Sept. 20, 1949. A. F. SCHWENDNER 2,482,560

GOVERNOR APPARATUS

Filed Sept. 26, 1945 2 Sheets-Sheet 1

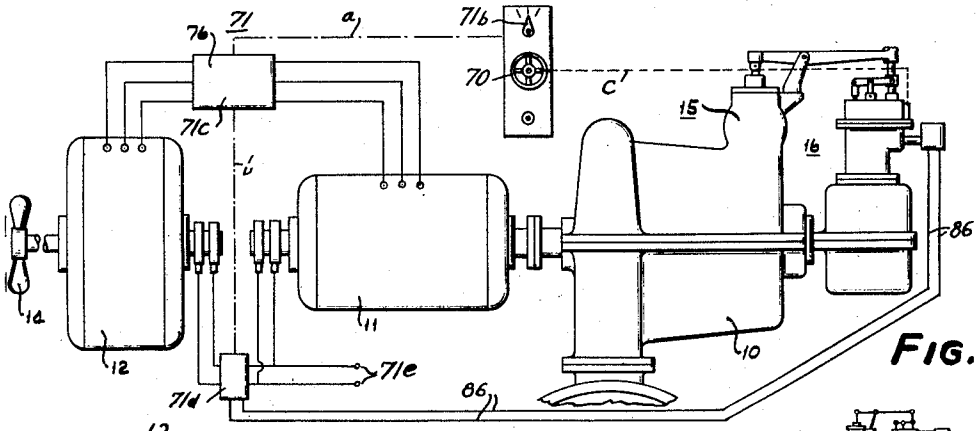


FIG. 1.

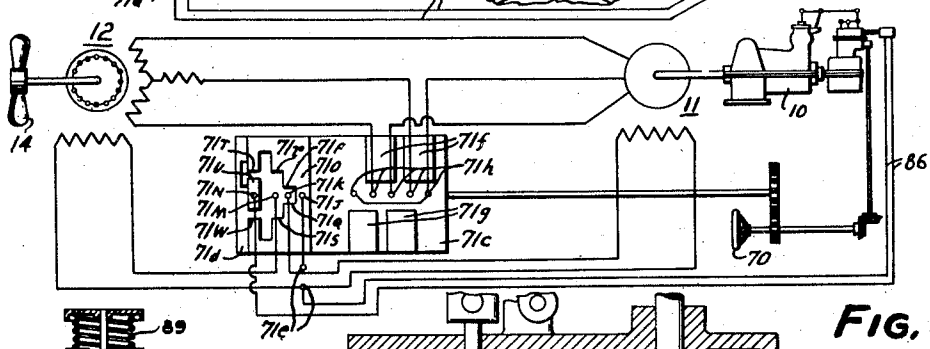


FIG. 5.

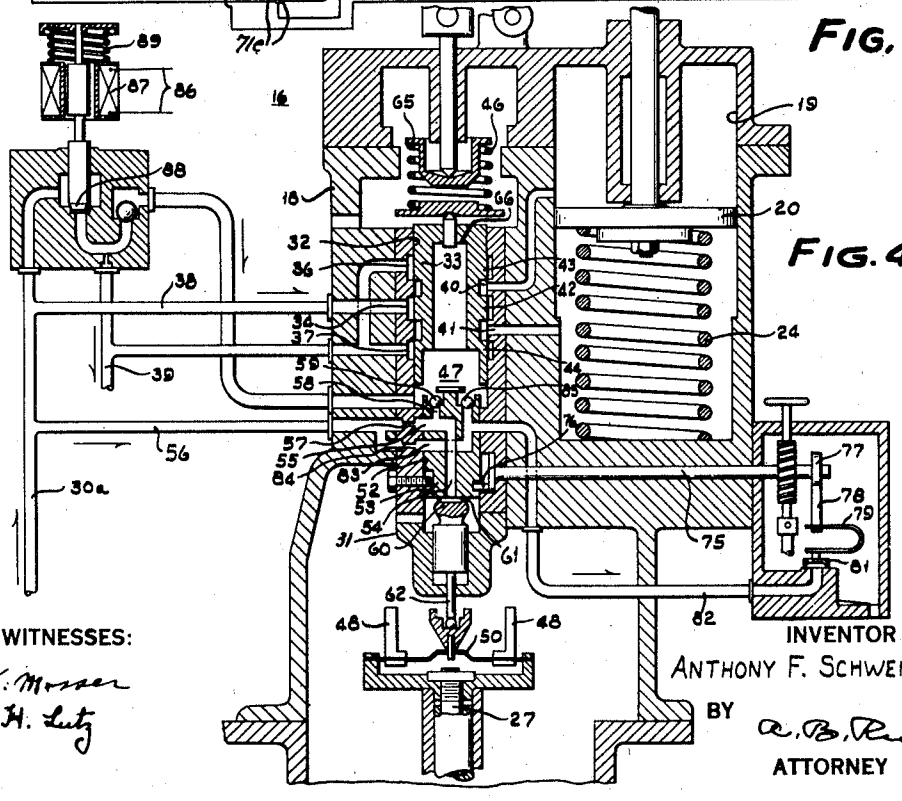


FIG. 4.

