

[54] **TURBINE OVERSPEED TRIP SYSTEM WITH TESTING MECHANISM**  
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[57] **ABSTRACT**

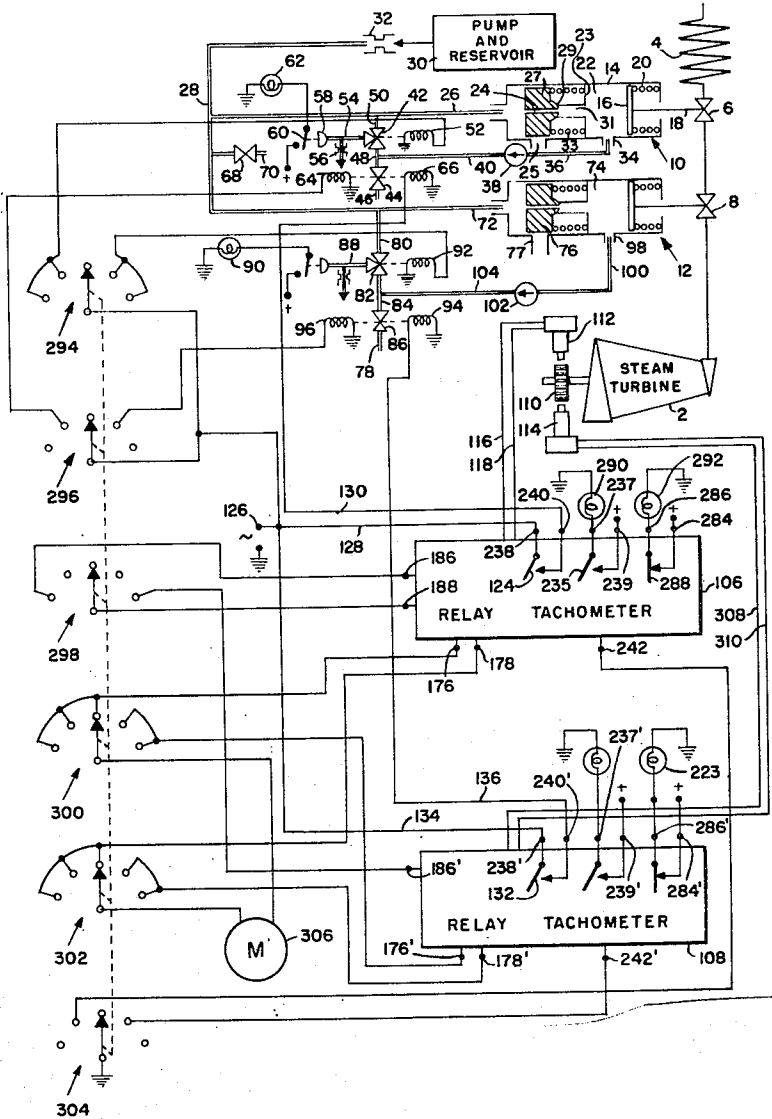
Each stop valve in a steam turbine power plant is controlled by a piston and cylinder unit. A control system is provided which allows full movement of the stop valve under actual overspeed conditions, and which produces a simulated overspeed condition effecting only a partial closing movement of the stop valve for test purposes.

