

April 13, 1954

M. D. CHURCH
REMOTE-CONTROL MEANS FOR CONTROLLING OPERATION
OF STEAM TURBINES DRIVING SUGAR MILLS

2,674,854

Filed Jan. 8, 1952

3 Sheets-Sheet 1

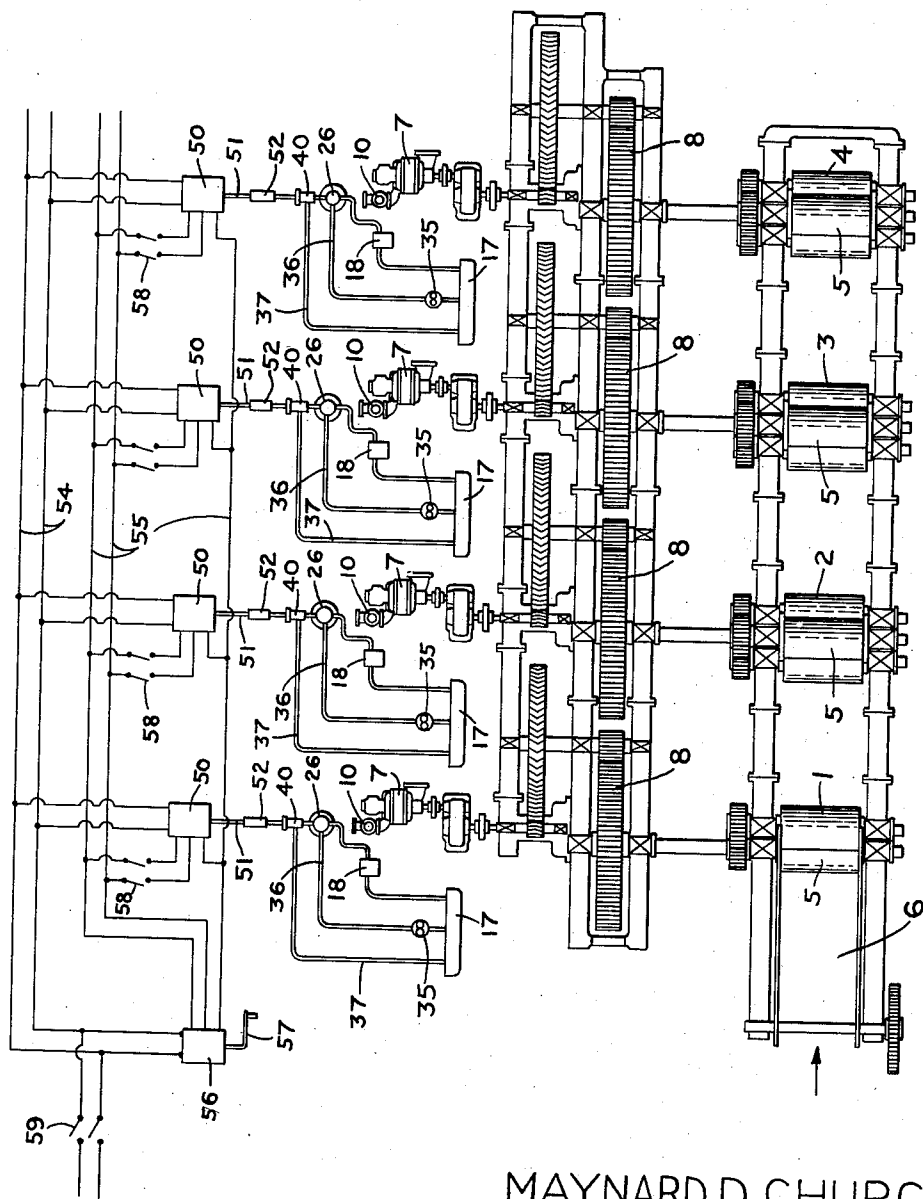


FIG. 1

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3 Sheets-Sheet 2

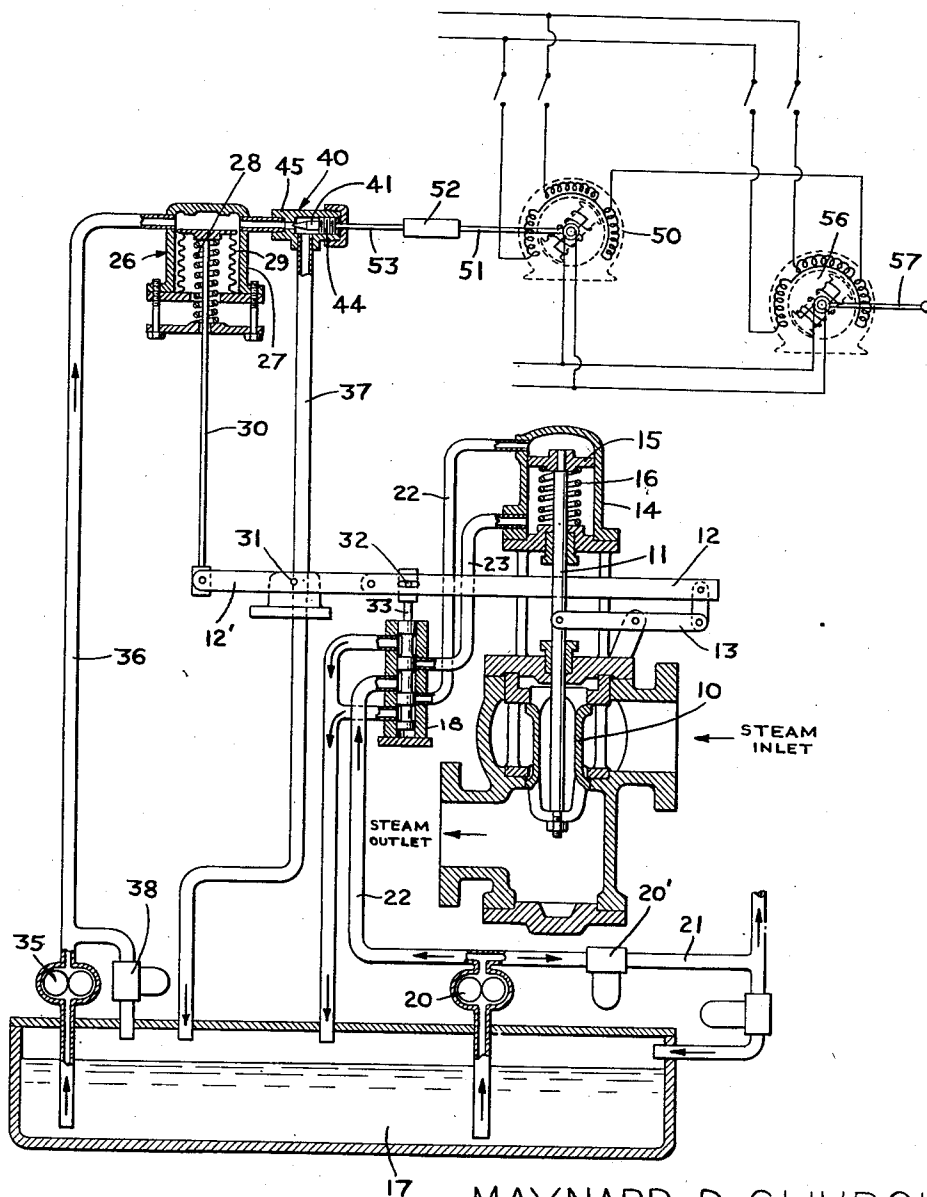


FIG. 2