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Sept. 20, 1949. A. F. SCHWENDNER 2,482,560

GOVERNOR APPARATUS

Filed Sept. 26, 1945 2 Sheets-Sheet 2

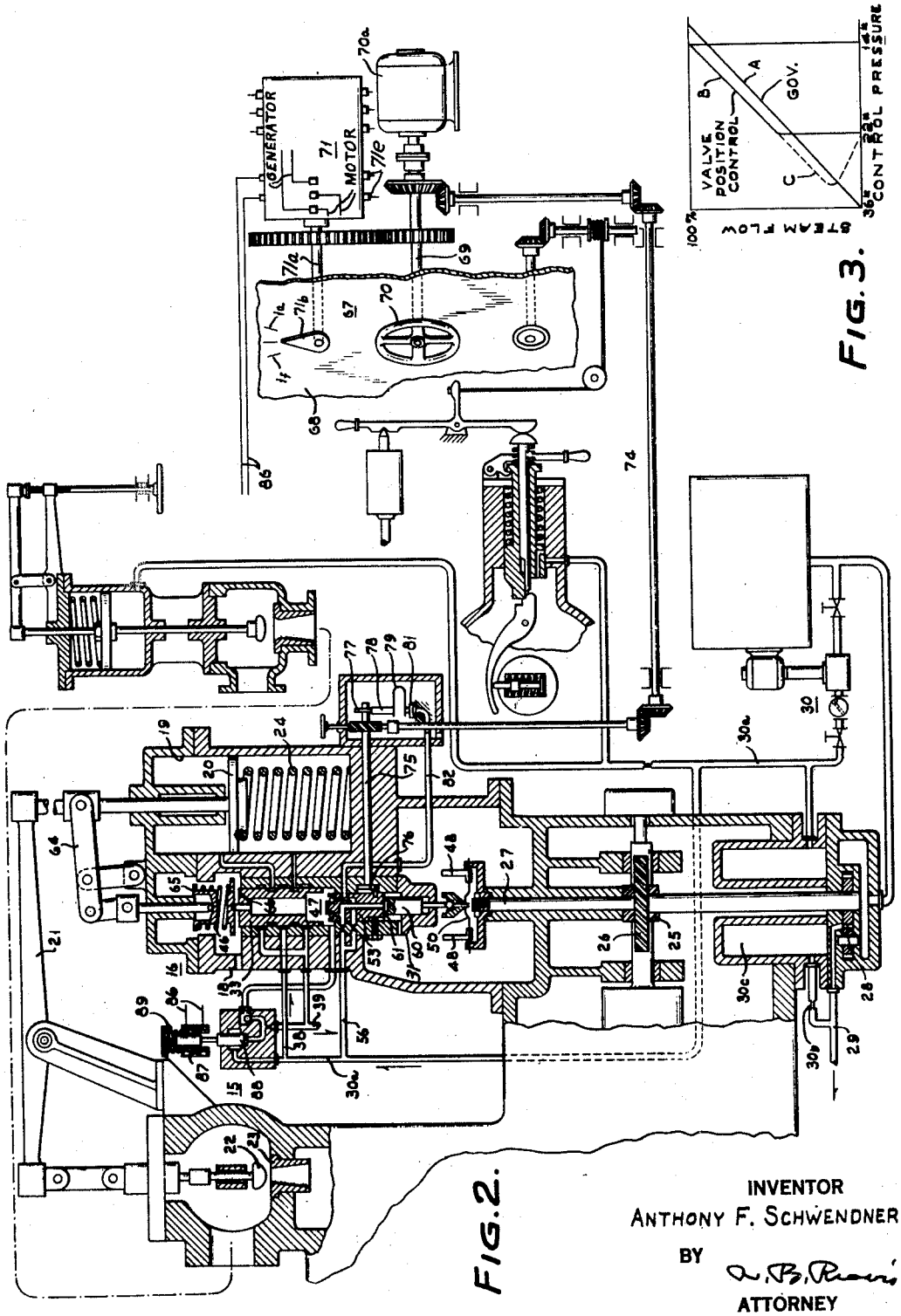


FIG. 2.

