely by the speed of the unit is so relatively sluggish that improper control is secured.

In accordance with my invention I provide a speed-controlled governor of any approved type for the normal control of the admission valve and I provide an element movable thereby in accordance with the speed. I further provide a wattmeter energized by the output mains of the geneator and cause said wattmeter to move an element disposed adjacent to said first named element, the arrangement being such that said two elements move in consonance so long as the load output bears a predetermined relation to the fluid admission.

When, however, the load output suddenly changes so that said predetermined relationship is temporarily departed from, there results a disparity in the position of said two elements and I provide means for developing a force proportional to the degree of disparity, said force being temporarily applied to the control of the admission valve so as to enable the turbo-generator sets to run at substantially constant speed, irrespective of load variations of the most violent and abrupt nature.

Referring to the drawing for a more detailed understanding of my invention, I show a turbo-generator set at 10 in Figure 1, said set comprising a fluid pressure turbine 11 and a generator 12 connected thereto by a suitable shaft 13, fluid being supplied to the turbine 11 from any desired source through a supply pipe 14 and a steam chest 15 containing a fluid admission valve.

A governor 16 of the usual type is mounted so as to be driven from the turbine 11 and is arranged to operate a lever 17, fixedly pivoted at 18. The arrangement is such that upon an increase in the speed of the turbine, the left hand end of the lever 17 is raised, depressing the right hand portion thereof and closing the fluid admission valve through a suitable link 19 and vice versa. It follows that upon a normal decrease of the load on the turbine the speed thereof tends to increase, whereupon the link 19 partly closes the admission valve and holds the turbine at the proper speed.

At the right hand end of the lever 17 is disposed a plate 20 carrying suitable contact members 21, 22, 23 and 24 on the face thereof. Said contact members are suitably insulated from each other and from the plate 20.

Two solenoids 25 and 26 are disposed, the one above and the other below the right hand portion of the lever 17 and core members 27 and 28 are respectively associated therewith, said core members in turn being connected to the lever 17 as by links 29 and 30.

A resilient brush member 31 is disposed to bear against the contact members 21 to 24, inclusive, and is carried from a wattmeter device 32 embodying for example, a fixed current coil 33 and a movable voltage coil 34, said coils being arranged to be energized from the output mains 35 of the generator 12, all as is well known in the art. If desired, the voltage coil may be fixed and the current coil moved. The weight of the moving member 34 and of the brush 31 is partially counterbalanced as by a weight 36.

An electric circuit is arranged from the brush member 31 through a current source 38 and the solenoid 25 to the contact member 21 and also through a resistor 39 to the contact member 22. In like manner, a circuit is arranged from the brush member 31

through a current source 40 and the solenoid 26 to the contact member 24, and likewise through a resistor 41 to the contact member 23.

Having thus described the arrangement of apparatus embodying a preferred form of my invention, the operation is as follows:

As has been previously set forth, upon slow load changes, the right hand end of the lever 17 rises and falls with the amount of fluid admission, carrying the plate 20 and contact members 21 to 24 therewith. In like manner, load changes cause the brush member 31 to be movable upwardly and downwardly from the wattmeter 32. The arrangement is such that so long as the load output of the generator 12 bears substantially a predetermined relation to the fluid admission, the plate 20 and the brush 31 move in consonance, the brush 31 occupying a central position as indicated and making contact with none of the contact members carried by the plate 20. It therefore follows that the governing is done entirely by the governor 16.

Let it now be assumed that a sudden and material increase in the load comes upon the generator 12; the watt-meter 32 immediately responds, raising the brush 31 more rapidly than the governor can raise the plate 20, causing the brush 31 to make contact with the member 22. The solenoid 25 is accordingly energized and the core 27 is drawn upwardly, raising the right hand portion of the lever 17 and opening the fluid admission valve. If the load increase is even more marked, the brush 31 may contact with the member 21, eliminating the resistor 39 from circuit and energizing the solenoid 25 more powerfully than before so as to open the fluid admission valve even more quickly. Conversely, let it be assumed that there is a sudden decrease in the load such as is occasioned by the stoppage of a hoist or by the tripping of the circuit breaker. The wattmeter 32 quickly responds, the brush 31 being lowered so as to make contact with the member 23 and energizes the solenoid 26, causing the right hand portion of the lever 17 to be drawn downwardly, partly closing the fluid admission valve. With extreme load decreases, such as the tripping of the breaker, the brush 31 may contact with the member 24, eliminating the resistor 41 from circuit and strongly energizing the solenoid 26 and with marked closure of the fluid admission valve.

Referring to the form of apparatus shown in Figure 2, a drum 45 is provided with six slip rings 46—46, upon each of which bears a brush 47 respectively. At the right hand end of the drum 45 there are provided spaced commutator segments 48—48 and a brush 49, concentrically mounted on an arm 50, is adapted to move over said segments. The drum 45 may be rotated in accordance with the position of the governor as through a crank arm 51 and link 52 connected to the lever 17 which is arranged as in Figure 1.

Likewise, a link 53 connects the arm 50 to a wattmeter mechanism so that a wattmeter such as that shown at 32 in Figure 1 may swing the arm 50, carrying the brush 49 over the segments 48.