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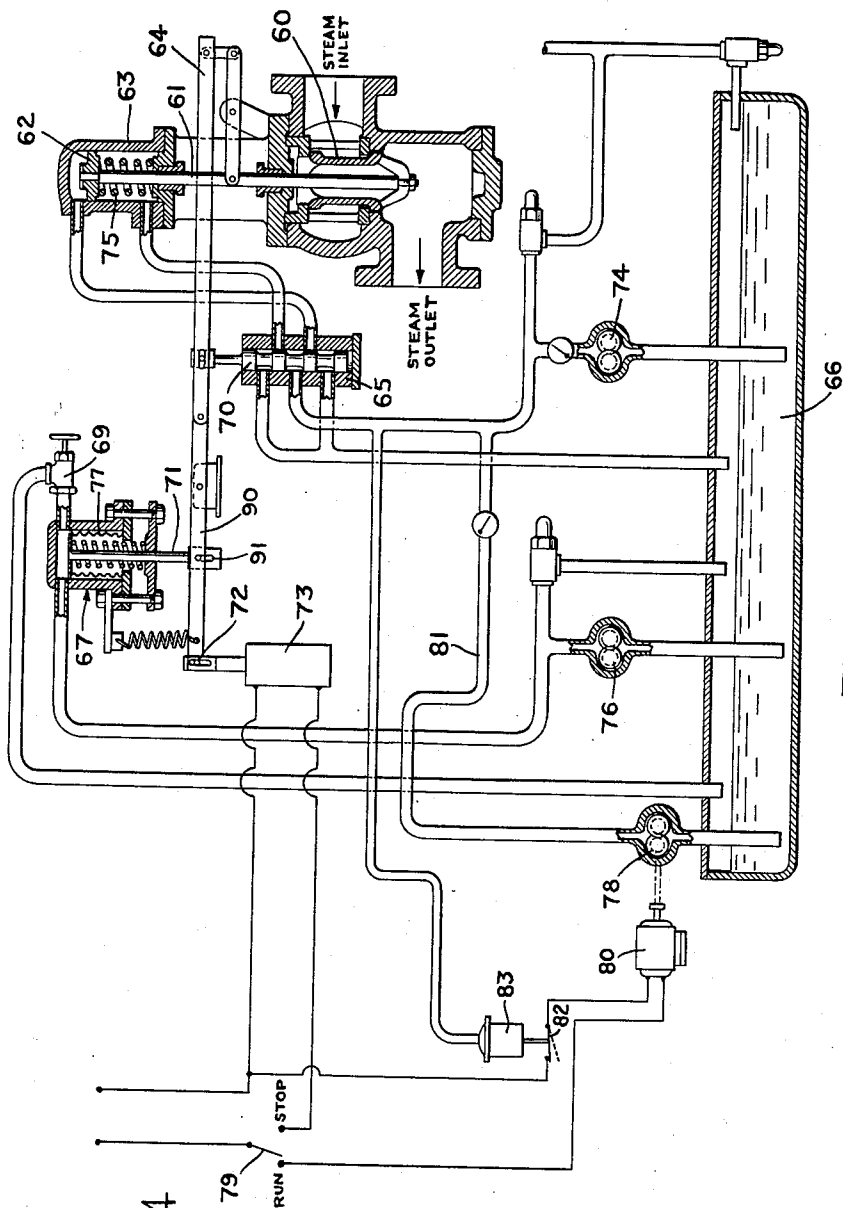


FIG. 3

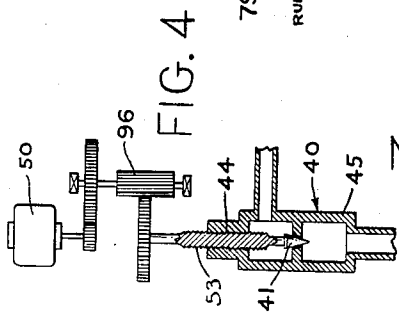


FIG. 4

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UNITED STATES PATENT OFFICE

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REMOTE-CONTROL MEANS FOR CONTROLLING OPERATION OF STEAM TURBINES DRIVING SUGAR MILLS

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6 Claims. (Cl. 60—102)

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This invention relates to steam turbines for driving sugar mills and more particularly to cases wherein several sections or sets of rolls in the tandem are individually driven by steam turbines.