FIG. 3.

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UNITED STATES PATENT OFFICE

2,482,560

GOVERNOR APPARATUS

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Application September 26, 1945, Serial No. 618,700

8 Claims. (Cl. 290—17)

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The invention relates to marine propulsion apparatus of the electric drive type and it has for an object to provide improved means for controlling the admission of motive fluid to the turbine and the mode of operation of the propulsion motor to avoid pulling the generator out of step with the motor.

Another object of the invention is to provide a turbine for an electric drive with a motive fluid admission valve subject to a governor and to position control together with means operative to hold the governor at idling speed and the position control at a valve positioning value which limits the turbine torque so as to avoid pulling the generator out of step with the motor while in idling speed position.

A further object of the invention is to provide a turbine for an electric drive with a motive fluid admission valve subject to a governor and to position control with mechanism operative to permit the governor to control the turbine speed at idling speed, to shift from the governor to position control at a speed above idling speed, and then to adjust the position control to increase the speed to full speed.

A further object of the invention is to provide for governor and position control of the admission valve of an electric drive turbine wherein, when operating under position control, at any setting of the latter, the governor remains effective, upon attainment of sufficient speed, to limit the admission of motive fluid, and, therefore, to limit the maximum speed of the unit for that particular setting.

Yet another object of the invention is to provide mechanism movable to adjust governor and position control devices for the admission valve of an electric drive turbine wherein a straight-line relationship is preserved as between travel of said mechanism and speed of the turbine.

A further object of the invention is to provide mechanism movable to adjust governor and position control devices for the admission valve of an electric drive turbine, such that the turbine is brought up to a speed, which is a predetermined fraction of full speed, by governor adjustment with the motor of the electric drive connected for induction and then synchronous operation and then is increased in speed from the fractional speed to full speed by adjustment of the position control device, together with means rendered effective incident to change-over of the motor connection from that for induction operation to that for synchronous operation to close the admission valve and thereby reduce

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the motive fluid torque to facilitate establishment of the synchronous connection.

Another object of the invention is to provide, for the turbine of any of the aforesaid arrangements, a motive fluid admission valve operated by pressure-responsive means arranged so that increase in liquid pressure furnished by the governor, the position control device, or by the means which becomes effective incident to change-over of the motor connection, causes the admission valve to close while a decrease in pressure causes the valve to open.

A further object of the invention is to provide apparatus of the above character, wherein the turbine admission valve is controlled by a speed-changing governor and by valve position controlling means and wherein a controller connects the motor to the generator for operation inductively or synchronously in either direction, together with mechanism movable from a neutral position in either direction, through an initial phase, to connect the motor for induction operation followed by shifting of the connection of the motor from that for induction operation to that for synchronous operation and to adjust the governor to control the admission valve to limit the governor-controlled speed to idling speed, through an intermediate phase, with the motor connected for synchronous operation, to adjust the governor and the position controlling means so that, upon a speed which is a predetermined fraction of full speed being reached, the valve position controlling means supersedes the governor in control of the admission valve, and, through a final phase, to adjust the valve position controlling means to increase the speed from said fractional speed to full speed and to control adjustment of the governor so that the latter remains effective to take control of the turbine to avoid overspeeding.

A further object of the invention is to provide, for propulsion means connected to a turbine by an electric drive and wherein control of the turbine requires a source of oil under sufficiently high pressure and the bearings require oil under pressure adequate for lubrication, a pump operated by an electric motor and constituting the source of oil under high pressure, a pump driven by the turbine and normally serving to supply the bearings with oil under lower pressure, and an orificed connection between the high-pressure supply and the bearing supply to provide for establishment of the low-pressure supply for lubrication of the bearings incident to starting of the turbine.

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 drawings, forming a part of this application, in which:

Fig. 1 is a diagrammatic view showing a turbine connected by an electric drive to propelling means;

Fig. 2 is a diagrammatic view with parts of the control arrangement shown in section;

Fig. 3 is a diagram showing the relation of steam flow to control pressure;

Fig. 4 is an enlarged detail view of apparatus shown in Fig. 2; and

Fig. 5 is a diagrammatic view showing the correlation of electrical control and governing systems.

