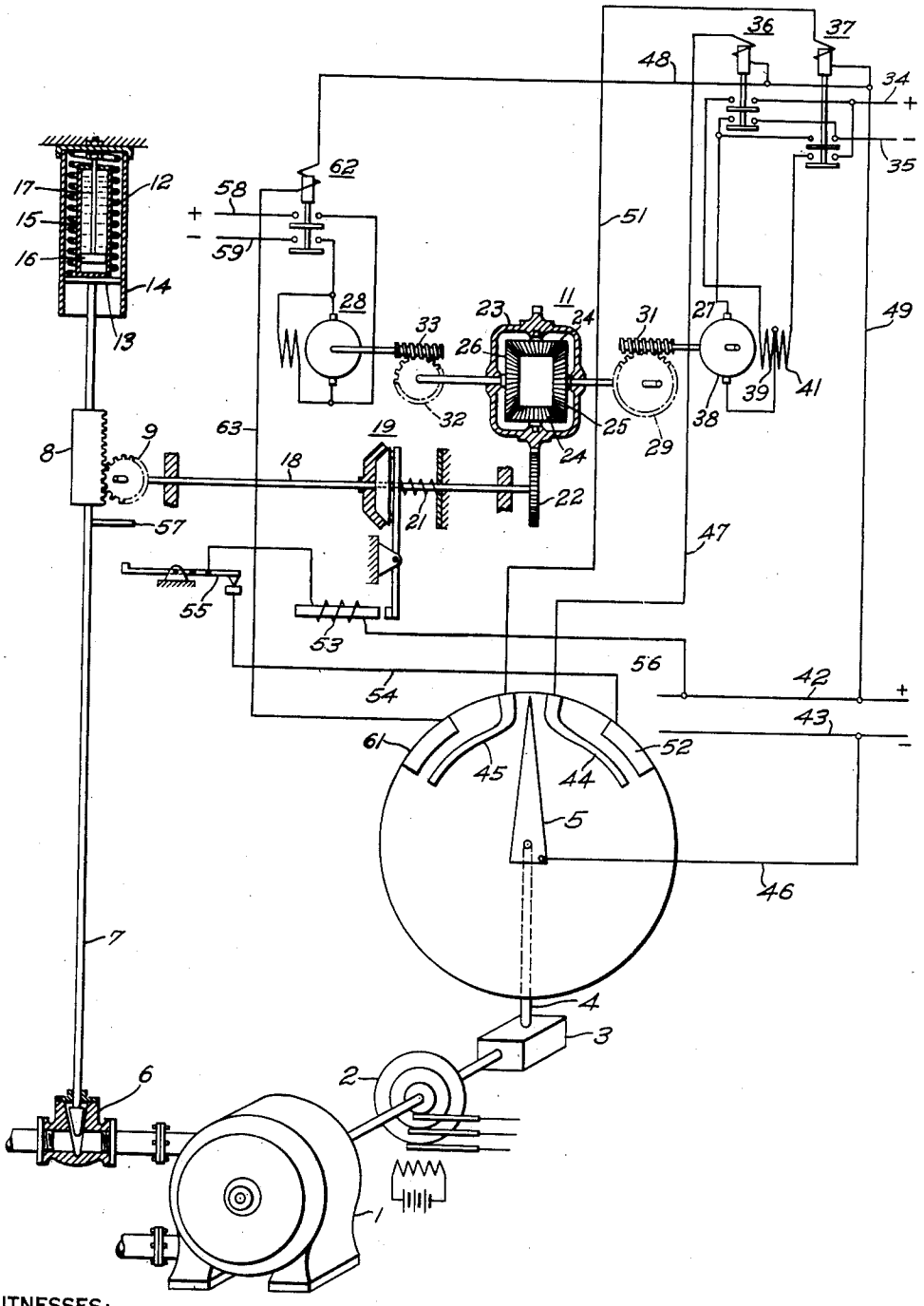
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REGULATOR SYSTEM

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WITNESSES:

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REGULATOR SYSTEM

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My invention relates to regulator systems and more particularly to such systems employed for controlling the speed of prime movers, such as steam turbines.