An object of the present invention is to provide means whereby any one or all of the steam turbines may be stopped and restarted, or their speed of operation varied individually or collectively from a central control station without assistance of an operating engineer at the turbine.

In practice, the several mills or sections in a sugar mill tandem normally run at different speeds, the speeds gradually increasing from the entering to the leaving end of the tandem. When the speed of each turbine has been adjusted to drive its section of the tandem at the desired speed, it is advantageous to be able to increase or decrease the speed of all the sections simultaneously and approximately in proportion, and the present invention embodies means for so doing. By this means, the amount of sugar cane being processed may be adjusted to suit conditions. The stop and restart provision also aids in convenient and efficient mill operation. If for example the cane carrier or any other part of the mill equipment requires repair or adjustment, the turbine operating engineer may go immediately to the point where he can assist in such work, leaving it to the sugar mill operator to stop the turbines and to quickly restart them when repairs have been completed. This results in a reduction of the time the mill is out of production for repairs.

In the present invention novel modifications have been introduced into the turbine governor control to accomplish the above referred to desirable operations by remote control.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing remote control means for controlling operation of steam turbines driving sugar mills embodying a preferred form of the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 of the drawings is a plan view showing a sugar mill embodying one form of the present invention.

Figure 2 is an enlarged fragmentary view in section showing a turbine governor together with one part of the control mechanism associated therewith.

Figure 3 is a fragmentary view in section show-

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ing the turbine governor together with another part of the control mechanism associated therewith.

Figure 4 is a detail view partly in section and partly in elevation illustrating one form of mechanism for operating the speed control valve of a turbine governor.

In sugar mills, it is the general practice to embody a plurality of sections or sets of rolls, usually from 5 to 7, each of which is usually driven at a different speed, the speeds of the rolls of the sections normally increasing progressively from the entrance to the leaving end of the mill.

Figure 1 of the drawings shows such a mill in plan but only four sections are illustrated for convenience of illustration, it being understood that the invention is applicable to sugar mills embodying the any number of sections in tandem.

In Figure 1 of the drawings the sugar mill comprises the various sections 1, 2, 3, and 4, each comprising a plurality of rolls 5, into which sections sugar cane is fed in the usual manner through a cane chute illustrated at 6.

Each of the sections 1, 2, 3, and 4 is driven independently of any of the other sections by means of steam turbines shown at 7 through a series of speed reducing gears shown at 8. Each of the turbine units 7 is similar, any approved type of steam turbine being employed and the speed of each of which is controlled by a governor mechanism illustrated in Figure 2 of the drawings.

The governor mechanism for governing the speed of operation of the turbine is similar in principle to variable speed oil relay turbine governors for general application with the exception of certain control features which will be described.

Oil pump 35 is driven from the turbine shaft and pumps a quantity of oil proportional to the turbine speed. This oil is pumped through pipe 36 and through turbine speed control valve 40 which may be opened or closed more or less to act as an adjustable orifice. From the speed control valve 40 the oil returns to oil tank 17 through pipe 37. Between pump 35 and valve 40 the pipe is operatively connected to bellows housing 26 where its pressure is imposed on a spring loaded bellows 29.

For any given opening of valve 40 there is a turbine speed at which the oil pressure existing in pipe 36 and bellows housing 26 is adequate to begin to compress bellows 29 against the resistance of a spring 28. Further slight increase of turbine speed will increase oil pressure and com-

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press the bellows 29 further and cause rod 30 to move downward through a greater amplitude. Reduction of speed will cause a corresponding upward movement of rod 30 under action of the spring 23. This movement of rod 30 in response to speed change is used to control the amount of steam admitted to the turbine and thereby govern the running speed of the turbine.

Governor valve 10 which controls the amount of steam admitted to the turbine is moved by a servomotor consisting primarily of oil cylinder 14 and piston 15, the piston being mechanically connected to governor valve 10.

Oil under pressure to act as motive fluid in the servomotor is pumped from oil tank 17 by oil pump 20 which is driven from the turbine shaft. The pressure of the oil is regulated by relief valve 20' which discharges any excess oil into pipe 21 which distributes it to the lubricating system, from which it returns to the tank 17.