In Fig. 1, there is shown an elastic fluid turbine 10 driving a generator 11 connected electrically to the motor 12 for driving the propelling means or propeller 14. The turbine has an admission valve, at 15, operatively connected to servo mechanism, at 16, the latter being controlled by a governor and by valve position controlling means, as hereinafter described.

As the present invention is not comprised by specific aspects of the motor, the generator and the controlling means therefor, the illustration is confined to a schematic or diagrammatic showing in these respects and the description embraces only enough to make clear the construction and operation of the improved speed-controlled means forming the present invention. In this connection, the motor is arranged to be connected for induction operation followed by synchronous connection thereof, with the governor adjusted to limit the governor-controlled speed to idling speed, then the governor and valve position controlling means are adjusted until a speed, which is a predetermined fraction of full speed, is reached, whereupon the valve position controlling means supersedes the governor in control of the turbine, and then the valve position controlling means is adjusted for operation from the fractional speed to full speed, adjustment of the governor being continued so that it is conditioned to take over control of the turbine and avoid over-speeding throughout the range from fractional to full speed, provision being made to restrict or stop the admission of motive fluid to the turbine temporarily incident to changing over from induction to synchronous operation to facilitate synchronizing and establishment of the synchronously-connected relation.

While details of the motor and of the controlling circuits providing for induction and synchronous operation are not shown and are not essential to the present invention, it will be obvious to those skilled in the art that the requirements in this regard may be met in any suitable manner. By restricting the motor to induction operation for starting and establishing the synchronous relation and then depending upon synchronous operation of the motor for substantially the full propulsion speed range, the motor windings may safely stand the currents involved in induction operation. Furthermore, if desired, the motor may have a separate winding connected for induction operation with provision for suitably controlling the motor excitation.

The servo-motor mechanism includes a housing 18 provided with an operating cylinder 19 for the operating piston 20 connected by a lever 21 to the plug member 22 cooperating with the seat 23 to vary the admission or flow area for elastic fluid entering the turbine. A spring 24 exerts force on the operating piston to move the valve plug in a closing direction, when permitted by conditions of pressure acting on the piston.

The turbine 10 drives, by means of gears 25 and 26, a spindle whose lower end is operatively connected to the gear pump 28 for supplying the bearing line 29.

A motor-operated pump, at 30, supplies the high-pressure line 30a connected, by means of an orifice 30b, to the low-pressure line for the bearings, whereby, before starting the turbine, the motor-operated pump may be placed in operation to supply oil to the low-pressure line to lubricate the bearings. Preferably the high-pressure line is connected to an air bell 30c providing increased pressure uniformity.

The housing 18 has a relay and governor body 31 provided with a cylindrical bore 32 for the relay 33. The bore has a pressure port 34 and exhaust ports 36 and 37, the pressure port being connected to the conduit 38 branching from the pressure supply line 30a and the exhaust ports being connected to the exhaust piping 39. The bore also has cylinder ports 40 and 41 communicating with the operating cylinder 19 above and below the operating piston.

As shown, the relay 33 has an intermediate land 42 which just laps the pressure port with the upper and lower lands 43 and 44 lapping the exhaust ports, at the sides of the latter adjacent to the pressure port, with the relay in neutral or mid position. The relay is positioned in its bore in response to opposed forces of the spring 46 and of liquid pressure in the space, at 47, below the relay.

With increase in pressure in the space, at 47, the relay 33 moves upwardly to connect the pressure port 34 with the cylinder port 41 and to connect the cylinder port 40 with the exhaust port 36 to supply motive liquid below the operating piston and to exhaust liquid from above the latter, in consequence of which the piston moves upwardly to move the admission valve in a closing direction. With decrease in pressure in the relay pressure space, at 47, the spring 46 moves the relay downwardly, thereby placing the pressure port in communication with the cylinder port 40 and the cylinder port 41 in communication with the exhaust port 37 to move the operating piston downwardly to move the valve in an opening direction.

Pressure of liquid in the space, at 47, is controlled either in response to speed of the turbine or in response to valve position controlling means. To effect speed control of the liquid pressure in such space, there is provided a centrifugal governor cooperating with a valve or relay to control the liquid pressure in the space such that the pressure is a function of turbine speed.

By way of example, the centrifugal governor is shown as being comprised by flyweights 48, 48 connected to the upper end of the spindle 27 by the leaf spring 50.

