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GOVERNOR APPARATUS

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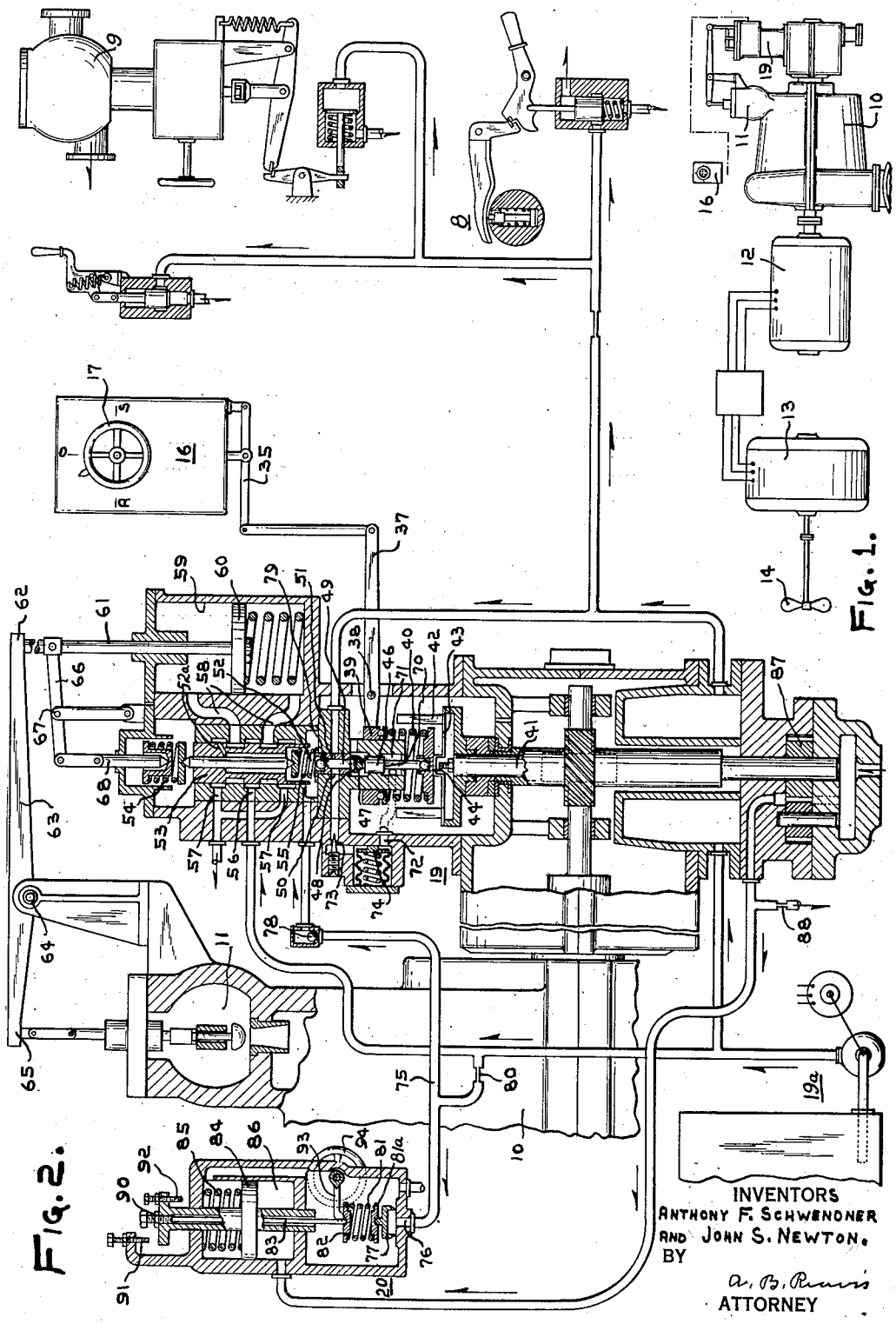


Fig. 1.

Fig. 2.