Bellows 29 and rod 30 and the stem connecting piston 15 and governor valve 10 are operatively connected to relay valve 33 through floating lever 12 and auxiliary levers 12' and 13 in a manner commonly used in oil relay governor mechanisms.

Oil from oil pump 20 is led by pipe 22 to the center port of relay valve 33. When speed increases the downward movement of rod 30, acting through lever 12' which is pivoted at 31, causes an upward movement of the relay valve 33, thereby releasing oil from above the piston 15 and admitting oil under the piston and causing the valve 10 to move towards a closed position. The movement of stem 11, acting through floating lever 12, will restore the relay valve 33 to a central position and thereby stop the governor valve 10 when its travel is proportional to the movement of bellows 29. On a reduction of speed the same action takes place in reverse.

The function of relief valve 38 is to prevent the pressure in pipe 36 from ever becoming great enough to damage bellows 29.

The speed control valve 40 is used to adjust the speed setting of the turbine governor. It is obvious that if this valve is opened wider, a higher speed of pump 35 and therefore of the turbine will be required to build up the pressure in the bellows housing 26 required to actuate the bellows 29 against the pressure of spring 23. Likewise reducing the opening of valve 40 will cause the turbine to run at a lower speed.

The above described mechanism is a usual form of governor mechanism for steam turbines and in such usual form of governor mechanisms the speed control valve 40 is manually operated, requiring a turbine engineer or operator at the turbine to vary the setting of the speed control valve and thereby vary the speed of operation of the turbine when necessary. With a number of turbines employed for individually driving the sections of the tandem of a sugar mill it would require a turbine operator acting under the instructions of the sugar mill operator to move from one turbine to another to adjust their speed, requiring considerable time and depending upon the skill and judgment of the turbine operator in adjusting the various speed control valves to give the proper proportionate speeds of operation of the various turbines to meet changing conditions.

The present invention embodies means whereby a single operator from a remote control station may stop or start any or all of the turbines and can adjust the speed of any turbine

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or of all of the turbines together and proportionately.

In Figures 1 and 2 of the drawings, this is provided through the medium of electrical means controlled by switches and other devices which are preferably located in a switch panel positioned at any convenient location so that they may all be operated by a single operator.

In Figures 1 and 2 of the drawings a self-synchronous motor 50 which we will call a "Selsyn" motor has its shaft 51 connected by a suitable coupling 52 to the stem 53 of the valve element 41. The valve element 41 has a threaded extension 44 thereon which is threadably connected with the housing 45 of the speed control valve structure 40 so that when the stem 53 is rotated the valve element 41 will be moved towards or from its seat depending upon the direction of rotation of the valve stem.

As shown in Figure 1 of the drawings, all of the Selsyn motors 50 and Selsyn transmitter 56 are connected to a power line indicated at 54 and "Selsyn" motors 50 are connected through the electrical control wiring 55 with the transmitter Selsyn 56. The rotor of the "Selsyn" transmitter 56 is manually rotated through the medium of a hand crank 57, and as is well known in the operation of "Selsyn" transmitter and receiver systems all of the receiver "Selsyns" 50 connected in the circuit with the "Selsyn" transmitter 56 will automatically assume the same angular position of their rotors about their axes as that of the transmitter "Selsyn." Thus by manually positioning the rotor of the transmitter "Selsyn" 56 the rotors of all of the "Selsyn" receivers 50 will automatically move into the same positions and in so doing will rotate their shafts 51 and thereby operate the speed control valves 40 accordingly. Thus by turning the rotor of the transmitter "Selsyn" 56, the speed setting of all the turbine governors can be adjusted simultaneously and proportionately.

For the purpose of permitting individual control of the "Selsyn" receivers 50 and, consequently, individual speed control of the turbines 7, a switch as indicated at 58 is connected in two of the three wires forming the connection between each of the "Selsyn" receivers 50 and the electrical power transmitting connection 55, thus by opening or closing the switches 59 the operator may cut any one of the "Selsyn" receivers 50 into or out of the circuit including the "Selsyn" transmitter 56 thereby permitting control of any one of the turbines 7 by its own "Selsyn" motor independently of any of the other turbines in the mill.