The relay and governor body 31 has a bore 52 below the bore 32 and a cylindrical plug 53 fits in the bore 52 and forms a part of the enclosure for the relay pressure space, at 47. The plug has an axial bore 54 whose upper end connects with the radial passage 55 and whose lower end opens through the bottom end of the plug. Oil is supplied from the pressure supply line 30a, through the branch conduit 56 and the fixed orifice 57, to the radial passage 55 and the bore

54. Liquid is supplied from the radial passage to the relay pressure space, at 47, through a port 58 provided with a check valve 59 opening toward the pressure space to prevent backflow from the latter to the radial passage.

The pressure of liquid or oil in the governing liquid pressure space formed by the bore 54 and the radial passage 55 is varied by varying the escape therefrom. This result is accomplished by means of a cup valve 60 covering the lower end of the bore and cooperating with the seat 61 at the lower end of the plug to define an annular escape orifice for the governing liquid pressure space.

The cup valve 60 is slidably mounted in the body 31 and it has a stem 62 in thrust engagement with the leaf spring 50.

The spring 46 for the upper end of the relay 33 has its compression varied by follow-up mechanism including a follow-up lever 64 connected at one end to the operating piston and having its other end operatively connected to the spring follower 65.

If there is an increase in speed, the flyweights 48 move outwardly to impart upward thrust to the cup valve 60, thereby increasing the pressure in the governing liquid pressure space and also in the control or relay pressure space, at 47, the check valve 59 providing for flow from the governing liquid pressure space to the relay pressure space as long as the pressure in the former prevails over that in the latter. Increase in pressure in the relay pressure space, at 47, results in upward movement of the relay and therefore of the operating piston to move the admission valve in a closing direction. This operation will continue until the increase in force of the spring 46 and the increase in force of governing liquid pressure acting on the cup valve balance the increase in centrifugal force with the relay in neutral or mid position.

If the turbine speed decreases, the contrary operation takes place, the pressure in the relay space, at 47, diminishing and the relay and operating piston both moving downwardly to move the admission valve in an opening direction. While the check valve 59 prevents backflow from the relay pressure space to the governing oil pressure space, nevertheless reduction in pressure in the latter space is followed by pressure reduction in the former because of leakage through the bleeder port 66 provided in the relay.

To effect speed adjustment of the governor, that is, change in the relation of governing liquid pressure and centrifugal force, the plug 53 is raised and lowered. Raising of the plug from a given position results in lowering of the governing liquid pressure to increase the speed, and vice versa.

Speed adjustment of the governor is preferably effected at a control station, at 67, including the panel 68, the operating shaft 69, and the manual operating member 70 connected to the shaft. If desired, the operating shaft may also be connected to a motor 70*a* controlled in any suitable manner.

The operating shaft 69 drives a control system indicated generally, at 71, and more particularly disclosed and claimed in the application of Schaelchlin, Serial No. 570,848, filed January 1, 1945, and assigned to applicant's assignee and which application has now become abandoned. The control system has a shaft 71*a* extending through the panel 68 for attachment to an indicator 71*b* cooperating with indicia provided on the panel. The shaft 69 also drives, by means of the shafting and gearing, at 74, the control shaft 75 having a cam 76 for raising and lowering the plug 53 of the governor to effect speed adjustment thereof and a cam 77 cooperating with the follower 78 to vary the loading exerted by the spring 79 on the escape valve 81 for the valve position controlling pressure space defined by the conduit 82 and the passage 83 formed in the plug 53. A check valve 85 provides for flow from the valve position controlling pressure space to the relay space, at 47, when the pressure of the former prevails over that of the latter.

The control system, at 71, includes a reversing component 71*c* and a component 71*d* controlling connection of the motor 12 for induction and synchronous operation. The component 71*d* also includes means for shutting off the steam to the turbine incident to synchronizing. In Fig. 1, these components are segregated and represented diagrammatically, the dash lines "*a*" and "*b*" indicating mechanical connection of the components with the mechanism operated by the handwheel 70 and the dash line "*c*" indicating mechanical connection of such mechanism with the governor. The component 71*d* has the usual exciter connections 71*e*; and, in addition to controlling the connection of the motor for induction or synchronous operation, it supplies the circuit 86, which, when interrupted, brings about shutting off the steam supply to the turbine.

