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EMERGENCY GOVERNING SYSTEM FOR A STEAM TURBINE

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2 Sheets-Sheet 1

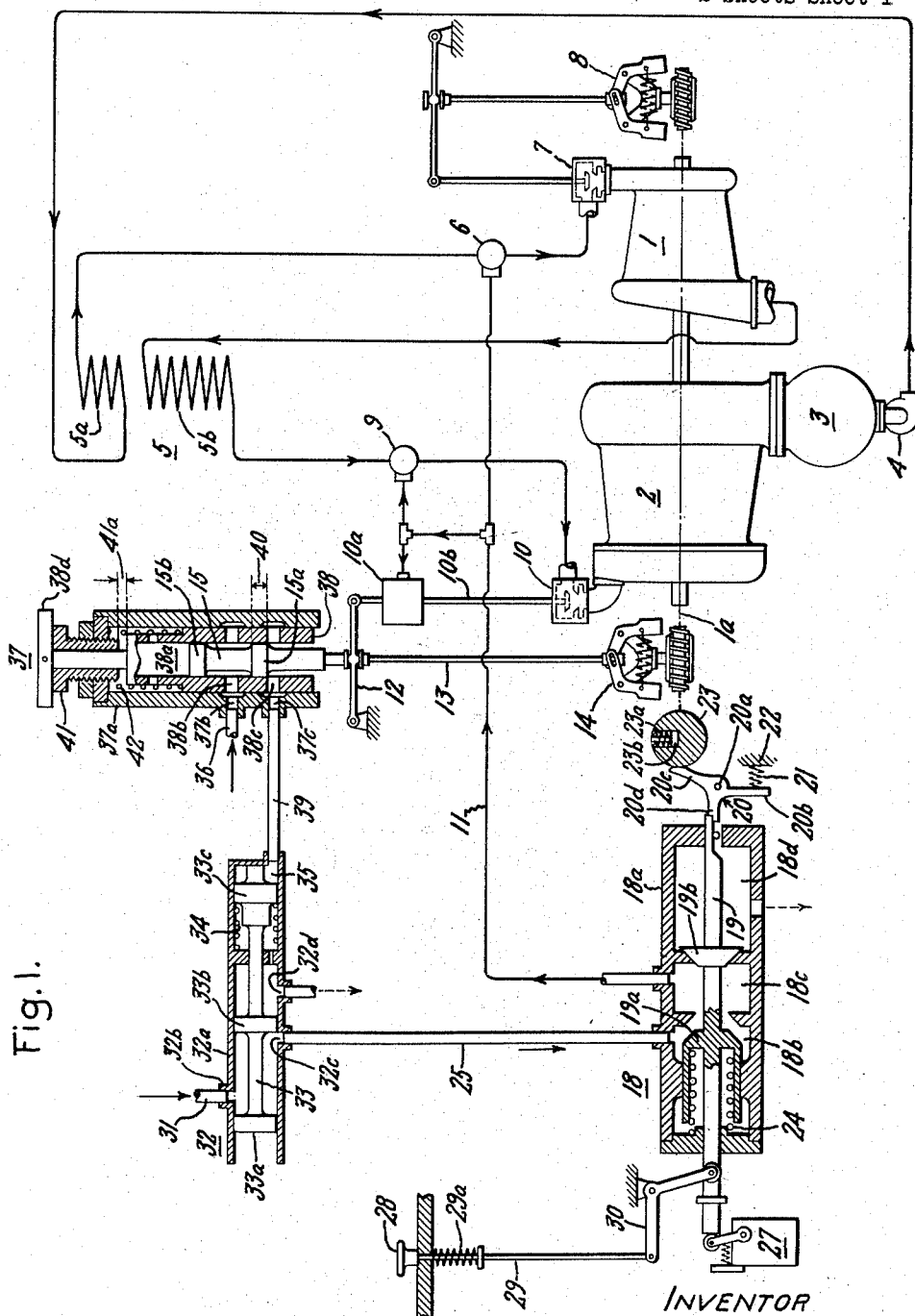


Fig. 1.