INVENTORS
ANTHONY F. SCHWENDNER
AND JOHN S. NEWTON.
BY
A. B. Rines
ATTORNEY

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GOVERNOR APPARATUS

Anthony F. Schwendner, Ridley Park, and John S. Newton, Drexel Hill, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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15 Claims. (Cl. 290—17)

The invention relates to a marine propulsion arrangement of the general type disclosed and claimed in application of Anthony F. Schwendner, Serial No. 470,555, filed December 30, 1942, and it has for an object to improve apparatus of this character so that torque may be limited and speed control of the turbine be effected from a remote point.

A further object of the invention is to effect limitation of torque in an arrangement of apparatus of the above character by means responsive to turbine speed.

A further object of the invention is to provide a turbine, for transmitting power to a propeller by means of an electric drive, wherein speed is controlled by varying the steam flow in response to speed-changing adjustment of a governor and wherein the torque is limited for each speed adjustment by means responsive to turbine speed.

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

Fig. 1 is a diagrammatic view of a propulsion system utilizing the improvement; and,

Fig. 2 is a schematic view showing essential parts of the controlling system.

As shown in the drawing, the elastic fluid turbine 10 is provided with the usual governor or admission valve 11. Also, at the right of Fig. 2, there is diagrammatically illustrated a conventional throttle valve 9 and emergency governor mechanism, at 8, effective, in the event of overspeeding of the turbine to a predetermined extent, to trip the throttle valve to cut off the supply of motive fluid to the turbine.

As shown in Fig. 1, the turbine 10 drives the generator 12 which is connected electrically to the motor 13 for driving the propeller 14. The generator and motor excitations are so arranged and controlled and the construction of the generator and motor are such that, to start, the motor is operated as an induction motor to accelerate it to reduce the slip sufficiently so that connections may be established for synchronous operation. These operations to bring the apparatus to "running" position take place at the low-speed setting of the turbine, for example, twenty per cent of full speed, and, with the synchronous relation established, increase in propulsion speed is effected by speed-changing adjustment of a governor controlling the admission valve 11. However, in increasing the speed, the rate at which the turbine torque is increased by increase in steam flow may be in excess of that at which the motor is capable of accelerating the ship with the result that the motor may be pulled out and the synchronous relation interrupted. The present invention relates to means responsive to turbine speed to restrict steam flow under these conditions in order to limit turbine torque and which means is also effective in a rough sea to avoid wider fluctuating steam requirements and the consequent effect thereof on boiler operation and particularly the combustion apparatus for the latter.

As shown, there is provided a control device, at 16, telemetrically connected in a suitable manner, not illustrated, to device or devices at remote point or points, such as on the bridge. The control device, at 16, includes an element 17 movable from a low-speed position "O" in directions "A" or "S" for ahead or astern operation. Assuming that the synchronous relation is established when the element 17 is in low-speed position "O," then, if such element is moved toward "A" or "S," the movement results in speed-changing adjustment of the governor, at 19, to increase the steam flow by opening the valve 11 wider to increase the propulsion speed. Also the apparatus, at 20, (Fig. 2) serves to limit the turbine torque, as elsewhere herein described.

Movement of the hand wheel 17 is transmitted by any suitable means, such as the linkage 35, to move the lever 37 fulcrumed at an intermediate point 38 and having its other end 39 bearing on the load spring 40 of the governor, at 19.

While any governor suitable for the purposes of the present invention may be employed, we prefer to use one of the general type disclosed in the application aforesaid and in the patent to Gottlieb No. 2,239,602, dated April 22, 1941. The governor comprises a spindle 41 having centrifugal flyweights 42 carried by a diametrally-extending leaf spring 43 whose ends are supported by the spindle. Centrifugal force of the flyweights applied to the leaf spring is opposed by the load spring 40 whose lower end is in thrust-transmitting relation with respect to the central portion 44 of the leaf spring. The central or U-shaped portion 44 of the leaf spring also has thrust-transmitting engagement with respect to the lower end of the cup valve member 46 whose upper end has a cup valve 47 cooperating with the seat 48 to define an escape orifice for the escape port 49 of the transformed fluid pressure space 50, the latter being supplied by means of an orifice 51 from a suitable pressure source, shown, at 19a, and comprising, for example, a

motor-operated pump supplying a system of passages from a reservoir.