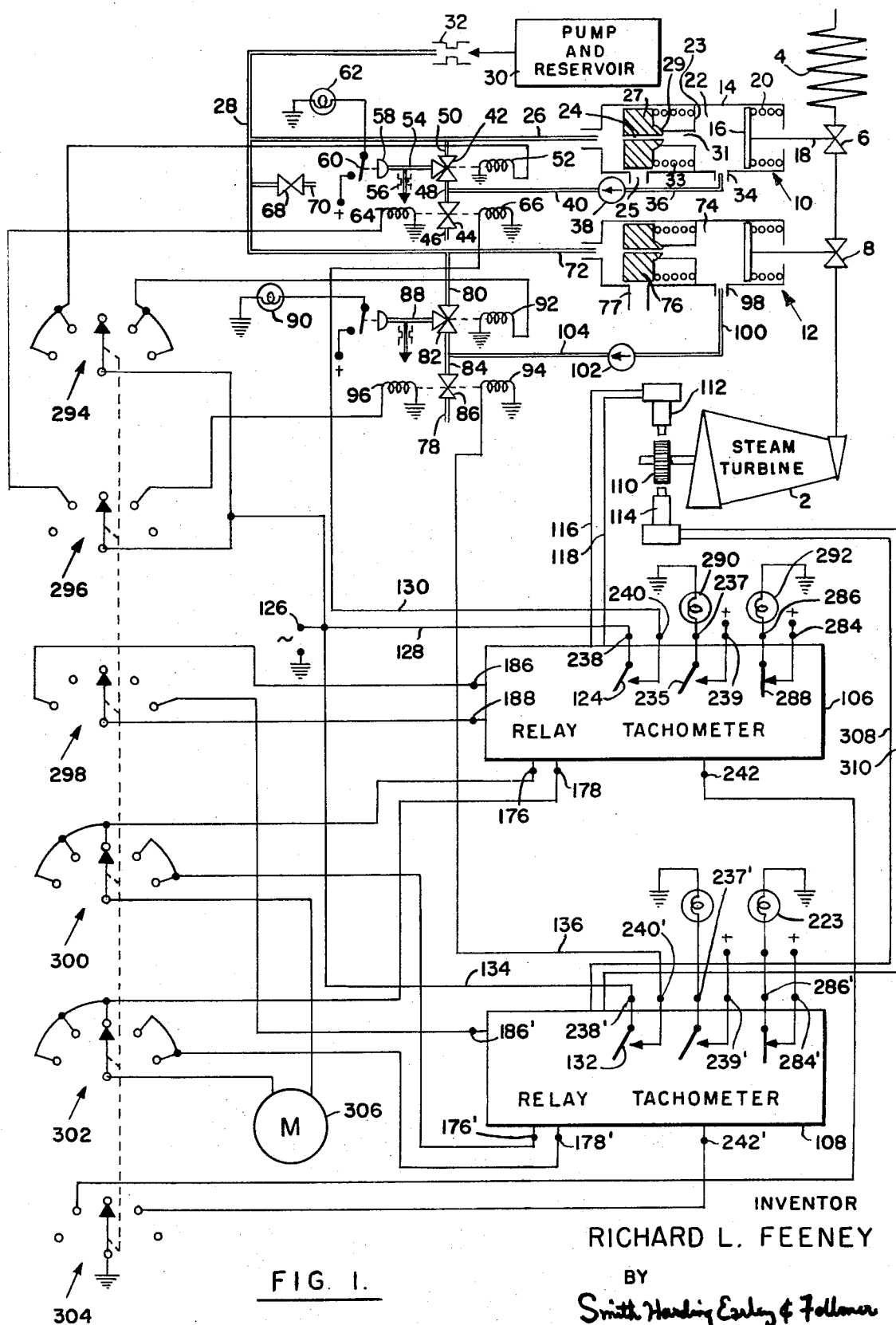
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**7 Claims, 2 Drawing Figures**

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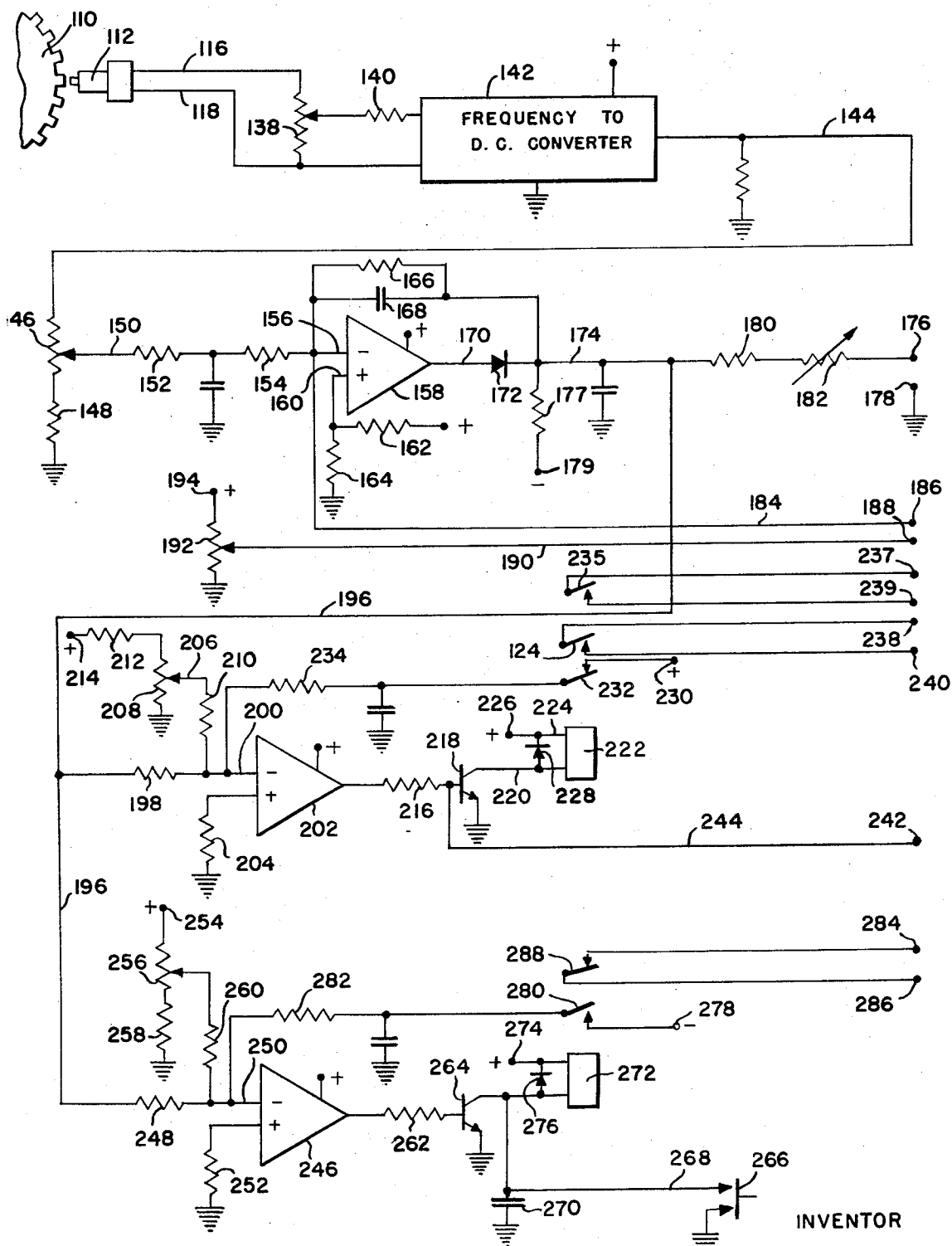