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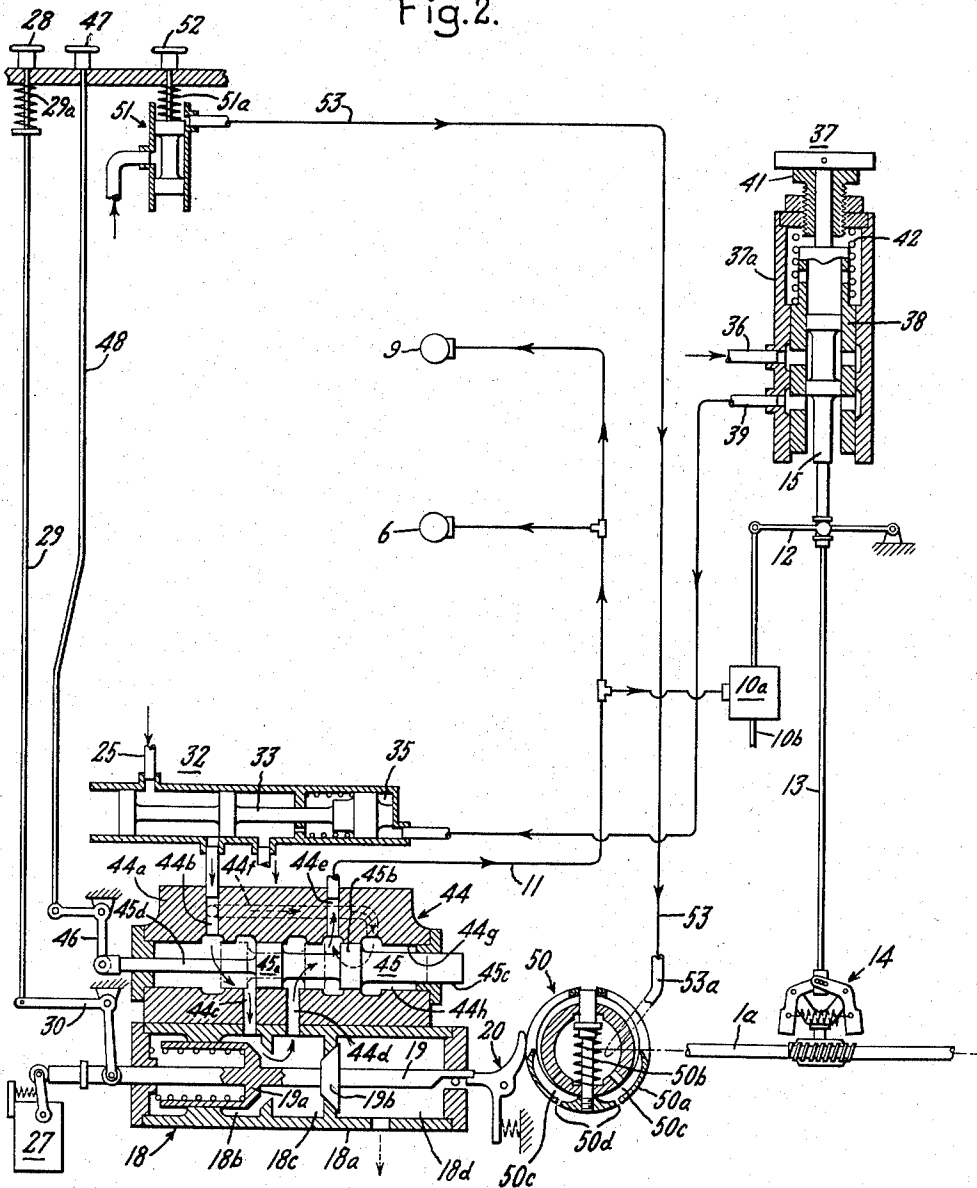
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Fig. 2.



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EMERGENCY GOVERNING SYSTEM FOR A STEAM TURBINE

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7 Claims. (Cl. 137—24)

This invention relates to a governing system for a prime mover such as a steam turbine, particularly to an emergency governing mechanism that permits testing of the emergency governor during turbine operation, and which also includes supplemental governing means for shutting down the turbine in the event of abnormal overspeed conditions while the emergency governor is being tested.

The conventional steam turbine is provided with a main governor for controlling the flow of fluid to the turbine in accordance with varying load demands on the turbine. In the event the turbine overspeeds by a preselected amount, an emergency governor is provided to completely shut down the turbine. Since steam turbines are expected to run for an extended period of time without being shut down for overhaul or periodic repairs, and since overspeeding of the turbine is relatively rare, it becomes necessary to provide means to periodically test the overspeed governor to ascertain if it is in proper working order during the normal operation of the turbine without bringing the prime mover up to the excess speed at which the emergency governor is set to trip. This is essential since the possibility exists that the emergency governor may become inoperative and thus unable to satisfactorily perform in the event the turbine overspeeds. The seriousness of this possibility cannot be overemphasized and requires that all the necessary precautions be taken to prevent its occurrence. It has been the practice to periodically test the emergency overspeed governor to prevent such an occurrence by actuating the governor to simulate the overspeed condition while the turbine is operating at normal speed. An illustration of a mechanism of this type is disclosed in U.S. Patent 1,666,490, issued April 17, 1928, to W. P. Dryer and assigned to the assignee of the present invention. However, this mechanism does not include means to shut down the turbine in the event the turbine overspeeds while the emergency governor is being tested. Without such safeguard, it is possible that the turbine may exceed the speed for which it is designed and cause extensive damage to the turbine.