The cup valve 47 provides a pressure area exposed to transformed fluid pressure in the space 50. Therefore, the cup valve occupies an equilibrium position where the upwardly-acting centrifugal force of the flyweights is balanced by the downwardly-acting force of the load spring 40 and the downwardly-acting force of transformed fluid pressure applied thereto.

Fluid under transformed pressure is supplied from the space 50 to the pressure chamber 52 to which the lower end of the relay 53 is exposed, the relay being held in position between upper and lower springs 54 and 55. The relay controls communication of the pressure and drain ports 56 and 57 with the admission and exhaust ports 58 communicating with opposite ends of the cylinder 59 for the operating piston 60, which has a stem 61 pivotally connected at 62 to one end of the lever 63 fulcrumed at an intermediate point 64 and having its other end pivotally connected at 65 to the valve 11. The stem 61 is also pivotally connected to one end of a follow-up lever 66 which is fulcrumed at an intermediate point 67 and has its other end arranged in thrust-transmitting engagement with respect to the upper end of the spring 54 by means of a stem 68.

With upward movement of the relay 53 in response to increase in transformed fluid pressure the operating piston 60 moves upwardly to move the valve 11 in a closing direction and vice versa, movement of the operating piston being in the direction for restoring the relay 53 to neutral cut-off position.

As a governor of the type more fully described in the aforesaid patent to Gottlieb is used to move the admission valve 11 in response to controlling movement of the handwheel 17, such a governor will now be briefly described in relation to marine propulsion.

In marine propulsion, assuming the propeller submergence is kept the same, change in turbine load is produced only by change in propulsion speed and there does not occur the condition of operating from no load to full load at any set speed changer spring position. When the handwheel 17 is moved in a speed-increasing direction, the governor, at 19, is thereby operated to move the admission valve 11 in an opening direction. As movement of the admission valve in this way takes place immediately and independently of any speed-responsive effect, it will be apparent that the valve can be operated at a rate in excess of that at which the propulsion speed may be increased with the result that the turbine torque may be increased to the pull-out point of the synchronous connection and it is the purpose of the limit device or apparatus, at 20, to interrupt movement of the admission valve before the pull-out point is reached, the limit device being effective until the gain in propulsion speed is sufficient to restore control of the valve to the governor, it being remembered, of course, that, with a given admission valve opening, the torque is reduced as the turbine gains in speed. The speed-responsive function of the governor is utilized to protect the turbine against overspeeding due to interruption of the electrical connection or breakage of the propeller shaft, in which event the amount of increase in speed required to close the admission valve depends upon the speed regulation of the governor at the particular setting of the speed changer spring and which is, in all cases, only a small part of the speed range attainable by the use of the speed changer spring.

The governor so far described operates with speed change due to load change; however, with the present type of application, it is desirable to provide for speed correction or compensation on this account. The purpose of speed correction or compensation in the marine propulsion and similar applications of the invention is to provide regulation which is reasonably stable at the high speed point while preserving a low speed change between the idling and the synchronizing load condition of the low speed point. Therefore, as described in the aforesaid Gottlieb patent, the cup valve member 46 has a downwardly-facing piston area 70 exposed to pressure existing in the chamber 71, pressure to the latter chamber being supplied from the pressure space by means of a passage 72 having the adjustable orifice 73. An accumulator or air bell 74 communicates with the passage between the orifice and the pressure chamber 71. Preferably, the piston area 70 is equal and opposite to that provided by the cup valve 47 with the result that, if the pressures existing in the spaces 50 and 71 are equal, then the forces thereof applied to the cup valve member 46 will be balanced, with the result that the latter member occupies a position with the force of the load spring balancing that due to centrifugal force. As changes in pressure in the space 71 lag with respect to changes in the space 50 because of the orifice and the air bell, it will be apparent that the governor has a transient phase of ordinary operation followed by operation to correct the speed for load change so that the governor is thereby rendered isochronous, or at least one having a very small speed change due to load change.