FIG. 2

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## TURBINE OVERSPEED TRIP SYSTEM WITH TESTING MECHANISM

### BACKGROUND OF THE INVENTION

This invention relates to steam turbines and particularly to a steam turbine overspeed trip system having provision for testing.

In steam turbine power plants, there are customarily provided safety systems which effect a shutting down of the steam turbine by closure of one or more steam stop valves when an overspeed condition exists. Typically, turbine shaft speed is measured by a centrifugal mechanism which is arranged to close the stop valve or valves whenever a predetermined speed is reached. The safety system should be checked from time to time to make certain that it will function properly in the event that the turbine should exceed its maximum safe speed.

Safety systems heretofore used in steam turbine power plants have been subject to one or more objections. For example, in some safety systems, it is necessary to run the turbine to an actual overspeed condition in order to test the trip mechanism. In some systems, it is necessary to shut down the turbine in order to test the safety system. In some systems, the stop valves are not exercised in the course of a test.

The foregoing objections have been overcome by the use of steam by-pass valves, but the use of by-pass valves results in a greater degree of complexity in the safety system and in its operation, and in a system involving by-pass valves, there is inherently the danger that the by-pass valve will be inadvertently left open so that the turbine can continue to run when the stop valve is closed during actual overspeed condition.

Systems involving by-pass valves ordinarily provide no overspeed protection while a test is being conducted.

### SUMMARY OF THE INVENTION

In accordance with this invention, there is provided a steam power plant in which the steam generator is connected to the turbine through at least one stop valve controlled by a piston and cylinder unit which is capable of effecting a partial or full closure of the stop valve depending on the condition of an associated hydraulic control system. The hydraulic control system is associated with a relay tachometer which measures the speed of the turbine shaft.

For test purposes, the hydraulic system associated with the stop valve can be set to permit only partial operation of the stop valve and a simulated overspeed condition can be generated by adjustment of the relay tachometer circuitry. When the simulated overspeed condition is generated, every part of the trip system associated with the stop valve which would operate under an actual overspeed condition is operated. The only exception is that the piston and cylinder unit is not actuated to the full extent so as to close the stop valve.

Where multiple stop valves are used, either in series or in parallel, a manually operable control switch is provided for effecting alternate testing of the duplicate stop valve trip system.

Duplicate speed sensing apparatus may be used, and each speed sensor is preferably capable of effecting operation of all of the stop valves in the system.

The principal object of this invention is to provide a trip system which is capable of being tested without the turbine shutdown and without effecting an actual overspeed condition of the turbine, which exercises the stop valves during a test, and which does not require steam by-pass valves.

Another object is to provide an overspeed trip system which is capable of adjustment while the unit is operating and regardless of the turbine speed.

Another object is to provide a turbine trip system in which the speed sensing and trip signals are electrical.

Another object is to allow tests to be made whether or not the turbine is in operation.

Another object is to provide an overspeed trip system in which tests can be made during turbine operation without the existence of any interval during which no overspeed protection is afforded.

Another object is to provide an overspeed trip system capable of operating multiple stop valves simultaneously when an overspeed condition occurs, but which allows for testing of said valves individually during turbine operation without substantial reduction of steam flow.

Other objects will be apparent from the following description when read in conjunction with the drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a steam turbine power plant provided with an overspeed trip system in accordance with the invention; and

FIG. 2 is a schematic diagram of a relay tachometer in accordance with the invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a conventional steam turbine 2 fed by a boiler 4 through stop valves 6 and 8, which are connected in series so that closure of either will cut off the flow of steam to the turbine.