Accordingly, it is an object of this invention to provide an emergency governing system for a turbine which consists of a main emergency governor for shutting down the turbine in the event the turbine overspeeds, and a supplemental governing mechanism for shutting down the turbine in the event the first emergency governor is not functioning.

A further object is to provide an emergency governing system for a turbine including a main governor, a hydraulic servo mechanism for facilitating testing of the emergency governor without disrupting normal operation of the turbine, and a second speed responsive governor for shutting down the turbine in the event the turbine overspeeds while the main emergency speed governor is being tested.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings in which:

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Fig. 1 is a diagrammatic representation of a compound steam turbine powerplant showing in detail an emergency governing mechanism embodying the invention; and

Fig. 2 is a diagrammatic representation illustrating an emergency governing mechanism similar to that disclosed in Fig. 1, but which further includes a hydraulic servo system for actuating the emergency governor to simulate overspeed conditions to permit testing of the emergency governor without shutting down the turbine.

Generally stated, the invention is practiced by providing an emergency speed governor for shutting down the turbine when the turbine overspeeds, a hydraulic servo system for actuating the emergency governor to simulate overspeed operation, which includes mechanism to permit testing of the governor without shutting down the turbine, and an additional speed responsive means adapted to shut down the turbine in the event the turbine overspeeds during the period when the emergency overspeed governor is rendered ineffective.

Referring now more particularly to Fig. 1, the invention is illustrated as applied to a compound steam turbine-generator plant having a high pressure turbine element 1 and at least one low pressure turbine element 2. These may be on different axes, or may be coupled together on a common axis, as shown in the drawing. The turbine 2 may exhaust into still lower pressure turbines or into the condenser 3, from which condensate is returned by boiler feed pump 4 to the steam generator indicated at 5 as having primary steam generating coils 5a and a reheater section 5b.

It will be seen in Fig. 1 that the path of the turbine motive fluid is from the boiler feed pump 4 to the steam generator 5, then through main stop valve 6 and main control valve 7, through the high pressure turbine 1 and back to the reheater 5b. Steam discharged from the reheater 5b passes through the reheat stop valve 9 and the intercept valve 10, thence to the inlet of the low pressure turbine 2. This simple diagrammatic showing, of course, does not include many conventional elements of steam powerplants, such as feed water heaters, lubricating system, packing control system, and numerous minor details of the turbine control system, the arrangement of which will be understood by those familiar with steam powerplant design.

The main steam controlling system includes the main control valves represented at 7 which are controlled by the main speed governor 8. The details of this governing valve mechanism are not material to an understanding of the present invention and are therefore not described in detail.

The reheat steam control mechanism includes a "pre-emergency governing system," which comprises a pre-emergency governor 14 driven by the turbine shaft 1a for controlling the intercept valve 10 through rod 13, lever 12, relay 10a and rod 10b to throttle the intercept valve when the turbine begins to overspeed. This is merely a diagrammatic showing of a conventional arrangement for controlling the intercept valve in accordance with the speed of the turbine. An embodiment of this mechanism is disclosed more particularly in U.S. Patent 2,747,373, issued to M. A. Eggenberger, and assigned to the assignee of the present invention. For the present purpose, it is sufficient to note that the function of relay 10a is to move intercept valve 10 to the closed position upon loss of operating fluid under pressure in conduit 11 which is controlled by the emergency governing system to be described in detail hereinafter. Main stop valve 6 and reheat stop valve 9 are maintained open by the operating fluid under pressure in conduit 11, which fluid flow is also controlled by the emergency governing mechanism and thus it serves as a second line of defense

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to shut down the turbine in the event of overspeed, which could be caused by the main steam supply in case of failure of the main or intercept valves to close if load should be suddenly lost on the turbine.

The main speed governor 8 controls the turbine under normal starting and running conditions, and when the turbine loses load and the speed increases, the pre-emergency governor 14 takes control away from the main governor 8 and controls the steady-state speed of the unit between approximately 105% and 101% of rated speed as long as there is steam available from the reheater. If the transient speed following loss of load exceeds 110%, approximately, the emergency governing system functions to shut off the flow of operating liquid to the stop valves 6, 9 to cause them to close and shut down the turbine.