It is general practice to control the speed of a steam turbine by means of a speed governor that is actuated in accordance with the speed of the turbine, and to also provide a rapidly closing emergency throttle valve to prevent dangerous over-speeding of the turbine. Should the turbine rapidly increase its speed, as for example, when the load carried by the turbine is suddenly removed while the control valves are in a relatively wide open position, the emergency throttle valve of the turbine will completely shut off the flow of steam supplied to the turbine, so that it becomes necessary to again start the turbine under manual control. The speed governor mechanism, and also the emergency governor, usually employ a circulating fluid, such as oil under pressure, that operates against pistons in pressure cylinders to open or close the valves.

In accordance with this invention, a regulating system is employed that controls the inlet valve by purely electrical means. A regulator system organized in accordance with this invention will not completely shut off the flow of steam to the turbine when the load is suddenly removed therefrom, but will throttle the flow of steam sufficiently to permit the turbine to keep running idle at substantially its normal speed.

Another feature of a regulator system organized in accordance with this invention is the provision of means whereby, in the case above referred to, after the steam supply to the turbine has been reduced to a point where the turbine is running idle for a short time, and load is again applied to the turbine, the steam-supply control valve of the turbine is automatically opened at a relatively rapid rate to supply the necessary power to the turbine. When the supply of steam to the turbine corresponds substantially to that required to supply the turbine load, a further control of the steam supply is effected through the governor mechanism. With this system, therefore, except for slight fluctuations, the speed of the turbine is kept continually at its normal value.

My invention will be better understood by reference to the accompanying drawing, in which the single figure illustrates apparatus and circuits employed in a regulator system organized in accordance with my invention.

Referring to the drawing, a steam turbine 1 is provided for driving an electric generator 2. A contact-making tachometer 3 is provided for controlling a steam supply valve 6 and operates the contact-making pointer 5 by means of the shaft 4 in accordance with variations in the speed of the turbine.

The valve 6 is connected to a valve stem 7 and is actuated by a rack 8, carried on the valve stem and having gear teeth engaging the teeth of a pinion 9 that is actuated by a differential gear mechanism 11 to control the valve position. The valve is normally biased to a closed position by means of a spring 12 that presses against a plate 13 on the end of the valve stem 7 and slides within a guide 14. In order to prevent the valve 6 from being too violently slapped against its valve seat under the influence of the spring 12, a dashpot 15 is provided that is movable with the valve stem and within which is slidably mounted a piston 16 that is carried by the rod 17 and suitable fixed against movement.

Movement of the valve 6 to control the speed of the turbine 1 is effected through the pinion 9, the shaft 18, a clutch 19 that is normally held in its closed or power transmitting position by a spring 21, and a gear wheel 22, in accordance with the movement of the casing 23 of the differential mechanism 11. Planetary gears 24 are mounted on the interior of the casing 23 and revolve therewith. The planetary gears are engaged by gears 25 and 26 that are actuated, respectively, in accordance with the operation of electric motors 27 and 28. The gear 25 of the differential mechanism 11 is operatively connected to the motor 27, by means of a worm gear 29, and a worm 31, and the gear 26 of the differential mechanism is operatively connected to the motor 28 by means of a worm gear 32 and a worm 33.

The motors 27 and 28 are controlled by the contact-making pointer 5 of the tachometer 3 in accordance with variations in the speed of the turbine 1 from its desired value. The motor 27 is energized from supply conductors 34 and 35 to operate, in the one or in the other direction, upon the closure of the one or the other of a pair of directional relays 36 and 37. The motor 27 comprises an armature winding 38 and a pair of differentially related field windings 39 and 41.

The directional relays 36 and 37 are energized from the supply conductors 42 and 43 upon engagement of the pointer 5 with the contact members 44 and 45, respectively, of the contact-

making tachometer, thus effecting operation of the energized relay to its circuit closing position.

