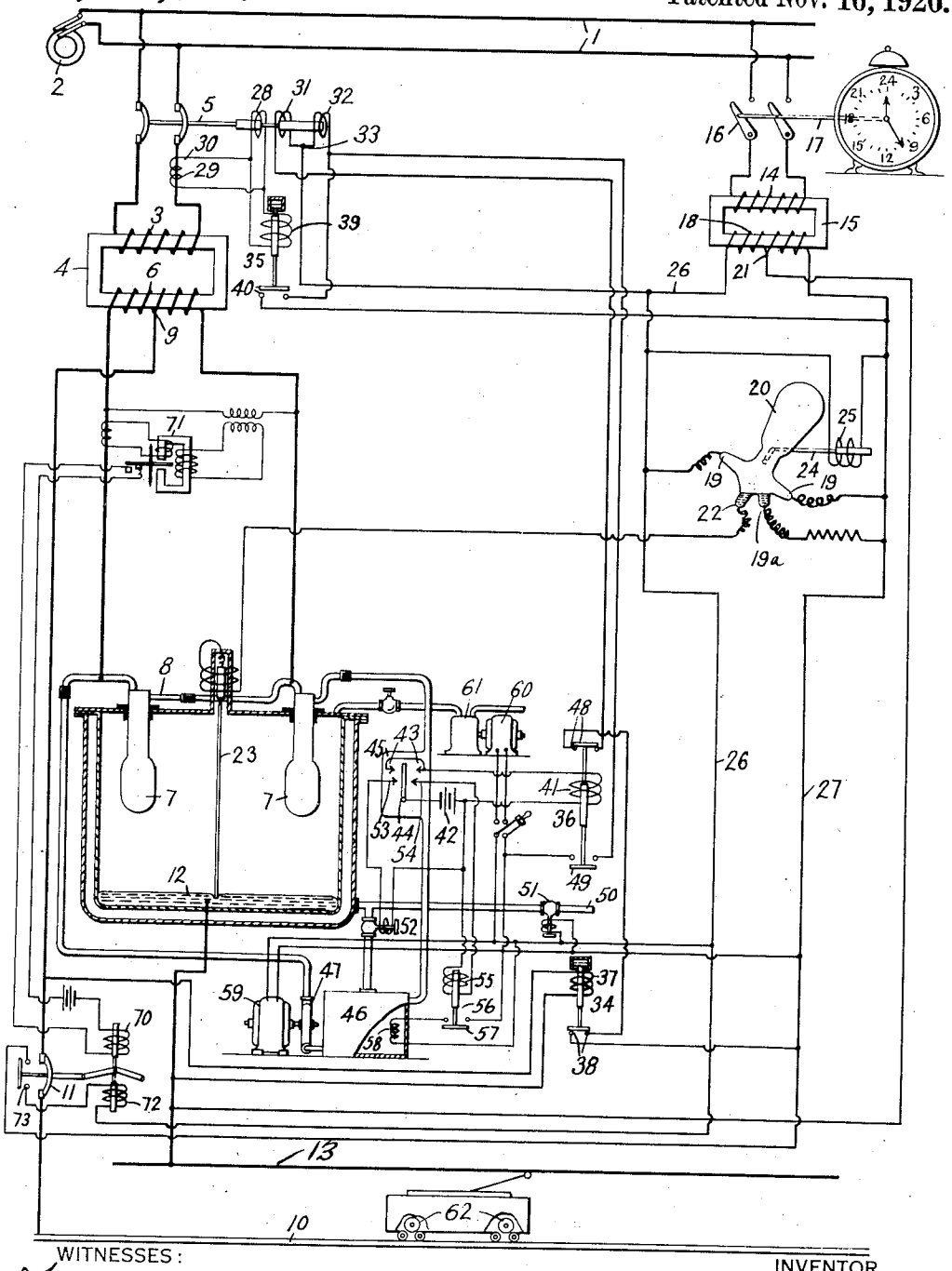
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AUTOMATICALLY CONTROLLED VAPOR CONVERTER SUBSTATION.