The emergency governing system illustrated in Fig. 1 comprises a main emergency governing mechanism which functions to shut down the turbine when the turbine overspeeds, and a supplementary governing mechanism which shuts down the turbine when the main emergency governing mechanism does not operate properly.

The main emergency governing mechanism includes a mechanically actuated spill or "trip" valve 18 which controls the flow of operating fluid between inlet conduit 25 and outlet conduit 11 leading to relay 10a, main stop valve 6, and reheat stop valve 9. Trip valve 18 comprises a casing 18a having inlet chamber 18b, outlet chamber 18c, and drain chamber 18d. Controlling the flow through the openings between chambers 18b, 18c, 18d are valve heads 19a, 19b respectively, secured to stem 19. In the position shown, valve head 19a is open and valve head 19b is closed, thus connecting chambers 18b, 18c in series between inlet conduit 25 and outlet conduit 11. When the position of the valves 19a, 19b is reversed, chamber 18c is disconnected from the fluid supply and the fluid contained in chamber 18c and conduit 11 is discharged through chamber 18d to a sump (not shown).

Valves 19a, 19b are biased to the right by compression spring 24 disposed between casing 18a and valve 19a but they are held in the position shown by arm 20d of a three-armed latch 20 supported on a fulcrum 20a, and biased into the position shown by a spring 21 disposed between latch arm 20b and stop 22. Arm 20c of latch 20 is associated with a conventional emergency speed governor 23 which has a bolt 23b biased inwardly against centrifugal force by a spring 23a. During operation, bolt 23b is forced outward by centrifugal force as the turbine reaches emergency speed to move latch 20 counterclockwise to disengage latch arm 20d from stem 19 to permit valves 19a, 19b to be moved to the right by spring 24, so as to close valve 19a and open valve 19b. When this occurs, operating fluid in conduit 11 is drained and main stop valve 6, reheat stop valve 9, and intercept valve 10 move to their closed position to shut down the turbine.

A conventional switching mechanism 27 is provided adjacent the left-hand end of stem 19, which functions to indicate when emergency governor 23 has been actuated. Also, a linkage mechanism including handle 28, rod 29, spring 29a and double arm lever 30 connected to stem 19 is provided to reset valves 19a, 19b when it is desired to re-set latch 20 to reopen stop valves 6, 9 by readmitting operating fluid to conduit 11. Spring 29a returns handle 28 to normal position after valves 19a, 19b are reset. The mechanism so far described is typical of an emergency governing system provided to shut down a turbine when it exceeds a predetermined speed.

In accordance with the invention, a second emergency governing mechanism is provided to drain the operating fluid from conduit 11 and thereby close the main and reheat stop valves in the event the emergency governor does not operate when the turbine overspeeds. The second emergency governing mechanism includes a hydrau-

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lically actuated spill valve 32 disposed between the source of operating fluid and trip valve 18, and a speed responsive mechanism consisting of pre-emergency governor 14, and pilot valve 37, to be described hereinafter, for actuating spill valve 32 in response to turbine overspeed to drain the operating fluid under pressure contained in conduits 25, and 11 to permit the main and reheat stop valves, and intercept valve to close.

Spill valve 32 consists of a housing 32a containing a piston valve member 33 having axially spaced lands 33a, 33b, 33c. Housing 32a is provided with an inlet 32b for receiving inlet conduit 31 which is connected to a source of operating fluid under pressure (not shown), an axially spaced outlet 32c leading to conduit 25, and a drain outlet 32d. In the position shown, piston valve 33 is biased to the extreme right-hand end of housing 32a by compression spring 34 to interconnect conduits 31, 25. Valve 33 remains in this position unless it is moved to the left by fluid supplied to chamber 35 located between land 33c and housing 32a. This movement of valve 33 disconnects inlet conduit 31 from conduit 25 and drains conduit 25 to effectuate closing of the turbine stop valves in the same manner as disclosed when trip valve 18 is actuated by mean emergency governor 23.

The supply of operating fluid under pressure to chamber 35 is controlled by pilot valve 37 which is operated in response to turbine speed. As will be discussed in detail hereinafter, pilot valve 37 is controlled by the pre-emergency governor 14 but it is noted that it is within the scope of this invention to control pilot valve 37 by the main control governor 8 or other suitable governing mechanism responsive to turbine speed.