Stop valve 6 is controlled by a valve controller 10, and stop valve 8 is controlled by controller 12, which is similar to controller 10 and therefore need not be described in detail. Controller 10 includes a piston and cylinder unit comprising cylinder 14 and piston 16 which is slidable therein. Piston 16 is connected to the valve through a control rod 18 so that movement of the piston with respect to the cylinder controls the opening and closing of the valve. Specifically, valve 6 is in a fully opened condition when piston 16 is toward the right of cylinder 14 as viewed in the drawing, and stop valve 6 is closed when piston 16 is positioned toward the left. Piston 16 is normally urged toward the left by a helical spring 20, and it is urged toward the right against the force of spring 20 by the pressure of a fluid in chamber 22 which is defined by cylinder 14, piston 16 and the end closure 23 of the cylinder. A greater than atmospheric pressure is required to hold piston 16 in the condition maintaining valve 6 opened. Thus, the system is "fail safe" in the sense that the failure of any component of the system supplying fluid pressure to chamber 22 is likely to reduce pressure in chamber 22 to atmospheric and result in closure of stop valve 6.

A valve 27 cooperates with a seat 29 to control the flow of oil into and out of chamber 22 through passage

31. Valve 27 has a restricted passage 24 which allows oil to flow from line 26 into chamber 22. Line 26 connects to supply line 28. Valve 27 prevents direct communication between line 26 and drain passage 25. It is held against seat 29 by pressure in line 26. However, if valve 27 moves away from its seat 29, it allows direct communication between chamber 22 and drain opening 25. Thus, valve 27 acts as a pilot valve, quickly draining chamber 22 through drain opening 25, when pressure in line 26 drops. Valve 27 is urged toward the left by spring 33. Therefore, a pressure differential need not exist to cause the valve to open.

Supply line 28 receives fluid, preferably oil, from a conventional pump and reservoir 30 through a restricted orifice 32. A port 34 is provided in the wall of the cylinder 14 at a position such that its connection with chamber 22 is cut off by piston 16 when the piston moves through a part of its range of movement from the position corresponding to a fully open condition of valve 6 to the position corresponding to a fully closed condition thereof. Preferably, port 34 is so positioned that it is closed off by piston 16 when valve 6 is still substantially fully open. In this way, a test can be performed without a substantial slowing down of the steam turbine, but nevertheless with a partial operation of the stop valve mechanism.

Briefly, the function of the controller just described is to effect a full closure of stop valve 6 whenever an actual overspeed condition exists in the steam turbine, and to effect only a partial closing movement of valve 6 for test purposes whenever an overspeed condition is simulated. This operation of valve controller 10 is accomplished by the hydraulic system which will now be described.

Port 34 is connected through line 36, check valve 38 and line 40 to an interconnection 48 between valves 42 and 44. The check valve is necessary for the reopening of the stop valve following a full closing thereof. It prevents the flow of oil into the space to the right of the piston, through valve 42 which would prevent the development of sufficient pressure to close pilot valve 27. During normal operation of the steam turbine, valve 42 connects line 26 to interconnection 48, and valve 44 is closed to prevent the flow of hydraulic fluid from interconnection 48 through drain connection 46. So long as a high pressure is maintained in line 28 by the pump, valve 27 remains closed and pressure in chamber 22 remains high to hold piston 16 toward the right.

Valve 42 is a three-way valve operated by solenoid 52. When solenoid 52 is energized, flow between lines 50 and interconnection 48 is cut off, and line 50 is connected to line 54 which, in turn, is connected through orifice 56 to a drain outlet. Valve 42 is preferably spring loaded so that, when solenoid 52 is de-energized, it returns to the normal condition to allow flow between lines 48 and 50.

A pressure actuated switch control 58 is connected to line 54 and operates a switch 60 whenever valve 42 is in a condition connecting lines 50 and 54. Closure of switch 60 operates an indicator lamp 62, indicating the blocked condition of line 50.

Valve 44 is controlled by a pair of solenoids 64 and 66, and is of the type which remains in the condition in which it is set. Energization of solenoid 64 sets valve 44

to a closed condition, while energization of solenoid 66 sets valve 44 to an open condition.

A manually operable valve 68 connects supply line 28 to a drain connection 70, and allows a manual operation of the stop valves by reduction of pressure in the chambers of the valve controllers.

The system for operating valve controller 12 is identical to the system just described with reference to controller 10. Line 72 connects chamber 74 of controller 12 to supply line 28. A pilot valve, similar to valve 27, is provided at 76. A drain opening, similar to opening 25, is provided at 77.