Figure 4 shows an arrangement whereby reduction gearing 96 is interposed between the "Selsyn" motor 50 and the threaded valve stem 53, thereby making finer control possible.

The stop and start control mechanism is illustrated in Figure 3 which shows many of the same elements as Figure 2 but with additions and modifications necessary to permit the turbine to be stopped and started from a remote point. The speed control mechanism and the stop and start control mechanism are shown separately for simplicity. In practice they are used together.

In the form of the invention shown in Figure 3 of the drawings the valve 60 which controls delivery of the steam to the turbine is the same as the valve 10 and its stem 61 is connected to a piston 62 in the cylinder 63. A relay valve structure 65 which is the same as the relay valve structure 18 controls admission of oil under

pressure to either end of oil cylinder 63 and also drainage of oil from either end. This control is the same as the control shown in Figure 2 and the spring loaded Sylphon structure 67 which is operated by pressure of oil from the governor oil pump 76 is also the same. The speed control valve 69, however, is shown manually operated and the setting of the valve 70 of the relay valve assembly 65 may be controlled in an additional manner than as shown in Figure 2 of the drawings. In this form of the invention the lever 90 is connected to Sylphon stem 71 by a slip joint 91 and is extended beyond its connection with the stem 71 of the spring loaded Sylphon structure 67 and has a slip joint connection 72 with an electrically operated solenoid 73. To stop the turbine, the solenoid 73 is energized at which time it pulls down on the extension of the lever 90 associated with the governor. The downward movement of the lever 90 raises the valve 70 of the relay valve assembly 65 thereby releasing oil from above oil piston 62 and admitting oil under pressure to the underside of the same piston, moving the oil piston 62 upwardly and closing the valve 60 to shut off the delivery of the steam to the turbine. When the turbine has stopped, the oil pump 74 which is driven from the turbine shaft (not shown) will also stop and delivery of oil to the cylinder 63 will consequently be stopped. However, the spring 75 will keep the piston 62 in its upper position and hold the valve 60 closed even if the solenoid 73 should be de-energized. To restart the turbine, the solenoid 73 is first de-energized returning control of the relay valve 65 to the spring loaded Sylphon structure 67. As the speed of operation of the turbine is zero at such time there will be no oil pressure on the Sylphon 77 since pump 76 will not be running. Since there is no oil pressure on the Sylphon 77 of the spring loaded Sylphon structure 67 the governor lever will lower the valve 70 of the relay valve assembly 65 to a position where it will direct oil pressure when available into the cylinder 63 above the piston 62. At this time an auxiliary oil pump 78 will be started through the manual manipulation of a switch 79 by moving the control switch into the "run" position. The pump 78 is driven by an electric motor 80. When the auxiliary oil pump 78 is started it will deliver oil under pressure through the pipe line 81 and relay valve 65 into the cylinder 63 above the piston 62 and move the piston downwardly to open the valve 60 and admit steam to the turbine for starting it. As the turbine comes up to speed it will, by operation of the oil pump 74, deliver oil from the tank 66 into the same system as pump 78. When the pressure of oil reaches a predetermined point it will through any suitable pressure actuated mechanism 83 actuate an electrical switch 82 interposed in the electrical connection between the electric current supply line and the motor 80. The pressure operated mechanism 83 employed to operate the switch 82 may be of any approved pressure operated type as may be purchased on the open market. When the switch 82 is open and the motor 80 stopped the governor mechanism will continue to operate in its normal manner. Should the oil pressure provided by the pump 74 stop for any cause, the drop in the pressure will cause closing of the switch 82 and the automatic starting of the auxiliary oil pump 78 thus providing oil to the system as long as the control switch 79 remains in the run position. In uti-