Pilot valve 37 consists of valve casing 37a, adjustable bushing 38, and piston valve member 15 which is slidably disposed in bore 38a of bushing 38. Valve member 15 is controlled by pre-emergency governor 14 through control rod 13. Casing 37a has inlet port 37b in communication with port 38b and an axially spaced outlet port 37c which communicates with port 38c of bushing 38. Inlet 37b is connected through conduit 36 to a source of fluid under pressure (not shown) and outlet 37c supplies fluid to conduit 39 and chamber 35 to bias piston valve member 33 to the left to drain conduit 25. Flow between ports 38b, 38c is controlled by the position of axially spaced lands 15a, 15b on valve member 15 in accordance with the operation of governor 14. The speed at which the piston valve member 15 is moved by governor 14 to a position to interconnect ports 37b, 37c is determined by the position of bushing 38. In the position shown, bushing 38 is set so that valve member 15 must travel a distance 40 before operating fluid is supplied to actuate spill valve 32 to shut off the flow of motive fluid to the turbine. In the embodiment illustrated, valve 37 will be moved to admit fluid to chamber 35 by governor 14 in response to a turbine speed slightly above that for which the main emergency governor 23 is set (approximately 112% of rated speed). The distance 40 and thus the speed at which valve 37 actuates valve 32 may be adjusted by moving stop 41, which sets the position of T-shaped member 38d. Member 38d is connected to bushing 38 in any suitable manner and limits the downward movement of bushing 38 which is biased into the position shown by compression spring 42 located between casing 37a and bushing 38.

In order to make it possible to obtain the proper setting of stop 41 at a speed below 110%, and thereby avoiding to have to lock the emergency governor out of action to perform the setting operation, the bushing 38 can be pulled up, as by manually grasping the stop 38d, a distance corresponding to the clearance 41a, which may for instance correspond to a speed change of 3%. In this position the distance 40 will be reduced by the distance 41a and therefore oil from conduit 36 will be admitted to chamber 35 at a speed 3% lower than in the position shown. The stop 41 is now adjusted properly to obtain

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a trip speed of 109% of rated speed and, thereafter, the bushing 38 will be lowered manually to the position shown and will then trip the mechanism at 112% of rated speed.

This feature is desirable not only in order to perform the setting operation without having to lock out the emergency governor 23, but also to be able to set this trip speed without actually making the turbine run at 112% of rated speed, which may be considered as unnecessarily hard duty by powerplant operators.

The operation of the system disclosed in Fig. 1 is as follows.

First, it is to be noted that the governing system as shown in the drawing illustrates the positions of the various components during normal operation of the turbine. During this period, the main stop valve 6 and reheat stop valve 9 are maintained in the open position and intercept valve relay 10a is effective to permit governor 14 to control intercept valve 10 by the actuating fluid supplied to conduit 11 through valve 32 and trip valve 18. The flow of steam through turbines 1, 2 is controlled in the conventional manner by control valves 7, 10, regulated by governors 8, 14 respectively.

When the turbine overspeeds, for instance to 110% of normal speed due to loss of load, emergency governor 23 actuates latch 20 to disengage it from valve stem 19 to permit spring 24 to close valve 19a and open valve 19b. This movement of valve stem 19 shuts off the flow of operating fluid from conduit 25 to conduit 11 and drains the fluid contained in conduit 11 to effect closing of the main and reheat stop valves 6, 9, and intercept valve 10. In the event emergency governor 23 is stuck and does not trip valve 18, piston valve member 15 is moved by pre-emergency governor 14, when the turbine reaches 112% of rated speed, to a position to interconnect conduits 36, 39 to supply fluid pressure to valve chamber 35 of spill valve 32. Fluid pressure in chamber 35 moves piston valve 33 to a position to stop the flow of fluid between conduits 31, 25 and drains conduit 25 to effectuate closing of the main and reheat stop valves and intercept valve in the same manner as if the trip valve 18 were actuated by emergency governor 23. Thus it can be seen that the embodiment disclosed in Fig. 1 provides a main emergency governing mechanism for shutting down the turbine upon overspeed and a supplemental governing mechanism for shutting down the turbine when the main emergency governor is inoperative.

Referring now to Fig. 2, the emergency governing mechanism disclosed therein is similar to that disclosed in Fig. 1 and in addition incorporates a "lockout" valve 44 which functions to bypass the operating fluid around the trip valve 18 to maintain the main and reheat stop valves open regardless of the position of the emergency trip valve 18. The emergency governor 50 can then be actuated by a separate hydraulic system to simulate overspeed conditions to ascertain if the emergency governor is in proper working order.