From the foregoing, it will be apparent that, as the handwheel 17 of the controlling device, at 16, is moved in a speed-increasing direction, the extent of opening of the admission valve 11 is increased, movement of the handwheel operating, through the instrumentality of the governor, at 19, to move the admission valve; and, as the governor is of the speed-compensating or speed-correcting type, the torque-limiting device, at 20, for the turbine may operate in proper relation to the governor for the full propulsion speed range to interrupt opening of the admission valve to avoid increase in turbine torque to the pull-out point. The apparatus, at 20, for limiting turbine torque will now be described.

If the turbine torque increases at a rate beyond that at which it can be utilized by the propulsion motor, the latter may pull out thereby interrupting the synchronous relation. Therefore, means, at 20, is employed in connection with the aforesaid speed-controlling system for limiting the turbine torque. Accordingly, there is provided a space 75 having a discharge port 76 with respect to which the cup valve 77 defines an escape orifice, the space 75 being supplied with fluid from any suitable pressure source, at 19a, by means of an orifice 80.

The cup valve 77 operates to provide pressure in the space 75 which is correlated to the transformed pressure in the space 50 and is arranged to supersede the latter and take over control of the pilot valve in the event of excessive turbine torque at any speed setting. To provide for the pilot valve being influenced by the higher of the two pressures, the chamber 52, to which it is directly exposed, communicates with either of the spaces 50 and 75, whichever is the higher, the check valves 78 and 79 for the spaces 75 and 50 opening toward the chamber 52 to provide for

such operation. As the check valve 79 interrupts communication between the space 52 and the transformed pressure space 50 whenever pressure in the latter tends to be lower than that in the former, the piston valve 53 is shown as being provided with a bleeder port 52a, which is effective to provide pressure in the space 52 which will decline whenever the pressure in the space 50 is reduced.

To provide turbine torque-limiting pressures in the space 75 suitable for the propulsion speed range, it is necessary that, as the turbine increases in speed in consequence of reduction of pressure in the space 50, the pressure in the space 75 shall also be reduced in suitable relation with respect to that in the space 50, the pressure in the space 75 being normally maintained below that in the spaces 52 and 50 to a desired extent.

The pressure in the space 75 depends upon the closing force exerted on the cup valve 77 by the spring 81 arranged between the abutment 81a and the follower 82, the closing force of the spring being varied by moving the follower 82 upwardly and downwardly.

The follower 82 is positioned to vary the force of the spring 81 to vary the pressure in the space 75 by means of piston structure including the stem 83 and the piston 84 secured thereto and subject to fluid pressure in the space 86. A load spring 85 acts on the piston structure in opposition to fluid pressure in the space 86 and the spring 81 acts thereon in opposition to the spring 85. The piston structure, therefore, seeks a position such that the downwardly-acting force of the spring 85 is balanced by the upwardly-acting force due to fluid pressure applied to the piston and to the spring 81.

Fluid under pressure is supplied to the space 86 by means of the gear pump 87 operatively connected to the turbine. An orifice 88 for the discharge of the gear pump assures that the pressure supplied to the space 86 shall vary with the turbine speed, the pressure increasing with increases in speed and vice versa. A change in pressure in the space 86 results in movement of the piston structure with change in force of the spring 85 in the same direction and of the spring 81 in the opposite direction until the downwardly-acting force exerted by the spring 85 is balanced by the upwardly-acting forces due to pressure applied to the piston 84 and to the spring 81. Therefore, as increase in speed occurs pursuant to having moved the admission valve in an opening direction, the pressure in the space 86 increases to move the piston structure upwardly to decrease the pressure in the space 75.

For a range of movement fixed by the adjustable stops 91 and 92, the pressure range in the space 75 may be shifted upwardly or downwardly by adjusting the threaded connection 90 between the stem 83 and the piston 84. As the stem 83 is screwed downwardly, the range of pressures in the space 75 is raised, and, as it is screwed upwardly, the reverse is true. By adjusting the stops 91 and 92, the pressure range in the space 75 may be increased or decreased, or the range may be shifted upwardly or downwardly, with or without change in the extent thereof.