lizing this construction shown in Figure 3 of the drawings, it is to be understood, of course, that control switches 79 may be employed for each of the turbines used for driving the sections of the sugar mill and that each of these turbines will be controlled by its control switch 79 all located at a central point.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In combination, a plurality of steam turbines for individually driving each of the sections of a sugar mill, individual governor means for controlling the speed of operation of each of said turbines, and means remote from and connected to said governor means whereby the speed setting of all of said governor means may be operated in unison, valves for controlling delivery of steam to the turbines, said governor means connected to said valves for operating them, said governor means including pressure operated means for operating said valves, relay valves for controlling the delivery of pressure fluid to said pressure operated means, speed control valves for controlling operation of said relay valves, said remote means including electrically operated means for providing turbine speed control and turbine stop and start operation of said relay valves.

2. In combination, a plurality of steam turbines for individually driving the sections of a sugar mill, individual governor means for controlling the speed of operation of each of said turbines, and means remote from and connected to said governor means whereby the speed setting of all of said governor means may be operated in unison, valves for controlling delivery of steam to the turbines, said governor means connected to said valves for operating them, said governor means including pressure operated means for operating the valves, relay valves for controlling delivery of pressure fluid to said pressure operated means, said remote means including electrically operated means for providing turbine stop and start operation of said relay valves, means operated by the turbine for supplying pressure fluid through said relay valves to said pressure operated means, and auxiliary pressure fluid supply means automatically operable upon failure of pressure fluid supply by said turbine operated means for supplying pressure fluid to said pressure operated means.

3. In combination, a plurality of steam turbines for individually driving the sections of a sugar mill, individual governor means for controlling the speed of operation of each of said turbines, and means remote from and connected to said governor means whereby the speed setting of all of said governor means may be operated in unison, valves for controlling delivery of steam to the turbines, said governor means connected to said valves for operating them, said governor means including pressure operated means for operating the valves, relay valves for controlling delivery of pressure fluid to said pressure operated means, said remote means including electrically operated means for providing turbine stop and start operation of said relay valves, said electrically operated means including solenoids, means connecting said solenoids and said relay valves for operating the relay valves upon energizing of the solenoids.

4. In combination, a plurality of steam turbines

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for individually driving the sections of a sugar mill, individual governor means for controlling operation of each of said turbines, and means remote from and connected to said governor means whereby the speed setting of all of said governor means may be operated in unison, valves for controlling delivery of steam to the turbines, said governor means connected to said valves for operating them, said governor means including pressure operated means for operating the valves, relay valves for controlling delivery of pressure fluid to said pressure operated means, said remote means including electrically operated means for providing turbine stop and start operation of said relay valves, said electrically operated means including solenoids, means connecting said solenoids and said relay valves for operating the relay valves upon energizing of the solenoids, means operated by the turbine for supplying pressure fluid through said relay valves to said pressure operated means, and auxiliary pressure fluid supply means automatically operable upon failure of pressure fluid supply by said turbine operated means for supplying pressure fluid to said pressure operated means.

5. In combination, a plurality of steam turbines for driving each of several sections of a sugar mill, individual governor means for controlling the speed of each of said turbines including pressure operated means for varying the turbine speed control settings of the governor valves, turbine speed control valves for controlling operation of said pressure operated means, electrically operated means for adjusting each of said speed control valves, a manually operated master device for controlling operation of said electrically operated means, all of said electrically operated means connected in one circuit, and switches

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whereby any one of said electrically operated means may be cut in or out of the circuit independently of the others, and means including electrically operated means whereby any one or all of the turbines may be stopped and restarted from a single control center.

6. In combination, a plurality of steam turbines for driving each of several sections of a sugar mill, individual governor means for controlling the speed of each of said turbines including pressure operated means for varying the turbine speed control settings of the governor means, turbine speed control valves for controlling operation of said pressure operated means, means whereby the setting of each of the turbine speed governors may be adjusted from a common control center including means whereby the speed settings of several or all of the turbine speed control valves may be simultaneously and proportionately adjusted, together with means located at a common control center whereby any turbine may be stopped and restarted independently of any of the other turbines.

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