Line 72 is connected to a drain outlet 78 through line 80, valve 82, interconnection 84, and valve 86. Valve 82 is identical to valve 42, and pressurizes line 88 when line 80 is blocked to effect operation of indicator lamp 90. Valve 82 is operated by solenoid 92, and valve 86 is set to an open condition upon energization of solenoid 94 and to a closed condition upon energization of solenoid 96.

Port 98 is connected through line 100, check valve 102, and line 104 to interconnection 84.

During normal operation of the steam turbine, valve 42 is in a condition to allow flow between line 50 and interconnection 48 and valve 82 is in a condition to allow flow between line 80 and interconnection 84. Valves 44 and 86 are closed. The pressure in line 28 and in lines 26 and 72 is relatively high, and the pressure in chambers 22 and 74 is correspondingly high so that the pilot valves remain closed and the pistons in the respective controllers hold stop valves 6 and 8 in a fully opened condition.

Whenever the speed of the turbine shaft reaches a predetermined limit, one or both of valves 44 and 86 open as a result of the operation of electrical circuitry described subsequently herein. If either or both of valves 44 and 86 open, the pressure in the system downstream of orifice 32, which includes lines 28, 26 and 72 decreases to a value slightly above atmospheric, and the pilot valves 27 and 76 operate, allowing the pistons to move to the left far enough to close the stop valves fully. Displaced hydraulic fluid is exhausted through drain openings 25 and 77.

The stop valves can be reopened by resetting whichever of valves 44 and 86 is opened. Oil passes through lines 26 and 72 and through the restricted passages in the pilot valves respectively into chambers 22 and 74. Check valves 38 and 102 prevent a pressure drop in the oil supply system while the pistons are to the left of openings 34 and 98.

An overspeed condition is simulated by operating one of valves 42 and 82, and subsequently opening the one of valves 44 and 86 which is associated with the first valve which is operated. For example, an overspeed condition can be simulated by operating valve 42 to block line 50, and subsequently opening valve 44 to reduce the pressure in chamber 22 and to allow flow of the fluid in chamber 22 outwardly through port 34 line 36, check valve 38, line 40, valve 44 and connection 46. Piston 16 moves toward the left until it cuts off connection between chamber 22 and port 34, whereupon because of the blocking of line 50 by valve 42, no further oil flows out of chamber 22. Thus, piston 16 can move to the left no farther than port 34. Stop valve 6 is exercised during the test, but is not moved sufficiently

far as to reduce the flow of steam to the turbine substantially.

The electrical circuitry which effects the above-described operation of solenoid-operated valves 42, 44, 82 and 86 comprises a pair of relay tachometers 106 and 108 which are substantially identical and shown as blocks in FIG. 1. The details of relay tachometer 106 are shown in FIG. 2 wherein elements common to both figures are similarly numbered.

A signal representative of the speed of rotation is derived from the teeth of a gear 110, which is rotated by steam turbine 2, through a conventional magnetic pick-up 112. A similar signal is derived through magnetic pick-up 114. These pick-ups are located adjacent the gear teeth and each produces an output in the form of a train of electrical pulses the repetition rate of which is proportional to the speed of rotation of the turbine rotor. The output of magnetic pick-up 112 is delivered through lines 116 and 118 to an input of relay tachometer 106. The output of pick-up 114 is similarly delivered to an input of relay tachometer 108 through lines 308 and 310.

Relay tachometer 106 includes a normally open set of relay contacts 124, one of which is connected to the ungrounded AC supply terminal 126 through line 128. The other contact is connected through line 130 to solenoid 66 so that when contacts 124 close, valve 44 is set to an open condition. Relay tachometer 108 has a similar set of normally open contacts 132, one of which is connected to the ungrounded AC terminal 126 through line 134 and the other of which is connected through line 136 to solenoid 94 to provide for setting of valve 86 to an open condition upon closure of contacts 132. Additional reference will now be made to FIG. 2 in order to explain how the contacts 124 are closed when the steam turbine rotor reaches a predetermined speed.

The fixed terminals of a variable resistor 138 are connected across lines 116 and 118, and the wiper is connected through resistor 140 to the input of a frequency-to-DC converter 142, a return being provided through line 118. The frequency-to-DC converter is the conventional circuit used in electrical automobile tachometers and in other applications. It produces a direct current the amplitude of which is directly proportional to the number of pulses per second applied to its input. The DC output is delivered through line 144 and through a dropping network including variable resistor 146 and fixed resistor 148 to line 150. Line 150 is connected through resistors 152 and 154 to an inverting input 156 of differential amplifier 158. A positive voltage is applied to the other input terminal 160 through a dropping network comprising resistors 162 and 164. Output line 170 of the differential amplifier is connected through diode 172 to line 174. Feedback is provided from line 174 through the parallel combination of resistor 166 and capacitor 168 to input 156. Because of the feedback network, the differential amplifier acts as a low-pass filter. In addition, it acts as a buffer and also inverts the polarity of the output of converter 142. Line 174 is connected through resistor 177 to a negative supply terminal 179. The voltage in line 174 varies from zero to a small negative value as the pulse frequency at the input of converter 142 increases. Terminal 176 and grounded

terminal 178 are provided for connection to a meter for reading the turbine rotor speed. Line 174 is connected through fixed resistor 180 and variable resistor 182 to terminal 176.