The crank abutment 93 carried by the handwheel 94 provides for manual adjustment of the minimum pressure that may exist in the space 75. Normally, the crank abutment 93 is positioned so as not to interfere with movement of the follower 82, thereby permitting of full control of position of the latter by means of the piston 84 and the stem 83; however, with the crank abutment 93 engaging the follower 82, as shown in Fig. 2, it will be apparent that, as it is moved downwardly, the minimum pressure that may exist in the space 75 is raised. As hereinafter pointed out, the purpose of this manual adjustment is to limit turbine and propulsion speed, particularly in a rough sea. Assuming that the propulsion speed is being increased in a rough sea by movement of the controlling handwheel 17, as the turbine speed increases, the pressure increases in the space 86 and the piston 84 moves upwardly, the pressure in the space 75 diminishing in consequence. The propulsion speed may increase with upward movement of the spring follower 82 as the piston 84 moves upwardly until the follower engages the crank abutment 93, whereupon, irrespective of any further upward movement of the piston 84, the spring follower 82 is held in position determined by the setting of the crank abutment 93 to limit the pressure attainable in the space 75. Continued increase in turbine speed brings about decrease in pressure in the space 50; however, as the pressure in the space 75 cannot be lowered further because of the position of the follower 82 being fixed by the crank abutment 93, just as soon as the pressure in the space 50 reaches a point where it tends to be lower than that existing in the space 75, then the pressure in the latter space supersedes that of the space 50 and takes control of the pilot valve, the check valve 79 then separating the spaces 50 and 52 and the check valve 78 permitting of pressure in the space 75 being effective in the space 52 to actuate the pilot valve.

In the event of operation in a rough sea, acceleration and retardation effects produced by emergence and submergence of the propeller may result in such wide changes in flow of steam in the turbine as to render control of the boiler and particularly the combustion apparatus of the latter difficult. Therefore, means is provided for controlling the pressure in the space 75 independently of the turbine speed, such means comprising a lever or abutment 93 connected to the auxiliary speed control hand wheel 94. Assuming that the ship is to be propelled at ⅝ speed, the hand wheel is moved to adjust the force of the spring 81 to establish a pressure in the space 75 and in the space 52 corresponding to a position of the admission valve for such speed. The control device 17 is then operated to adjust the governor, at 19, for a slightly higher speed. Therefore, the propulsion turbine will be controlled primarily by the pressure existing in the space 75; however, with increase in speed, the governor comes into play to move the admission valve 11 in a closing direction to limit such speed increase. Therefore, the steam flow through the turbine is held within a narrow range of variation as determined by the pressure in the space 75 and whatever slightly higher pressure developed by the governor in response to increase in speed may be necessary to move the admission valve 11 in a closing direction.

While we have shown our invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and we desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What is claimed is:

1. In apparatus for controlling the admission

of motive fluid to a prime mover coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled prime mover and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the prime mover, mechanism including a member which is manually movable to control the admission valve to vary the speed of movement of the body, said mechanism also including a governor operatively connected to the admission valve and provided with a speed changer which is adjusted in response to movement of said member, and means responsive to prime mover speed for interrupting opening movement of the valve when the prime mover speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount.

2. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine, mechanism including a member which is manually movable to control the admission valve to vary the speed of movement of the body, said mechanism also including a governor operatively connected to the admission valve and provided with a speed changer which is adjusted in response to movement of said member, means providing fluid under pressure dependent upon speed of the turbine, and means responsive to pressure of such fluid for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of opening of the latter exceeds the actual speed a predetermined amount.

3. The combination as claimed in claim 2 with manually-controlled means for rendering the responsive means effective to limit the extent to which the admission valve may be opened.

4. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable to control the admission valve to vary the speed of movement of the body; said mechanism also comprising pressure-responsive means for moving the admission valve in response to pressure of liquid and including a pressure chamber, said pressure-responsive means and the admission valve being so arranged that a decrease in pressure results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve arranged to open toward the latter, a flyweight governor operated by the turbine, means utilizing the governor to provide in said first space liquid under pressure which increases as the turbine speed increases and vice versa, and speed-changing means for the governor adjustable in response to movement of said controlling element to effect movement of the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure and communicating with the pressure-responsive means through a check valve arranged to open toward the latter, means for maintaining in said second space liquid under pressure which decreases as the turbine speed increases and vice versa and including an escape port and a relief valve cooperating with the latter, a load spring for exerting closing force on the relief valve, and means dependent upon turbine speed for varying the loading of said load spring such that as the turbine speed increases the loading is reduced and vice versa.

5. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable to control the admission valve to vary the speed of movement of the body; said first mechanism also comprising pressure-responsive means for moving the admission valve in response to pressure of liquid and including a pressure chamber, said pressure-responsive means and the admission valve being so arranged that a decrease in pressure results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve arranged to open toward the latter, a flyweight governor operated by the turbine, means utilizing the governor to provide in said first space liquid under pressure which increases as the turbine speed increases and vice versa, and speed-changing means for the governor adjustable in response to movement of said controlling element to effect movement of the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure, means for maintaining liquid under pressure in said second space and including an escape port and a relief valve cooperating with the latter, a load spring having one end in abutment relation with respect to the relief valve for exerting closing force on the latter, means abutting the other end of the load spring and movable in response to turbine speed so that the force of the spring exerted on the relief valve is decreased with increases in turbine speed and vice versa, and abutment means for said other end of the spring and movable manually to adjust the minimum attainable spring force for limiting the extent to which the pressure may be reduced in said second space so as to limit the extent to which the admission valve may be opened.

6. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable to control the admission valve to vary the speed of movement of the

body; said mechanism also comprising pressure-responsive means for moving the admission valve in response to pressure of liquid and including a pressure chamber, said pressure-responsive means and the admission valve being so arranged that a decrease in pressure applied to the pressure-responsive means results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve arranged to open toward the latter, a governor operated by the turbine, means utilizing the governor for maintaining in said first space liquid under pressure dependent upon turbine speed such that, as the turbine speed increases and decreases the pressure increases and decreases, said governor including flyweights and a spring for resisting outward movement of the flyweights under the influence of centrifugal force, and means responsive to movement of the controlling element for varying the force of said spring to cause the governor to move the admission valve such that, as the controlling element is moved in a speed-increasing direction, the spring force is increased to reduce the pressure of liquid applied to the pressure-responsive means in order to move the admission valve in an opening direction and vice versa; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure communicating with said pressure chamber through a check valve arranged to open toward the latter, means for maintaining liquid under pressure in the second space including an escape port and a second valve in covering relation with respect thereto, said second valve having an area subject to the pressure existing in the second space, and means including a spring for exerting closing force on said second valve and operative in response to turbine speed so that, as the turbine speed increases, the closing force is reduced and vice versa.

7. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; mechanism including an element which is movable manually to control the admission valve to vary the speed of movement of the body, said mechanism also including a speed-compensated governor operatively connected to the admission valve and provided with speed-changing means adjusted in response to movement of said controlling element so that movement of the latter results in movement of the admission valve, a pump operated by the turbine, means providing a pressure space supplied with liquid from the pump, an orifice communicating with the pressure space so that the pump is effective to provide for liquid pressure therein which increases and decreases as the turbine speed increases and decreases, and means responsive to pressure in said space for interrupting movement of the admission valve in an opening direction when the turbine speed corresponding to the extent of opening of the latter exceeds the actual speed a predetermined amount.

8. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element movable to control the admission valve to vary the speed of movement of the body; said first mechanism also comprising means for moving the admission valve in response to pressure of liquid and including a pressure chamber, said pressure-responsive means and the admission valve having such relation that decrease in pressure applied to the pressure-responsive means results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said first space and including an escape port and a first valve cooperating with the latter to control the pressure in said space, means responsive to speed of the turbine for applying force to said first valve in a direction to increase the pressure in the first space, a first spring having one end in abutment relation with respect to the speed-responsive means for opposing the force of the latter in response to speed, an abutment for the other end of said first spring, and means utilizing said controlling element to move the abutment so that the resulting change in spring force is effective to change the pressure in said first space to move the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure and which communicates with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said second space including an escape port and a second valve cooperating with the latter for controlling the pressure, and means responsive to turbine speed and cooperating with the last-named valve to maintain in said second space liquid under pressure which decreases as the turbine increases in speed and vice versa.

9. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable manually to control the admission valve to vary the speed of movement of said body; said mechanism also comprising means for moving the admission valve in response to pressure of liquid and including a pressure chamber, said pressure-responsive means and admission valve having such relation that decrease in pressure applied to the pressure-responsive means results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with the pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said first space and including an escape port and a first valve cooperating with the latter to control the pressure in

said space, means responsive to speed of the turbine for applying force to the first valve in a direction to increase the pressure in the first space, a first spring having one end in abutment relation with respect to the speed-responsive means and effective to oppose the force of the latter, an abutment for the other end of the spring, means utilizing said controlling element to move the abutment so that the resulting change in spring force is effective to change the pressure in said first space to move the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said second space including an escape port and a second valve cooperating with the latter for controlling the pressure, means responsive to turbine speed and cooperating with the last-named valve to maintain in said second space liquid under pressure which decreases as the turbine increases in speed and vice versa, and manual means operative to vary the minimum pressure which may be attained in said second space so that such minimum may be adjusted to limit the extent to which the admission valve may be opened.

10. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable manually to control the admission valve to vary the speed of movement of said body; said mechanism also comprising pressure-responsive means for controlling the admission valve and including a pressure chamber, said pressure-responsive means and admission valve having such relation that decrease in pressure applied to the pressure-responsive means results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said first space and including an escape port and a first valve cooperating with the latter to control the pressure in said space, means responsive to speed of the turbine for applying force to the first valve in a direction to increase the pressure in the first space, a first spring having one end in abutment relation with respect to the speed-responsive means and effective to oppose the force of the latter, an abutment for the other end of the first spring, and means utilizing said controlling element to move the abutment so that the resulting change in first spring force is effective to change the pressure in said first space to move the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure and which communicates with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said second space including an escape port and a second valve cooperating with the latter for controlling the pressure, a second spring having one end engaging the second valve and effective to exert closing force on the latter, means providing a third pressure space, means for supplying liquid to the third pressure space under pressure dependent upon turbine speed, abutment means engaging the other end of the second spring, means controlling the position of the abutment means comprising a piston unitary with the latter and a third spring with the third spring arranged to exert force on the abutment means in opposition to the second spring and with the piston arranged to be exposed to pressure in the third space so that force due to such pressure may be exerted thereon in opposed relation to that of the third spring, and adjustable stops for limiting movements of the abutment means in opposite directions.

11. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable manually to control the admission valve to vary the speed of movement of said body; said mechanism also comprising pressure-responsive means for controlling the admission valve and including a pressure chamber, said pressure-responsive means and admission valve having such relation that decrease in pressure applied to the pressure-responsive means results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said first space and including an escape port and a first valve cooperating with the latter to control the pressure in said space, means responsive to speed of the turbine for applying force to the first valve in a direction to increase the pressure in the first space, a first spring having one end in abutment relation with respect to the speed-responsive means and effective to oppose the force of the latter, an abutment for the other end of the first spring, and means utilizing said controlling element to move the abutment so that the resulting change in first spring force is effective to change the pressure in said first space to move the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure and which communicates with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said second space including an escape port and a second valve cooperating with the latter for controlling the pressure, a second spring having one end engaging the second valve and effective to exert closing force on the latter, means providing a third pressure space,

means for supplying liquid to the third pressure space under pressure dependent upon turbine speed, abutment means engaging the other end of the second spring, means controlling the position of the abutment means comprising a piston unitary with the latter and a third spring with the third spring arranged to exert force on the abutment means in opposition to the second spring and with the piston arranged to be exposed to pressure in the third space so that force due to such pressure may be exerted thereon in opposed relation to that of the third spring, and means providing for relative axial adjustment of the piston of the abutment means with respect to the portion of the latter in abutment relation with respect to the second spring.

12. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable manually to control the admission valve to vary the speed of movement of said body; said mechanism also comprising pressure-responsive means for controlling the admission valve and including a pressure chamber, said pressure-responsive means and admission valve having such relation that decrease in pressure applied to the pressure-responsive means results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said first space and including an escape port and a first valve cooperating with the latter to control the pressure in said space, means responsive to speed of the turbine for applying force to the first valve in a direction to increase the pressure in the first space, a first spring having one end in abutment relation with respect to the speed-responsive means and effective to oppose the force of the latter, an abutment for the other end of the first spring, and means utilizing said controlling element to move the abutment so that the resulting change in first spring force is effective to change the pressure in said first space to move the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure and which communicates with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said second space including an escape port and a second valve cooperating with the latter for controlling the pressure, a second spring having one end engaging the second valve and effective to exert closing force on the latter, means providing a third pressure space, means for supplying liquid to the third pressure space under pressure depending upon turbine speed, abutment means engaging the other end of the second spring, means controlling the position of the abutment means comprising a piston unitary with the latter and a third spring with the third spring arranged to exert force on the abutment means in opposition to the second spring and with the piston arranged to be exposed to pressure in the third space in order that force due to such pressure may be exerted thereon in opposed relation to that of the third spring, adjustable stops for limiting movements of the abutment means in opposite directions, and manual means providing for adjustment of the second spring independently of the abutment means to vary the minimum pressure which may be attained in said second space so that such minimum pressure may be adjusted to limit the extent to which the admission valve may be opened.

13. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable manually to control the admission valve to vary the speed of movement of said body; said first mechanism also comprising pressure-responsive means for moving the admission valve in response to pressure of liquid and including a pressure chamber, said pressure-responsive means and the admission valve being so arranged that a decrease in pressure applied to the pressure-responsive means results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said first space and including an escape port and a valve cooperating with the latter to control the pressure in said space, means responsive to speed of the turbine for applying force to the first valve in a direction to increase the pressure in the first space, a first spring having one end in abutment relation with respect to the speed-responsive means and effective to oppose the force of the latter, an abutment for the other end of the first spring, and means utilizing said controlling element to move the abutment so that the resulting change in spring force is effective to change the pressure in said first space to move the admission valve; and second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising a second space for liquid under pressure communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said second space and including an escape port and a second valve cooperating with the latter to control the escape of liquid through the port, a second spring for applying force to the second valve in a valve-closing direction, and means responsive to speed of the turbine and acting on the second spring to decrease the pressure in said second space with increases in turbine speed and vice versa.

14. In apparatus for controlling the admission of motive fluid to a turbine coupled to a generator which is synchronously connected to motor means operated to effect movement of a body and wherein the inertia of the coupled turbine and generator is comparatively small in relation to that of the body, a motive fluid admission valve for the turbine; first mechanism including an element which is movable manually

to control the admission valve to vary the speed of movement of said body; said first mechanism also comprising pressure-responsive means for controlling the admission valve and including a pressure chamber, said pressure-responsive means and admission valve having such relation that decrease in pressure results in movement of the admission valve in an opening direction and vice versa, means providing a first pressure space communicating with said pressure chamber through a check valve opening toward the latter, means for maintaining liquid under pressure in said first space and including an escape port and a valve cooperating with the latter to control the pressure, means responsive to speed of the turbine for applying force to the valve in a direction to increase the pressure in said first space, a first spring having one end in abutment relation with respect to the speed-responsive means and effective to oppose the force of the latter, said first valve having a first area exposed to pressure in said first space and a second area arranged in opposed relation with respect to the first area, and means for applying pressure to the second area including a passage connected to the first space and having an orifice and an accumulator connected to the passage between the orifice and the second area; second mechanism responsive to turbine speed for interrupting opening movement of the admission valve when the turbine speed corresponding to the extent of admission valve opening exceeds the actual speed a predetermined amount and comprising means providing a second space for liquid under pressure, means for maintaining liquid under pressure in said second space and including an escape port and a second valve cooperating with the latter, said second valve having an area exposed to pressure of the second space so that force is applied thereto in a valve-opening direction, a second spring for applying force to the last-named valve in a valve-closing direction, means providing a third space for liquid under pressure, means for supplying liquid to said third space under pressure dependent on turbine speed, and means for varying the loading of the second spring including an element movable in response to pressure in said third space so that as the pressure in the latter increases the loading of the second spring is reduced to reduce the pressure in the second space and vice versa.

15. The combination as claimed in claim 14 with means manually adjustable to vary the minimum loading of the second spring to provide for pressure in the second space effective to limit the extent of opening of the admission valve.

ANTHONY F. SCHWENDNER.
JOHN S. NEWTON.