Lockout valve 44 consists of a housing 44a having flow passages 44b, 44c interconnecting conduit 25 with trip valve chamber 18b; flow passages 44d, 44e interconnecting chamber 18c with conduit 11; and passage 44f which interconnects passages 44b with chamber 44h. Flow between passages 44b, 44c; 44d, 44e; and 44b, 44f, 44e is controlled by a piston valve member 45 located in bore 44g and having lands 45a, 45b. Piston valve member 45 is connected to lever 46 which is operated by handle 47 through rod 48 to move piston valve 45 to the position shown in the dotted lines against the oil supply pressure tending to move piston valve 45 to the right due to the different diameters of rods 45c, 45d. When handle 47 is released, this oil pressure will return valve 45 to the normal position shown in solid lines. In the position shown in solid lines, oil flows from conduit 25 through passages 44b, 44c, trip valve chambers 18b, 18c, to conduit 11. When the piston valve member 45

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is moved to the position shown in dotted lines, oil is still supplied to conduit 11 through passages 44b, 44f, chamber 44h, and passage 44e. Thus valve 44 can be set to "lock out" trip valve 18 by directing the flow of operating fluid around trip valve 18 so that the main emergency governor 50 can be actuated for testing purposes without affecting the flow of operating fluid to the turbine stop valves.

The emergency governor 50 disclosed in Fig. 2 consists of an unbalanced ring 50a which is actuated by centrifugal force against the force of a spring 50b when the turbine overspeeds. In ordinary practice the tension of spring 50b is adjusted so the emergency governor will operate at about 110% of normal rated speed. This movement puts ring 50a in an eccentric position so that it strikes latch 20 to "trip" valve 18. The governor 50 may, for test purposes be tripped at normal speed by the admission of oil through hand valve 51, which is manually actuated by handle 52, conduit 53, and nozzle 53a. Spring 51a is provided to return valve 51 to the position shown when handle 52 is released. Ring 50a defines pockets 50c which receive the oil from nozzle 53a. The weight of the oil admitted into pockets 50c unbalances ring 50a causing the governor to trip at a speed below the rated speed of the turbine. After the governor trips and the hand valve 51 is closed, the oil pockets 50c empty through two small holes 50d in ring 50 by centrifugal force, and the governor resets itself. Holes 50d are of such size as compared to nozzle 53a that liquid can be supplied by the nozzle 53a to pockets 50c faster than it can escape from the pockets through holes 50d. A governor of this general type has been used extensively and is more particularly described in U.S. Patent 1,666,490—Dryer, issued April 17, 1928 and assigned to the assignee of the present invention.

When it is desired to test emergency governor 50, the mechanism disclosed in Fig. 2 is operated in the following manner.

Handle 47 is first moved upwardly to move piston valve member 45 to the left to interconnect conduits 25, 11 through passages 44b, 44f and 44e so that operating fluid is supplied to conduit 11 to maintain main and reheat stop valves open regardless of the operation of emergency governor 50. Oil is then admitted to conduit 53 by opening hand valve 51 by handle 52 to supply oil to pockets 50c to trip emergency governor 50 and trip valve 18 while the turbine is operating at normal speed. If the emergency governor is working properly, signal switch 27 is actuated due to movement of stem 19 to indicate satisfactory operation. Handle 52 is then released to close off the supply of oil to governor 50 and the oil contained in pockets 50c drains out through holes 50d to permit governor 50 to reset itself. Valve 18 is then reset by pulling on handle 28, which will reset valve 18 by action of rod 29 and lever 30. The indicating light switch 27 will then operate in the reverse direction indicating that valve 18 is in operating position again. The spring 29a will return handle 28 to normal position. Lockout valve 44 is then moved back to the position shown in solid lines by handle 47 to place trip valve 18 back in the circuit between conduits 25 and 11.

It remains to note that the emergency governing system disclosed in Fig. 2 operates in the same manner as that disclosed in Fig. 1 with regard to the operation of the supplementary emergency governing mechanism which functions to shut down the turbine if it overspeeds while the emergency governor is being tested. That is to say, if the turbine overspeeds when the emergency governor is "locked out," pre-emergency governor 14 will move piston valve 15 to a position to supply fluid to chamber 35 to actuate piston 33 of valve 32 to drain conduits 25 and 11 to cause the main and reheat stop valves to close and shut down the turbine.

Thus it can be seen that the novel emergency governing mechanism disclosed permits testing of the emergency

governor during normal turbine operation and also provides a supplemental governing mechanism for shutting down the turbine when the main emergency governor is rendered inoperative, either through faulty operation or to permit testing.