Fig. 5 shows in a diagrammatic and schematic way essential features of the control components. The component 71*c* includes segments 71*f* and 71*g* cooperating with contacts 71*h* to reverse the three-phase connection between the generator and the motor. The component 71*d* is shown as comprising contacts 71*j*, 71*k*, 71*m* and 71*n* cooperating, respectively, with connected segments 71*o*, 71*p*, 71*q*, 71*r*, 71*s*, 71*t*, 71*u* and 71*w*. With engagement of either segments 71*p* or 71*q* with the contact 71*k*, the generator field is connected in the exciter circuit, the field circuit of the motor remaining open until engagement of either of the segments 71*r* or 71*s* with the contact 71*m*, whereupon the motor synchronous connection is established. Preceding engagement of either of the latter segments with the contact 71*m*, the contact 71*n* enters one of the gaps between the segment 71*u* and the segments 71*t* and 71*w* to interrupt the circuit 86 to bring about closing of the steam valve. It is to be understood that only so much of the electrical control system is shown in a conventional way as is required to illustrate the correlation thereof to the governing system. For a more complete disclosure and description of a suitable electrical control system and details thereof, reference is made to the aforesaid application of Schaelchlin and to the patent of Schaelchlin et al., 2,370,078, issued February 20, 1945.

The control system, at 71, and the cams 76 and 77 are correlated in operation so that, as the controller is moved from zero or neutral position in either direction, the motor is first connected by the control system to the generator for induction operation followed by change-over of the motor from the connection for induction operation to that for synchronous operation, the cam 76 operating to hold the adjustment of the governor to limit the governor-controlled speed to idling speed. With the motor synchronously connected to the generator, the cam 76 is operated to adjust the governor to increase the speed to a pre-

determined fraction of full speed, the fractional speed setting being indicated "1f" and "1a" for forward and astern operation in Fig. 2, whereupon, due to action of the cam 77 in relation to that of cam 76, the valve position controlling pressure prevails over the governing pressure in control of the turbine. Continued movement of the manually operable controlling member is effective to vary the valve position controlling pressure to operate the pressure-responsive means independently of the governor to position the admission valve for increase in speed of the turbine from fractional speed to full speed; however, the cam 76 continues to adjust the governor to condition the latter to take over control of the turbine to avoid overspeeding from the fractional speed to full speed.

The controller system, at 71, controls a circuit 86 for energizing the winding 87 to close the valve 88 between the pressure supply line 30a and the relay pressure space, at 47. Incident to, preferably an instant before, changing over the connection of the motor from that for induction to that for synchronous operation, the controller opens the circuit to deenergize the winding 87 and the spring 89 opens the valve 88 to supply oil from the pressure line to the relay pressure space, at 47, to effect operation of the servo-motor to close the admission valve. As the turbine and generator are, in this manner, relieved of motive fluid torque, pulling the generator out of step with the motor incident to establishing the synchronous relation is avoided.

The apparatus described operates as follows: With the indicator 71b at "zero" or neutral position and the turbine at idling, the handwheel 70 is moved for forward or astern operation, both the control system, at 71, and the cams 76 and 77 being thereby operated. Immediately upon movement being initiated the control system connects the motor for induction operation in the direction corresponding to that of movement of the manual control member or handwheel, the cam 76 holding the governor adjusted to hold the governor-controlled speed at idling speed, followed by change-over of the connection of the motor from that for induction operation to that for synchronous operation. Further movement of the handwheel operates the cams 76 and 77 to increase the speed to a speed which is a predetermined fraction of full speed, at which time the valve position controlling means supersedes the governor in control of the turbine, these positions being indicated at "1f" and "1a" in Fig. 2.

Continued movement of the manually operable control member operates the cams so that the cam 77 varies the valve position controlling pressure to increase the speed from the fractional to the full speed.

The control system, at 71, is arranged, by means of the circuit 86, to close the admission valve an instant ahead of the change-over of the motor from that for induction operation to that for synchronous operation to facilitate establishment of the synchronous relation, the circuit 86 preferably being opened so that the spring 89 is effective to open the valve 88 and thereby supply high pressure liquid to the relay space, at 47, to bring about movement of the admission valve, at 15, in a closing direction, this being particularly desirable in making crash stops.

The cams 76 and 77 are so shaped and timed that a straight-line relationship is preserved as between turbine speed and movement of the manually operable control mechanism for the control system and the valves, both when the turbine is being operated by governor control of the admission valve and by position control thereof.