Where the turbine is running at its desired speed, the pointer 5 of the contact-making tachometer 4 will be positioned between the contact members 44 and 45, as illustrated. Upon an increase in the speed of the turbine, the pointer 5 is moved in a clockwise direction and, upon engagement with the contact member 44, closes a circuit from the supply conductor 43 through conductor 48, pointer 5, contact member 44, conductor 47, the coil of the relay 36 and conductors 46 and 49 to the supply conductor 42. The relay 36, thus energized, operates to close a circuit from the supply conductor 34 through the relay contacts, the field winding 35 and the armature winding 30 of the motor 27, causing the motor to operate. Thus a rotary motion of the pinion 9 through the differential mechanism 11 in a direction to cause the valve 6 to be actuated in a closing direction, [illegible] the motor 27 moves [illegible] circuit through the contact members 44, thus causing the motor to stop.

[illegible] the speed of the turbine 1 [illegible] the contact member 5 [illegible] the contact member 45, thus completing [illegible] the supply conductor 43 through [illegible] pointer 5, contact member 45, conductor 50, the operating [illegible] and conductor 49 to the [illegible] thus energizing the direct [illegible] 51 is provided a circuit closing position. The energization of the relay 37 closes a circuit from the supply conductor 34 through the [illegible] winding 38, the [illegible] to the supply conductor 42, thus causing the motor 27 to operate [illegible] through the differential [illegible] a movement of the valve 6 in [illegible] the turbine at its normal speed [illegible] the admitted steam [illegible] are in equilibrium, [illegible] from this normal speed will be [illegible] the motor 27 as above described. [illegible] the turbine is suddenly [illegible] will increase rapidly, [illegible] function performed [illegible] not act fast enough [illegible] speed. Upon [illegible] increase in speed, [illegible] will move in a clockwise direction, [illegible] when it has moved [illegible] contact member 52 of [illegible] a circuit will be [illegible] of an electromagnet 53, [illegible] release the clutch 19 and disengage [illegible] from the gear wheel 20 of the [illegible]. This circuit is traced [illegible] conductor 43 through conductor [illegible] contact member 52, the contacts of the normally [illegible] the coil of the clutch re[illegible] conductor 42 to the [illegible] conductor. [illegible] the electromagnet 53 is [illegible] to release the valve [illegible] will be moved downward by the [illegible] to its closing [illegible] the valve 6 is completely [illegible] such as the pin 57 carried by [illegible] operated in accordance with the valve movement to operate the switch 58 to its circuit opening position, thus deenergizing the coil of the magnet 53. Upon deenergization of the electromagnet 53, the clutch 19 is [illegible] closed by the spring 21, thus operatively [illegible] the pinion 9 to the gear wheel 20, disengaging the further control of the valve 6 and the operation of the differential mechanism 11. The valve will, accordingly, be controlled by the contact-making tachometer and the motor 27 in the manner above described.

Should it now happen that a full load, or [illegible] load, comes on the turbine, its speed will decrease, causing the pointer 5 to be moved in a counterclockwise direction. Upon engagement of the pointer 5 with the contact member 45, the motor 27 will operate in a direction to again open the valve 6. However, upon a sudden change from no load to a relatively heavy load, the time required for the opening of the valve 6 by the motor 27 [illegible] enable the turbine to carry the [illegible] relatively long. This is because the gearing between the worm 31 and the worm wheel 32 has been designed for direction opposition under normal operating conditions. In order to overcome this disadvantage, the motor 39 has been provided and is operated from the supply conductors 43 and 49 upon engagement of the pointer 5 of the contact-making tachometer with the contact member 61, which closes a circuit through the operating coil of the relay 60, that may be traced from the supply conductor 43, conductor 48, contact-making pointer 5, contact member 61, conductor 62, the operating coil of the relay 60, conductor 49 to the supply conductor 42.

When the energization of the relay 60 has caused it to its circuit closing position, the motor 39 will be operated in a direction to effect an opening of the valve 6 through the differential mechanism 11. The gearing between the worm 33 and the worm wheel 32 is materially larger than the ratio between the worm 31 and the worm wheel 32, so that the motor 39, which actuates the valve 6 through the differential mechanism 11, independently of the motor 27, will effect a relatively rapid movement of the valve.