Input 156 of differential amplifier 158 is connected through line 184 to terminal 186. A positive voltage is applied to terminal 188 through line 190 which connects to the wiper of variable resistor 192 connected between a positive supply terminal 194 and ground. Line 174 is connected through line 196 and through a resistor 198 to inverting input 200 of differential amplifier 202 the other input of which is connected through resistor 204 to ground. A positive voltage at wiper 206 of variable resistor 208 is connected through resistor 210 to input 200. Variable resistor 208 is part of a dropping network including fixed resistor 212 which is connected in series with variable resistor 208 between positive terminal 214 and ground.

The output of differential amplifier 202 is connected through resistor 216 to the base of NPN transistor 218, the emitter of which is connected to ground. The collector is connected through line 220 to relay coil 222. The other terminal of the relay coil is connected through line 224 to a positive terminal 226. A protective diode 228 is connected across the terminals of relay coil 222. Positive terminal 230 is connected through normally closed contacts 232 and through resistor 234 to the inverting input 200 of differential amplifier 202. Normally open contacts 124 of relay 222 are connected to terminals 238 and 240. Additional normally open contacts 235 connect terminals 237 and 239. The base of transistor 218 is connected to terminal 242 through line 244.

Line 196 is also connected to another very similar circuit comprising differential amplifier 246. Line 196 is connected through resistor 248 to the inverting input line 250. The other input is connected through resistor 252 to ground. Positive supply terminal 254 is connected to ground through a dropping network comprising variable resistor 256 and fixed resistor 258 connected in series. The wiper of the variable resistor is connected through resistor 260 to input line 250. The output of the differential amplifier is connected through resistor 262 to the base of NPN transistor 264 and the collector is connected through line 268 and reset button 266 to ground. Capacitor 270 is connected between line 268 and ground. The emitter of transistor 264 is grounded and the collector is connected through relay coil 272 to positive terminal 274. A protective diode 276 is connected across the coil.

Negative supply terminal 278 is connected through normally open contacts 280 of relay coil 272 and through resistor 282 to the inverting input line 250.

Terminals 284 and 286 are connected through normally closed contacts 288 of relay coil 272.

The terminals at the right hand side of FIG. 2 are also shown in FIG. 1 in connection with relay tachometer 106. Indicator lamp 290 is connected between ground and terminal 237. A similar indicator lamp 292 is connected between terminal 286 and ground.

A five-position, six-pole switch is shown at the left hand side of FIG. 1 as including banks 294, 296, 298, 300, 302 and 304. This switch is preferably a spring-loaded switch arranged so that, unless it is held manually in another position, the wipers return to the normal condition in which they are shown.

Meter 306 is connected between the wipers of banks 300 and 302. In the normal condition, the meter is connected through banks 300 and 302 to terminals 176 and 178. The five-position switch makes no other connections when in the normal condition.

When the switch is moved one step in the counterclockwise direction, bank 294 connects the AC Terminal 126 to solenoid 52. Bank 296 connects AC terminal 126 to solenoid 64. No connection is made through bank 298 at this time. Banks 300 and 302 again connect the meter 306 to terminals 176 and 178 of relay tachometer 106. Bank 304 grounds terminal 242.

When the switch is moved a further step in the counterclockwise direction, solenoid 52 remains energized through bank 294. No connection is made through bank 296. Terminals 186 and 188 are connected together through bank 298. Meter 306 remains connected to terminals 176 and 178. No connection is made through bank 304.

The positions of the switch which are in the clockwise direction from the normal position perform the identical function as the two counterclockwise positions but pertain to valve solenoids 92 and 96 and to relay tachometer 108. Relay tachometer 108 is shown with primed numerals identical to those used in FIG. 2 so that the connections to the internal circuitry of tachometer 108 can be ascertained. Relay tachometer 108 receives its input from magnetic pickup 114 through lines 308 and 310.

In the first switch position, in the clockwise direction from normal, solenoid 92 is connected to AC terminal 126 through bank 294. Solenoid 96 is connected to AC terminal 126 through bank 296. No connection is made through bank 298. Meter 306 is connected through banks 300 and 302 to terminals 176' and 178' of relay tachometer 108. Terminal 242' is grounded through bank 304.