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AUTOMATICALLY-CONTROLLED VAPOR-CONVERTER SUBSTATION.

1,358,713. Specification of Letters Patent. Patented Nov. 16, 1920.

Application filed September 9, 1916. Serial No. 119,286.

To all whom it may concern:

Be it known that I, EDWARD P. DILLON, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Automatically-Controlled Vapor-Converter Substations, of which the following is a specification.

My invention relates to means for automatically controlling the operation of vapor converting apparatus when installed in substations employed in connection with electric railway or lighting systems.

An automatically-controlled substation may be defined as one in which the several operations of starting and connecting the converting apparatus to the line, whenever there is a demand for power, and finally shutting down and disconnecting the converting apparatus, after the demand for power has ceased, are all performed in their proper sequence without the assistance of an operator, either in the substation or in adjacent stations. The automatically-controlled substation has no direct connection with the main generating station other than through the power-supply circuits and is, therefore, essentially different from a remotely-controlled substation which requires a separate feeder to each piece of converting apparatus and in which the operations of both stopping and starting the apparatus are performed by an attendant in the central station from which the power is supplied.

The starting, operation and shutting down of the converting apparatus in manually-operated substations has heretofore been left to the judgment of an attendant who depends upon the indications of ammeters, voltmeters, wattmeters or other instruments to indicate to him whether or not there is a demand for power and also to indicate the proper timing of the starting operations. In order to render the operation of the converting apparatus in the substation independent of the judgment of an operator, it is one object of my invention to utilize the changes in the conditions of the electric circuit, which the attendant has heretofore observed on the indicating instruments, to automatically control the operation of the converting apparatus through suitable relays or other controlling devices.

A further object of my invention is to make the operation of the controlling devices responsive to certain operating characteristics peculiar to vapor converters so that it will be impossible for the converters to operate under unfavorable conditions.

A still further object of my invention is to provide an arrangement for temporarily cutting out of service the auxiliary transformer and converter which supply the control circuits and the keep-alive circuit of the main converter, respectively.

The single figure of the accompanying drawing is a diagrammatic view of the apparatus and circuit connections employed in an automatically-controlled substation and arranged in accordance with my invention.

Mains 1 are connected to a suitable alternating-current source, such as a single-phase alternator 2 and the primary winding 3 of a main transformer 4 is connected to the mains 1 through an electrically-operated switch 5. The terminals of the secondary winding 6 of the transformer 4 are respectively connected to the anodes 7 of a vapor converter 8, and an intermediate point 9 of the secondary winding 6 is connected to one side of a direct-current receiving circuit, such as the ground-return rail 10 of an electric railway system, through a circuit breaker 11. The circuit breaker 11 is provided with a reverse-current tripping coil 70 that is adapted to be energized through a reverse-energy relay 71 coupled to the anode leads of the converter. The circuit breaker is further provided with a closing coil 72 that is adapted to be energized from a suitable control circuit through auxiliary contact member 73 carried by the plunger of the circuit breaker. The mercury cathode 12 of the converter 8 is connected to a trolley conductor 13 which is maintained at a substantially constant potential above the rail 10 by other converting apparatus (not shown) which may be located in a main generating station or in other substations. The primary winding 14 of an auxiliary transformer 15 is connected to the mains 1 through a switch 16, the operation of which is dependent upon a clock-controlled mechanism 17. The terminals of

the secondary winding 18 of the transformer 14 are connected to the anodes 19 of an auxiliary vapor converter 20, and an intermediate point 21 of the winding 18 is connected to the cathode 12 of the main converter 8. The cathode 22 of the converter 20 is connected to a suitable keep-alive anode 23 of the main converter 8. The converter 20 is adapted for self-starting by means of a tilting device 24 that is actuated by a coil 25 connected across the secondary winding 18 and an auxiliary starting anode 19^a. Control conductors 26 and 27 are connected to the respective terminals of the secondary winding 18 to supply the control circuits and auxiliary apparatus of the converter 8, as will hereinafter be described.