It will be appreciated that the structure described specifically herein is intended to be illustrative only, and actual embodiments of the invention may take various forms. The constructions of the spill valve 32, trip valve 18, and lockout valve 44 may take other forms, i.e., solenoid operated valves, consistent with the functions they are intended to perform. Also, it is apparent that governor 50 could be used in Fig. 1 in place of governor 23 if such is desired. In addition, it can be appreciated that this system is readily applicable to a cross-compound turbine by providing an additional governor mechanism that is responsive to the speed of the low pressure unit.

It is, of course, intended to cover by the appended claims all such modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a turbine having inlet valve means controlling the flow of motive fluid to the turbine, a governing system for said turbine comprising fluid pressure actuated means connected to operate said inlet valve means, a source of actuating fluid under pressure, first spill valve means connected to discharge actuating fluid from the inlet valve operating means, main emergency governing mechanism responsive to a first preselected turbine overspeed condition to actuate the first spill valve means to effect closing of the inlet valve means to shut down the turbine upon occurrence of said first overspeed condition, second spill valve means connected to discharge actuating fluid from the inlet valve operating means, fluid pressure servo motor means positioning said second spill valve, pilot valve means controlling the flow of actuating fluid from said source to said servo motor means, and second governor means responsive to a second predetermined turbine overspeed condition above said first overspeed condition and including an output member for positioning the pilot valve means to actuate said servo motor means to discharge actuating fluid from the inlet valve operating means and shut down the turbine in the event the main emergency governing mechanism fails to function, said output member being also connected to operate the inlet valve means over a predetermined range of turbine overspeed.

2. In combination, a turbine having inlet valve means controlling the flow of motive fluid to the turbine, a governing system for said turbine comprising first fluid pressure motor means connected to operate the inlet valve means, a source of actuating fluid under pressure, first spill valve means connected to discharge actuating fluid from said first motor means, first emergency governor means responsive to a first preselected turbine overspeed condition to actuate the first spill valve means to discharge actuating fluid from the first motor means, whereby the inlet valve means will be moved to the closed position, second spill valve means connected to discharge actuating fluid from the first motor means, servo motor means connected to position said second spill valve means, pilot valve means connected to control the flow of fluid from said source to actuate said servo motor means, and second emergency governor mechanism responsive to a second preselected turbine speed condition above said first speed condition and including an output member for positioning said pilot valve means to actuate said servo motor to discharge actuating fluid from said first motor means, said output member being also connected to operate the inlet valve means over a predetermined range of turbine overspeed, whereby when the turbine reaches said first overspeed condition, the first governor means positions the first spill valve means to close the inlet valve means and shut down the turbine and,

in the event the first governor becomes inoperative, the second governor mechanism effects closing of the inlet valve means to shut down the turbine when the turbine reaches said second overspeed condition.

3. In combination, a turbine having inlet valve means controlling the supply of motive fluid, a governing system for said turbine comprising fluid pressure actuated means connected to operate said inlet valve means, a source of actuating fluid under pressure, first spill valve means connected to interrupt the flow of actuating fluid from the source to the inlet valve operating means, main emergency governing mechanism including a first governor responsive to a first predetermined turbine overspeed condition and connected to trip said first spill valve means to shut down the turbine upon occurrence of said first overspeed condition, means connected to cause said first governor to trip said first spill valve means at a speed lower than said first overspeed condition, valve means connected to bypass actuating fluid from said source around said first spill valve means to the inlet valve operating means, means for actuating said bypass valve at will whereby the first governor means can be actuated to trip said first spill valve means without shutting down the turbine, second spill valve means connected to discharge actuating fluid from the inlet valve operating means, servo motor means connected to position said second spill valve means, pilot valve means to control the supply of fluid from said source to said servo motor means, and second governor means including an output member for positioning said pilot valve means to interrupt the flow of operating fluid to the inlet valve operating means and shut down the turbine upon occurrence of a second predetermined overspeed condition higher than said first overspeed condition, said output member being also connected to operate the inlet valve means over a predetermined range of turbine overspeed, whereby the second governor means will shut down the turbine in the event the turbine reaches said second overspeed condition during testing or upon malfunction of the first governor.