In the second switch position clockwise from normal, solenoid 92 is again energized through bank 294. No connection is made through bank 296. Terminal 186' is connected to terminal 188 of relay tachometer 106 through bank 298. Meter 306 remains connected to terminals 176' and 178' through banks 300 and 302. No connection is made through bank 304.

It should be noted that variable resistor 192 (FIG. 2) exists only in relay tachometer 106. It provides a variable test voltage at terminal 188 for both of the relay tachometers.

The normal operation of the apparatus just described will now be explained. This will be followed by a description of the steps typically used in performing a test.

As the rotational speed of the gear 110 increases, the repetition rate of the pulses of line 116 increases. This results in a corresponding increase in the DC voltage in line 144 and at input 156 of differential amplifier 158. The rotational speed of the turbine rotor is read on meter 306. In the normal condition of the selector switch, this reading is derived through magnetic pickup 112 and its associated circuitry.

As speed increases, the DC voltage in line 196 decreases from zero toward a negative value. When the voltage in line 196 becomes sufficiently negative to overcome a threshold established by the positive voltage applied to input line 200 by resistor 210 and re-

sistor 234, the output of differential amplifier 202 swings in the positive direction and causes transistor 218 to conduct, energizing relay coil 222. At this time, the opening of contacts 232 disconnects positive terminal 230 from input 200 producing a further negative swing in the voltage at input 200 and a further positive swing in the output of differential amplifier 202, thereby causing the relay to be held in an energized condition. Closure of contacts 124 of the relay effects energization of solenoid 66, opening valve 44. Valves 42 and 44 are both open at this time, and piston 16 moves toward the left closing stop valve 6. Since pressure in line 72 is also relieved through valve 42 and 44, the piston in valve controller 12 also moves toward the left, closing stop valve 8.

The foregoing assumes that the set point established by the adjustment of variable resistor 208 in relay tachometer 106 is such that relay tachometer 106 is the first to be tripped. If relay tachometer 108 is the first to be tripped, then solenoid 94 is energized, opening valve 86. If this is the case, pressure in lines 26 and 72 is relieved through valves 82 and 86, and stop valves 6 and 8 are similarly closed.

In order to verify the settings of the dual overspeed trip system and to exercise the stop valves, the operator typically performs the following operations. First, the selector switch is moved from the normal position to the first counterclockwise position. Lamp 62, controlled by pressure-actuated switch 60 indicates when valve 42 is in the test position blocking communication between line 50 and connection 48. The selector switch is then moved to the second counterclockwise position to perform the first part of the test. Solenoid 52 is energized so that line 50 remains blocked. Bank 298 connects terminals 186 and 188. The setting of variable resistor 192 is adjusted to move input 156 of differential amplifier 158 in the positive direction. This increases the apparent speed as displayed on meter 306, and ultimately effects energization of relay coil 222. Contacts 124 energize solenoid 66, and valve 44 opens reducing the pressure in lines 40 and 36 substantially to atmospheric pressure. Piston 16 moves to the left until port 34 is closed off, exercising valve 6, but not substantially reducing the flow of steam. Closure of contacts 235 energizes indicator lamp 290.

At this time, since contacts 232 are opened, relay coil 222 is held in the energized condition. When the selector switch is returned to normal, it passes through the first position counterclockwise from normal and terminal 242 is grounded through bank 304. This de-energizes the relay coil 222. At the same time, resetting solenoid 64 is energized through bank 296 and returns valve 44 to a closed condition. When the selector switch returns to normal, valve 42 returns to a condition allowing communication between line 50 and interconnection 48. The system automatically returns to its normal operating condition when the selector switch is returned to normal.

Stop valve 8 is exercised and the second part of the test is performed in a substantially identical manner by rotating the selector switch through the two clockwise positions and again adjusting variable resistor 192 (of relay tachometer 106) to simulate an overspeed condition of the turbine. Valves 82 and 86 and the circuitry of relay tachometer 108 are operated.

The purpose of differential amplifier 246 and its associated circuitry is to provide an indication by lighting lamp 292 (FIG. 1) when the circuitry delivering a signal to line 196 fails. In normal operation, the voltage in line 196 is sufficiently negative to cause energization of relay coil 272. This opens contacts 288 preventing operation of lamp 292. The voltage at input 250 of differential amplifier 246 is a result of the voltages applied through resistors 248, 260 and 282. If the signal in line 196 fails, the voltage at input 250 moves in a positive direction and relay 272 is deenergized. The opening of contacts 280 causes the voltage at input 250 to swing further in the positive direction and insures that relay 272 will remain de-energized until it is reset by momentary closure of push button 266.