When the speed of the turbine has been sufficiently increased to cause the pointer 5 to disengage with the contact member 61, the motor 39 stops and further speed increase of the turbine is effected by control of the motor 27 in the manner above described.

In the system described, it will be appreciated that it is possible to keep the turbine in operation substantially its normal speed when the load is suddenly dropped, and to also automatically control the flow of inlet steam to the turbine when the load suddenly returns, in such manner that the speed fluctuations of the turbine are kept within very narrow limits. This avoids [illegible] shutdown of the turbine by operation of the usual emergency governor, and also avoids the [illegible] bringing the turbine back to its normal speed by manual control thereof, which results in a [illegible] loss of time and [illegible] of the turbine and the generator.

It is obvious that many modifications of the [illegible] disclosed within the spirit of the invention will occur to one skilled in the art, and I do not wish to be limited other than by the scope of the appended claims.

I claim as my invention:

1. In a regulator system, a prime mover, a regulating valve for controlling the supply of motive fluid to said prime mover, means for biasing said valve toward its closed position, means responsive to the speed of the prime mover for adjusting the position of the regulating valve, means actuated upon a predetermined increase in the speed of the prime mover above its desired value for disconnecting said second named means from said valve thus permitting said biasing means to actuate said valve in a closing direction, and means actuated upon a predetermined closing of said valve for effecting a reconnection of said second named means to said valve.

2. In a regulator system, a prime mover, a regulating valve for controlling the supply of motive fluid to said prime mover, means for biasing said valve to its closed position, means responsive to the speed of the prime mover for adjusting the position of the regulating valve, means actuated upon a predetermined increase in the speed of the prime mover above its desired value for disconnecting said second named means from said valve thus permitting said biasing means to actuate said valve in a closing direction, means actuated upon a predetermined closing of said valve for effecting a reconnection of said second named means to said valve, and means responsive to a predetermined decrease in the prime mover below its desired value for actuating said valve in an opening direction independently of said above named valve adjusting means.

3. In a regulator system, a prime mover, a regulating valve for controlling the supply of motive fluid to said prime mover, means for biasing said valve toward its closed position, a mechanism for operating said valve, an electro-responsive device for actuating said mechanism, means responsive to variations in the speed of the prime mover from its desired value for controlling the operation of said electro-responsive device, and means actuated upon a predetermined increase in the speed of the prime mover above its desired value for disconnecting said mechanism from said valve, thus permitting said biasing means to actuate said valve in a closing direction.

4. In a regulator system, a prime mover, a regulating valve for controlling the supply of motive fluid to said prime mover, means for biasing said valve to its closed position, a mechanism for operating said valve, an electro-responsive device for actuating said mechanism, means responsive to variations in the speed of the prime mover from its desired value for controlling the operation of said electro-responsive device, means actuated upon a predetermined increase in the speed of the prime mover above its desired value for disconnecting said mechanism from said valve, thus permitting said biasing means to actuate said valve in a closing direction, and means responsive to a predetermined decrease in the speed of the prime mover below its desired value for actuating said valve in an opening direction independently of said above named valve adjusting means.

5. In a regulator system, a prime mover, a regulating valve for controlling the supply of motive fluid to said prime mover, means for biasing said valve toward its closed position, a three element differential gear mechanism having one of said elements operatively connected to actuate said valve, electro-responsive means for actuating another element of said differential gear mechanism, means responsive to variations in the speed of the prime mover from its desired value for controlling the operation of said electroresponsive means, means actuated upon a predetermined increase in the speed of the prime mover above its desired value for disconnecting said differential gear mechanism from said valve, thus permitting said biasing means to actuate said valve in a closing direction, a second electroresponsive means operatively connected to the third element of said differential gear mechanism, and means responsive to a predetermined decrease in the speed of the prime mover below its desired value for controlling said second named electroresponsive means to effect the operation of said valve in an opening direction independently of said valve adjusting means.

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