The switch 5 is provided with an overload opening-coil 28, the terminals of which are connected across the secondary winding 29 of a current transformer 30 that is connected in one of the leads to the primary winding 3 of the transformer 4. The switch 5 is further provided with a closing-coil 31 and an opening-coil 32, one terminal of each coil being connected to the control conductor 26 at the point 33. The other terminals of the coils 31 and 32 are connected to the control conductor 27 through the relay devices 34, 35 and 36. The relay 34 comprises a voltage coil 37 which is connected across the direct-current mains and is adapted to hold open the relay contact members 38 in the circuit of the closing coil 31 so long as the direct current voltage exceeds a predetermined value. The relay 34 has a dash pot action, as indicated, so that it will not close unless the voltage reaches and remains below a predetermined minimum value for a predetermined period. The actuating coil 39 of the relay 35 is connected across the terminals of the secondary winding 29 of the current transformer 30 and is adapted to hold open the contact members 40 in the circuit of the opening coil 32 so long as the current in the secondary winding 29 exceeds a predetermined value. The relay 35 also has a dash pot action so that the relay contacts will not close unless the current reaches and remains below a predetermined minimum value for a predetermined period. The relay 36 comprises an actuating coil 41 which is adapted to be connected across a suitable source of electromotive force, such as a battery 42, through the relatively movable contact members 43 and 44 of a thermostatic device 45. The thermostatic device 45 is located in the anode-cooling system of the converter 8 which comprises suitable piping connecting the anodes 7 to a reservoir 46 and a circulating pump 47. The thermostatic device 45 is so arranged that the movable contact member 44 is adapted to complete the circuit of the coil 41 through the battery 42 whenever the temperature in the anode-cooling system exceeds or falls below a predetermined value. The upper contact members 48 of the relay 36, which are in the circuit of the closing coil 31, are normally closed when the coil 41 is deënergized, while the lower contact members 49, which are in the circuit of the opening coil 32, are normally open.

The cathode-cooling system is connected to a suitable water supply through a pipe 50, the flow of water therein being controlled by an electromagnetically operated valve 51 that is held open as long as the control conductors are energized. The reservoir 46 is connected to the supply pipe through an electromagnetically operated valve 52, the actuating coil of which is adapted to be energized through the movable contact member 44 and an auxiliary stationary contact member 53 of the thermostatic device 45 whenever the temperature of the anode-cooling system exceeds a predetermined value and before the contact member 44 engages the left-hand stationary contact member 43. The thermostatic device 45 is further provided with a stationary auxiliary contact member 54 which controls the circuit of the actuating coil 55 of a relay device 56. The movable contact member 44 is adapted to complete the circuit of the coil 55 whenever the temperature of the anode-cooling system falls below a predetermined value and before it makes contact with the right-hand stationary contact member 43. The normally open contact members 57 of the relay 56 are in the circuit of a heating coil 58 that is located in the reservoir 46 and is adapted to be energized from the control conductors 26 and 27. Motors 59 and 60 for driving the circulating and evacuating pumps 47 and 51, respectively, are also connected to the conductors 26 and 27.

Having described the various parts entering into my invention, the operation thereof is as follows: The clock-controlled device 17 closes the switch 16 at certain intervals during which a demand for power from the main converter 8 is liable to occur. The closing of the switch 16 automatically starts the auxiliary converter 20 by means of the tilting device 24 and starting anode 19^a, thereby energizing the keep-alive circuit of the main converter 8. The energization of the control conductors from the secondary winding 18 opens the valve 51 and starts the motor 59. If the temperature in the anode-cooling system is below a predetermined value, the movable contact member 44 of the thermostatic device 45 moves to the right, thereby completing the circuit of the heating coil 58 or, if the temperature is above a predetermined value, the contact member 44 moves to the left, thereby opening the valve 52 and allowing cold water to enter the reservoir. When the temperature