In Fig. 3, the lines "A" and "B" represent the governing and valve position controlling pressures in relation to steam flow. With steam turned on and the governor adjusted for idling speed, the extent of opening of the admission valve and consequent steam flow depends, of course, upon the load; and, with the generator and motor synchronously connected, the synchronous relation may be broken or its establishment made difficult if the steam torque is excessive. Therefore, as shown, when the control pressure due to the governor is reduced to a point corresponding to the setting of the control pressure due to the valve position control means, further decrease in control pressure is prevented and the steam flow and torque are consequently limited. For example, in Fig. 3, with the control pressure ranging from 36 pounds, for minimum opening of the valve, to 14 pounds, for maximum opening of the valve, if the control pressure due to the governor is reduced to 22 pounds, further reduction is prevented because the control pressure due to the valve position control means has that value. In addition to the valve position controlling pressure functioning in this way to limit the load, or steam torque, it may be adjusted, after it supersedes the governing pressure, to effect further increase in steam flow to increase the speed. With the plant idling, the synchronous relation established and the governing pressure higher than the valve position controlling pressure, the speed is increased by making speed-changing adjustment to the governor by means of the cam 76 operated by movement of the handwheel 70. As shown in full lines in Fig. 3, the speed may be increased in this way by governor adjustment until the control pressure is reduced to 22 pounds, at which point the valve position controlling pressure supersedes it and further decrease in pressure is secured by operation of the cam 77. As the induction connection of the motor fulfills its purpose in the starting and synchronizing operation, as soon as the synchronous relation is established, further increase in speed may be effected by adjustment of the valve position controlling pressure instead of continuing adjustment of the governor until the control pressure is reduced to 22 pounds. This result may be secured by shaping the cam 77 to increase the position control pressure temporarily to meet that of the governing pressure at any value, as indicated by the dotted line "C" of Fig. 3, after which the position control pressure may be gradually reduced to increase the speed.

Because of the orifice between the high-pressure oil supply maintained by the motor-operated pump and the supply normally furnished by the turbine-operated pump, it will be apparent that, to place the turbine in operation, the motor-operated pump is started to provide the high-pressure oil supply and to furnish oil to the low-pressure supply for lubrication of bearings before motion of the turbine begins.

While the invention has been shown 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.

What is claimed is:

1. In a propulsion arrangement wherein an elastic fluid turbine provided with an admission valve drives a generator, a motor drives propelling

means, and an electrical connection supplies electrical energy from the generator to the motor: apparatus for controlling the admission valve and the connection of the motor to the generator for induction or synchronous operation in either direction and comprising a governor responsive to speed of the turbine for controlling the admission valve and including speed-changing means; valve position controlling means for controlling the admission valve; a control system operative to connect the motor to the generator for induction or synchronous operation in either direction; and controlling mechanism movable in either direction from a neutral position, through an initial phase, to operate the control system to connect the motor for induction operation followed by shifting the connection of the motor from that for induction operation to that for synchronous operation and to hold the speed-changing means adjusted to operate the admission valve so as to limit the governor-controlled speed to idling speed, through an intermediate phase, with the motor connected for synchronous operation, to adjust the speed-changing means to operate the admission valve to increase the speed to a speed which is a predetermined fraction of full speed and then to shift control of the admission valve from the governor to said valve position controlling means, and through a final phase, to adjust the valve position controlling means to operate the admission valve to increase the speed from said fractional speed to full speed.

2. The combination as claimed in claim 1 with means operated by the control system to move the admission valve in a closing direction incident to change-over of the connection of the motor from that for induction operation to that for synchronous operation.

3. The combination as claimed in claim 1 wherein, during the final phase of movement of said mechanism, the speed-changing means of the governor is adjusted to maintain the governor effective to take control of the turbine to avoid overspeeding.

4. In a propulsion arrangement wherein an elastic fluid turbine provided with an admission valve drives a generator, a motor drives propelling means, and an electrical connection supplies electrical energy from the generator to the motor: apparatus for controlling the admission valve and the connection of the motor to the generator for induction or synchronous operation in either direction and including pressure-responsive means for operating the admission valve to vary the admission of elastic fluid to the turbine; a governor responsive to turbine speed to provide a governing liquid pressure which bears a proportional relation to speed; valve position controlling means providing a controlling liquid pressure and being adjustable to vary such pressure; mechanism for adjusting the governor and the valve position controlling means such that the governing liquid pressure is gradually changed as the turbine is increased in speed and the controlling liquid pressure is caused to predominate over the governing liquid pressure when the turbine reaches a speed which is a predetermined fraction of full speed and then to change in the same direction as that of the governing liquid pressure while predominating over the latter from the fractional speed to full speed; means effective to supply the predominating liquid pressure to the pressure-responsive means; a control system operative to connect the motor to the generator for induction or synchronous operation in either direction; and controlling mechanism movable in either direction from neutral position, through an initial phase, to operate the control system to connect the motor for induction operation followed by shifting of the connection of the motor from that for induction operation to that for synchronous operation and to hold the governor adjusted to control the governing liquid pressure for operation of the admission valve so as to limit the governor-controlled speed to idling speed, through an intermediate phase, with the motor connected for synchronous operation, to adjust the governor to vary the governing liquid pressure and to adjust the valve position controlling means to vary the controlling pressure so that the governing liquid pressure is effective to operate the admission valve to increase the speed to said fractional speed whereupon the controlling liquid pressure predominates over the governing liquid pressure in controlling said pressure-responsive means, and, through a final phase, to adjust said valve position controlling means to vary the controlling pressure for operation of the pressure-responsive means for movement of the admission valve to increase the speed from said fractional speed to full speed.