In summary, the system allows a test of the trip system to be performed without a shutting down of the turbine, and the test includes an exercising of the stop valves by virtue of the special stop valve actuators and their associated blocking and trip valves. The speed detection, relay circuitry, and valves are duplicated in the system, and operation of either of the duplicated assemblies will shut off the steam turbine. The selector switch provides for convenient testing of both of the duplicated assemblies, and the system provides protection even during a test. Set point adjustments can be made by adjustment of variable resistor 208 or its counterpart in tachometer 108 while the turbine is in operation.

While the foregoing describes a system in which two stop valves are connected in series, it will be apparent that the control system is also applicable to a power plant in which two stop valves are provided, each connecting a turbine to one of a pair of independent steam sources. In such a power plant, testing of the trip system produces no substantial reduction in the turbine output.

What is claimed is:

1. A steam turbine overspeed trip system comprising:
  - a valve means adapted to control the flow of steam from a steam generator to the inlet of a steam turbine,
  - a valve controller comprising a cylinder, a piston slidable in said cylinder, said piston and cylinder comprising an enclosed chamber of variable volume, means responsive to relative movement of said piston and cylinder for effecting opening and closing movement of said valve means, said opening and closing movements corresponding respectively to enlargement and contraction of the volume of said chamber, means urging said piston and cylinder relative to each other in a direction to effect closure of said valve means, a first port communicating with said chamber throughout the range of travel of the piston relative to the cylinder, means normally preventing flow of fluid outwardly from said chamber through said first port, a second port normally communicating with said chamber and arranged to be closed off when said piston and cylinder travel a part of the range of movement from the relative positions corresponding to a fully open condition of the valve means to the relative positions corresponding to a fully closed condition thereof,
  - means for delivering a fluid under pressure into said chamber,

means responsive to the turbine shaft speed for effecting an opening of said first port when the turbine shaft speed exceeds a predetermined limit, and

manually operable means for preventing outward flow from said chamber through said first port and allowing fluid to flow from said chamber through said second port to allow a relative movement of said cylinder and piston through said part of said range.

2. A steam turbine overspeed trip system according to claim 1 in which said means normally preventing flow of fluid outwardly from said chamber through said first port comprises a fluid pressure-actuated pilot valve, and in which said means for delivering a fluid under pressure into said chamber comprises a restricted passage.

3. A steam turbine overspeed trip system comprising:
  - valve means adapted to control the flow of steam from a steam generator to the inlet of a steam turbine,

- a valve controller comprising a cylinder, a piston slidable in said cylinder, said piston and cylinder comprising an enclosed chamber of variable volume, means responsive to relative movement of said piston and cylinder for effecting opening and closing movement of said valve means, said opening and closing movements corresponding respectively to enlargement and contraction of the volume of said chamber, means urging said piston and cylinder relative to each other in a direction to effect closure of said valve means, a first port communicating with said chamber throughout the range of travel of the piston relative to the cylinder, means normally preventing flow of fluid outwardly from said chamber through said first port, a second port normally communicating with said chamber and arranged to be closed off when said piston and cylinder travel a part of the range of movement from the relative positions corresponding to a fully open condition of the valve means to the relative positions corresponding to a fully closed condition thereof, and means normally preventing flow of fluid outwardly from said chamber through said second port

means for delivering a fluid under pressure into said chamber,

first and second valves connected in series, one end of said series of valves being connected to said means for delivering a fluid, and the interconnection between said valves being connected to said second port, said first valve being normally open and said second valve being normally closed,

means responsive to the turbine shaft speed for effecting an opening of said second valve when the turbine shaft speed exceeds a predetermined limit, and

manually operable means for closing said first valve, and opening said second valve, thereby allowing fluid to flow from said chamber through said second port and said second valve to allow a relative movement of said cylinder and piston through part of said range.

4. A steam turbine overspeed trip system according to claim 3 in which said second valve is a solenoid-operated valve having a solenoid arranged to effect

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opening of said valve when energized, and wherein said means responsive to the turbine shaft speed includes means for energizing said solenoid, and said manually operable means also includes means for energizing said solenoid.

5. A steam turbine overspeed trip system according to claim 3 wherein said first valve is a solenoid-operated valve including means maintaining said first valve in an opened condition except when said solenoid is energized.

6. A steam turbine overspeed trip system according to claim 3 including a switch having a pressure-responsive actuator and wherein said first valve is a three-way valve arranged to allow flow of fluid from said means for delivering a fluid when in an opened condition, and to block said flow and allow flow from said means for

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delivering a fluid to said pressure-responsive actuator when in a closed condition.

7. A steam turbine overspeed trip system comprising: first and second steam stop valves adapted to control the flow of steam from a steam generator to the inlet of a steam turbine, first and second fluid-actuated valve controllers, each arranged to control one of said stop valves, means responsive to the turbine shaft speed for operating said controllers simultaneously to effect full closure of both of said stop valves when the shaft speed exceeds a predetermined limit, and manually operable means for operating said controllers individually to effect partial closure of each of said stop valves.

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