The respective segments 48—48 are connected to the slip rings 46—46 and two solenoids 54 and 55 are disposed in operative relation to a core member 56 carried on the link 52.

A circuit is arranged from the brush 49 through a current source 57 and the solenoids 54 and 55 to the brushes 47—47 through suitable resistors 58—58.

The operation of this apparatus in the system of Figure 1 will be obvious.

With slow load changes the drum 45 and the arm 50 move in consonance and the brush 49 would not make contact with any of the segments 48—48. Upon disparity of movement, however, between the wattmeter and the governor, relative motion takes place and the brush 49 makes contact with the proper segment 48, energizing the solenoids 54 or 55 to the proper degree to give the desired action to the fluid admission valve.

Referring to the form of my invention shown in Figure 3, a turbo-generator set 10 is provided as before except that instead of employing a governor of the centrifugal fly-ball type, I may employ a fluid pressure governing system comprising the centrifugal pump 60 mounted on the turbine shaft and supplying oil or other suitable fluid from a reservoir 61 to a pressure motor 62 shown as comprising a cylinder 63 having a closely fitted piston 64 therein, said piston being biased downwardly as by a spring 65. Fluid pressure from the pump 60 is admitted through a port 66 beneath the piston 64 and fluid may escape from beneath the piston through a restricted orifice 67 back to the reservoir 61, the space above the piston 64 being drained as by a conduit 68.

As is well known and understood in the art, apparatus of the character just described operates to move the piston 64 proportionally to the speed of the turbine since said piston is moved against the spring 65 by the fluid pressure developed in the pump 60, said pump pressure being variable with the turbine speed.

A vertical link 69 connected to the piston 64 is pivoted to a floating lever 70, the right hand of which is pivoted to a bell crank lever 71 having fixed pivot at 72. A link 73 depends from the link 70 and in turn is pivoted to the left hand end of a floating

lever 74 attached at 75 to the piston rod of an oil relay mechanism 76 and also pivoted at 77 to the piston rod 78 of a pressure motor 79, said motor comprising a cylinder 80 containing a piston 81.

The details of this pressure motor and relay mechanism need not be given in full as this apparatus is well known in the art. Suffice to say, fluid pressure from the pump 60 is supplied through a conduit 82 to the relay mechanism and is thence supplied either above or below the piston 81 for the operation thereof, the right hand end of a valve operating lever 83 being pivoted to the piston rod 78 and the left hand end thereof having a fixed pivot at 84. A link 85 connects the lever 83 to the valve 15 so that upward movement of the point 75 raises the relay piston, admitting fluid pressure above the piston 81 and depressing the lever 83, partly closing the valve 15 and vice versa, all as will be obvious to those skilled in the art.

A lever 90 has a fixed pivot at 91 and is connected at its left hand end to the piston rod 69, being further pivoted at its right hand end to a floating lever 92. The right hand end of the floating lever 92 is pivoted to the moving element 34 of a wattmeter 32, similar to that described in connection with Figure 1. An arm 93 is rigidly attached to the floating lever 92 and depends downwardly, passing freely through an aperture 94 formed in a link 95 pivoted at its left hand end to the depending arm of the bell crank lever 71.

During normal load changes the fluid admission valve is subjected to the control of the fluid pressure governor as above described, attention being directed to the following operation of the specific system shown. Upon a load increase the turbine slows down somewhat and the piston 64 descends, lowering the left hand end of the lever 90 and raising the right hand end thereof, and the left hand end of the link 92. At the same time, load increase causes the core member 34 to be drawn upwardly, raising the right hand end of the link 92: thus it follows that with slow load changes the link 92 rises and falls but at all times maintains a horizontal position so that the arm 93 slides freely through the opening 94. The left hand end of the lever 70 is moved downwardly by the link 69 upon downward movement of the piston 64, the right hand end being held stationary by the bell-crank lever 71, which acts as a fulcrum for the lever 70 during slow load changes. The downward movement of the lever 70 controls the oil relay mechanism 79 to effect opening movement of the admission valve in the steam chest 15.

Should, however, the load suddenly increase, the right hand end of the lever 92 rises more rapidly than the left hand end thereof and the arm 93 is swung counter-clockwise, drawing the link 95 to the right and rotating the bell crank lever 71 also in a counter-clockwise direction. It follows that the right hand end of the link 70 is depressed, depressing the relay piston and causing the piston 81 to open the fluid admission valve. A converse operation takes place with a sudden load decrease.

While I have described my invention in connection with fluid pressure turbines of the type ordinarily used, employing an expansible medium, it is obvious that the system could equally well be applied to the control of various types of prime movers such as reciprocating engines, internal combustion engines or water wheels without departing from the spirit thereof.

I have illustrated the neutral position of the wattmeter-actuated brush as a central position with an equal number of equi-spaced contact members on each side thereof but in certain cases, one set of contact members may be dispensed with. Thus on hoisting outfits, the main demand is for quick acceleration of the turbine with sudden load increase and the contact members for sudden decrease of load need not be employed.