5. The combination as claimed in claim 4 wherein the mechanism for adjusting the governor and the valve position controlling means includes a pair of mechanically-connected cams cooperating with the governor and with the valve position controlling means, respectively, and which cams are so shaped and timed that a straight line relationship is preserved as between travel of the controlling mechanism and turbine speed both for operation of the turbine under control of the governor and of the valve position controlling means.

6. In a propulsion arrangement wherein an elastic fluid turbine provided with an admission valve drives a generator, a motor drives propelling means, and an electrical connection supplies electrical energy from the generator to the motor: apparatus for controlling the admission valve and the connection of the motor to the generator for induction or synchronous operation in either direction and including pressure-responsive means for operating the admission valve to vary the admission of elastic fluid to the turbine such that a decrease in pressure supplied to the pressure-responsive means is followed by increase of admission of elastic fluid to the turbine and vice versa; a governor responsive to turbine speed to provide a governing liquid pressure which decreases for increase in speed; valve position controlling means providing a controlling liquid pressure which is decreased as the turbine speed is increased; mechanism cooperating with the governor and with the valve position controlling means to vary the relation as between turbine speed and governing liquid pressure and to vary the controlling liquid pressure such that the governing liquid pressure is gradually reduced as the turbine is increased in speed and the controlling liquid pressure predominates over the governing liquid pressure when the turbine reaches a speed which is a predetermined fraction of full speed and then is decreased while predominating over the governing liquid pressure from the fractional speed to full speed; means for supplying the predominant liquid pressure to the pressure-responsive means; a control system operative to connect the motor to the generator for induction or synchronous operation in either direction; and controlling mechanism movable in either direction from a neutral position, through an initial phase,

to operate the control system to connect the motor for induction operation followed by shifting of the connection of the motor from that for induction operation to that for synchronous operation and to operate said first mechanism to hold the governor adjusted to provide governing liquid pressure controlling the admission valve so as to limit the governor-controlled speed to idling speed, through an intermediate phase, to adjust said mechanism to decrease the governing liquid pressure and to adjust the valve position controlling means so that the governing liquid pressure is effective for operation of the pressure-responsive means to increase the speed to said fractional speed whereupon the controlling liquid pressure predominates over the governing liquid pressure in controlling the admission valve, and, through a final phase, to adjust said valve position controlling means to decrease the controlling liquid pressure for movement of the admission valve to increase the speed from said fractional speed to full speed.

7. The combination as claimed in claim 6 with means responsive to operation of the control system to supply to the pressure-responsive means liquid under pressure predominating over either the governing liquid pressure or the valve position controlling pressure to operate the pressure-responsive means to move the admission valve in a closing direction incident to changing over the connection of the motor from that for induction operation to that for synchronous operation.

8. In a propulsion arrangement wherein an elastic fluid turbine provided with an admission valve drives a generator, a motor drives propelling means, and an electrical connection supplies electrical energy from the generator to the motor: apparatus for controlling the admission valve and the connection of the motor to the generator for induction or synchronous operation in either direction and comprising a governor responsive to

speed of the turbine for controlling the admission valve and including speed-changing means; a control system operable to connect the motor for induction or synchronous operation by the generator; control means operable to limit the extent of opening of the admission valve to limit the elastic fluid intake of the turbine to a safe torque value while the governor controls the valve for operation of the turbine at idling speed; and controlling mechanism movable in either direction from neutral position, through an initial phase, to operate the control system to connect the motor for induction operation followed by shifting of the connection of the motor from that for induction operation to that for synchronous operation while holding the speed-changing means adjusted to limit the governor-controlled speed to idling speed, through an intermediate phase, to adjust the speed-changing means of the governor to operate the admission valve to increase the speed to a speed which is a predetermined fraction of full speed and then to shift control of the admission valve from the governor to said control means, and, through a final phase, to adjust the control means to operate the admission valve to increase the speed from said fractional speed to full speed.

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