4. In combination, a turbine having inlet valve means controlling the supply of motive fluid, a governing system for said turbine comprising fluid pressure actuated means connected to operate said inlet valve means, a source of actuating fluid under pressure, trip valve means connected to control the flow of actuating fluid from the source to the inlet valve operating means, a main emergency governor connected to position said trip valve to interrupt the flow of operating fluid to the inlet valve operating means and shut down the turbine when the speed of the turbine reaches a first predetermined value, means for modifying the action of the emergency governor while the turbine is running to effect operation of the trip valve at a speed lower than said first predetermined speed value whereby the trip valve and emergency governor may be tested during normal operation, lockout valve means connected to bypass actuating fluid around said trip valve means to the inlet valve operating means whereby the flow of actuating fluid to said inlet valve operating means is rendered independent of the setting of said emergency governor to permit testing of the emergency governor without shutting down the turbine, spill valve means connected to discharge actuating fluid from said inlet valve operating means, a servo motor connected to operate said spill valve means, pilot valve means connected to control the flow of fluid from said source to actuate said servo motor, and second governing means including an output member for positioning said pilot valve means to effect closing of the inlet valve means to shut down the turbine in accordance with a second predetermined speed condition of the turbine higher than said first speed, said output member being also connected to operate the inlet valve means over a predetermined range of turbine overspeed, whereby the

second governor means will shut down the turbine when the turbine reaches said second speed while the main emergency governor is being tested.

5. In combination, a turbine having inlet valve means controlling the supply of motive fluid, a governing system for said turbine comprising fluid pressure actuated means connected to operate said inlet valve means, a source of actuating fluid under pressure, trip valve means connected to control the flow of operating fluid from said source to the inlet valve operating means, a main emergency governor connected to close said trip valve to shut off the flow of operating fluid to the inlet valve operating means and shut down the turbine when the speed of the turbine reaches a first predetermined value, means for modifying the action of said main emergency governor to effect closing of the trip valve at a speed lower than said first value while the turbine is in normal operation, bypass valve means for directing actuating fluid from said source around said trip valve means to the inlet valve operating means, and means for positioning said bypass valve at will whereby the main emergency governor can be tripped without shutting down the turbine, spill valve means connected to discharge actuating fluid from the inlet valve operating means, a servo motor connected to operate said spill valve means, pilot valve means connected to control the flow of fluid from said source to said servo motor, and second governor means with an output member for positioning said pilot valve means to control the flow of actuating fluid to the inlet valve operating means to effect closing of the inlet valve means and shut down the turbine upon occurrence of a second predetermined turbine speed higher than said first value, said output member being also connected to operate the inlet valve means over a predetermined range of turbine overspeed, whereby the main emergency governing mechanism may be tripped for test purposes without shutting down the turbine while the second governor means will shut down the turbine in the event said second speed condition occurs during the testing period.

6. In combination, a turbine having inlet valve means controlling the flow of motive fluid to the turbine, a governing system for said turbine comprising fluid pressure actuated means connected to operate said inlet valve means, a source of actuating fluid under pressure connected to said inlet valve operating means, first and second spill valve means connected between said actuating fluid pressure source and the pressure actuated inlet valve operating means, and arranged to discharge actuating fluid so that actuation of either of said first and second spill valve means will cause said inlet valve means to close, first speed sensitive means actuating said first spill valve means at a first predetermined condition of turbine

overspeed, second speed sensitive means having an output member connected to operate said inlet valve means over a predetermined range of turbine overspeed and arranged to actuate said second spill valve means at a second and higher predetermined condition of turbine overspeed, whereby inlet valve overspeed control will reside sequentially, during increasing turbine overspeed, in the second speed sensitive means, the first speed sensitive means, and the second speed sensitive means.

7. In combination, a turbine having inlet valve means for controlling the flow of motive fluid to the turbine, a governing system for said turbine comprising fluid pressure actuated means connected to operate said inlet valve means, a source of actuating fluid under pressure connected to actuate said inlet valve operating means against a closing bias, first spill valve means connected to interrupt the flow between said actuating fluid pressure source and the inlet valve operating means, second spill valve means including a servo motor positioning it to interrupt the flow between said actuating fluid pressure source and the inlet valve operating means, said first and second spill valve means arranged so that actuation of either of said spill valve means will discharge actuating fluid to allow said biased inlet valve operating means to close the inlet valve means, pilot valve means to control the flow of actuating fluid to said servo motor, first speed sensitive means connected to actuate said first spill valve means at a first predetermined condition of turbine overspeed, second speed sensitive means having an output member connected to operate said inlet valve means over a predetermined range of turbine overspeed and actuating said pilot valve means at a second higher predetermined condition of turbine overspeed to admit actuating fluid to said servo means thereby closing said inlet valve means, whereby operating control of said inlet valve means resides sequentially in said second speed sensitive means, said first speed sensitive means, and said second speed sensitive means during increasing turbine overspeed.

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