Likewise, in central station installations, the main use of my invention is when a circuit breaker trips and the entire load is suddenly dropped from a unit. Under these conditions the contact members operative upon a sudden increase of load need not be employed. Rather than to entirely dispense with either set of contact members, they may be spaced further away from the neutral brush position so that they come into play only under extremely abnormal conditions.

I have disclosed the actuation of the brush by a wattmeter but it will be obvious that an ammeter or a voltmeter control may be used where control in accordance with current surges or voltage surges is desired. Likewise, a frequency meter may be employed to actuate the brush where control in accordance with frequency rise or fall is desired.

I have shown the brush as moved in accordance with conditions in the load mains and the contact segments as moved in accordance with the governor position but obviously this arrangement may be reversed, moving the segments in accordance with conditions in the load mains and the brush in accordance with the governor setting.

While I have shown my invention 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 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 a turbo-generator set having a fluid-admitting valve and a speed controlled governing device for the actuation of said valve, said governing device maintaining the fluid admission substantially as a function of the speed of the turbine, of mechanism responsive to changes in a predetermined variable in the load conditions on the generator and effective to temporarily supersede said governing device in the control of said valve upon relatively rapid changes in said variable.

2. In a governing mechanism for a turbo-generator set, an element adapted to move with speed changes, an additional element adapted to move with changes in a variable characteristic of the generator output, said elements moving in unison with relatively slow changes in said variable characteristic and there being a disparity of movement between said elements upon relatively sudden changes in said variable characteristic, and mechanism operative in accordance with the degree of such disparity to govern said set.

3. The combination with a turbo-generator set having a fluid-admitting valve and a speed-controlled governing device for the actuation of said valve, said governing device maintaining the fluid admission substantially as a function of the speed of the turbine with relatively slow load changes, of mechanism subject to the control of the load output and effective to temporarily supersede said governing device in the control of said valve upon relatively quick load changes.

4. In a governing mechanism for a turbo-generator set, an element adapted to move with speed changes, an additional element adapted to move with load changes, said elements moving in unison with relatively slow load changes, and there being a disparity of movement between said elements upon relatively sudden load changes, and mechanism operative in accordance with the degree of such disparity to govern said set.

5. In a governing mechanism for a turbo-generator set, a speed operated governor arranged to control a fluid admission valve, an element carried thereby and movable therewith, a wattmeter device energized from the output leads of the generator and movable in proportion to the load, an element movable thereby and adapted to move in consonance with said first mentioned element so long as the load output varies with the fluid admission and to move in disparity with said first mentioned element when the load changes are more sudden than the variations in fluid admission, and means operable in accordance with such disparity to operate said valve.

6. A mechanism for governing a turbo-generator set subject to more sudden load variations than may be accurately followed by a speed-controlled governing mechanism which comprises means for developing a force substantially proportional to the disparity between fluid admission and load output and means employing said force to temporarily govern said set during periods of violent load change.

7. In a governing system for a turbo-generator set, a speed operated governor arranged to normally control a fluid admission valve, an element carried thereby and movable therewith, a wattmeter device energized from the output mains of said generator and arranged to move an element opposing said first named element, the motion of said elements being in consonance so long as the load output bears a predetermined relation to the fluid admission, a plurality of spaced contact members on one of said elements, a brush on the other of said elements adapted to make contact with said contact members upon relative movement of said elements and electro-motor devices arranged to be energized in accordance with such contact and to exert a controlling influence upon said fluid admission valve, the arrangement being such that under normal operation with relatively slow load changes, said elements move in consonance and said brush does not make contact with said contact members and upon relatively rapid load changes, relative movement of said elements takes place with resultant closure of an energizing circuit and energization of one of said electro-motor devices takes place with resultant adjustment of fluid admission to accord with the load.

8. The combination with a prime mover having an admission valve, of speed-responsive means normally controlling said valve to provide a fluid admission varying as a function of the speed, and means responsive to disparity between speed and a load condition on said prime mover for effecting movement of the admission valve.

9. The combination with a turbine and an electrical generator driven thereby, of an admission valve for said turbine, means responsive to speed of the turbine and controlling said valve during normal variations in load, said means having an element movable thereby in accordance with speed variations, means responsive to the load on the electrical generator and having an element movable with the speed responsive element during normal variations in load and there being a disparity of movement between said elements upon relatively sudden changes in load, and means operable upon disparity of movement between said elements for controlling said admission valve.

10. In a governing mechanism for a prime mover, the combination of an admission valve for said prime mover, means for mov-

ing said admission valve in response to speed of the prime mover, and means responsive to disparity between fluid admission and a load condition of said prime mover for moving said admission valve.

11. The combination with a turbo-generator set having a fluid-admitting valve and a speed controlled governing device for the actuation of said valve, said governing device maintaining the fluid admission substantially proportional to the value of a predetermined variable in the load conditions on the generator with relatively slow changes in said variable, and mechanism responsive to disparity between fluid admission and said variable for effecting movement of said valve in the direction to make the fluid admission proportional to said variable.

In testimony whereof, I have hereunto subscribed my name this 5th day of Nov. 1925.

JOSEPH BANCROFT WILSON.