of the cooling system reaches the proper value, the contact member 44 of the thermostatic device 45 moves to its middle position, thereby deënergizing the heating coil 58 and opening the valve 52, and the converter 8 is then ready for operation. The load between the trolley 13 and the ground return rail 10 may be represented by one or more electric motors 62 mounted on a railway vehicle. As the vehicle approaches the substation, the current taken by the motors 62 causes the voltage between the trolley and the rail to decrease and, if the voltage falls below a predetermined value for a predetermined period, the partial deënergization of the voltage coil 37 of the relay 34 allows the contact members 38 to close. Assuming the converter 8 to be in its proper operating condition, as previously described, that is, with the contacts 48 of the relay 36 closed the closing coil 31 of the switch 5 is energized and the transformer 4 is connected to the alternating-current mains 1. The vapor converter 8 is immediately started by means of the keep-alive electrode 23 to supply unidirectional current to the trolley 13 at the proper voltage. While the converter 8 is in operation, the coil 39 of the relay 35 is energized through the current transformer 30, and the contact members 40 are held open but, if the output of the converter decreases to such an extent that the current through the coil 39 falls below a predetermined minimum value for a predetermined period, the contact members 40 are allowed to close, thus completing the circuit of the opening coil 32 of the switch 5 and disconnecting the converter from the alternating-current mains 1. During the normal operation of the converter, the temperature of the cooling water is maintained substantially constant, as the energization of the heating coil 58 or the opening of the valve 52 through the operation of the thermostatic device 45 automatically compensates for small variations in the temperature. If, however, the temperature exceeds or falls below a predetermined value, the continued travel of the movable contact member 44 to the left or to the right energizes the relay coil 41 and thus completes the circuit of the opening coil 31 until the proper temperature is obtained. In case a short circuit occurs in the anodes of the converter, the reverse-energy relay 71 will open the circuit breaker 70. The energization of the closing coil 72, through the contact members 73, will immediately close the breaker as soon as the short circuit is cleared and again connect the converter to the line.

It is apparent from the foregoing that all of the steps in the starting and operation of the converter are automatically performed in their proper sequence whenever a demand for power occurs at the substation, although the converter can only be operated when the anodes are at their proper temperature. Furthermore, the operation of the auxiliary converter only during the intervals when there is liable to be a demand for power from the main converter decreases the stand-by transformer losses.

While I have shown my invention in its simplest and preferred form and as applied to a certain type of vapor converting apparatus, it is not so limited but may equally as well be applied to other converting apparatus operating on the same principle and I desire, therefore, that only such limitations shall be imposed thereupon as come within the scope of the appended claims.

I claim as my invention:

1. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter provided with a cooling system, means for automatically connecting said vapor converter to said source and other means dependent upon the temperature in said system for automatically disconnecting said converter from said source.

2. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter provided with a cooling system, means for automatically connecting said vapor converter to said source and a thermostatic device located in said system for automatically disconnecting said converter from said source when the temperature in the said system exceeds or falls below a predetermined value.

3. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter provided with controlling devices for automatically connecting said converter to said source and to said circuit, an auxiliary transformer for supplying said controlling devices, and means for automatically connecting said auxiliary transformer to said source only during certain intervals.

4. The combination with an alternating-current source and a direct-current consuming circuit, of a main vapor converter provided with a keep-alive circuit, an auxiliary converter for supplying said keep-alive circuit and means for automatically connecting said auxiliary converter to said source only during certain intervals.

5. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter provided with controlling devices for automatically connecting said converter to said source and to said circuit, and an auxiliary transformer for automatically supplying said controlling devices only during certain intervals.

6. The combination with an alternating-current source and a direct-current consuming circuit, of a main vapor converter connected therebetween and provided with a

keep-alive circuit, an auxiliary converter for supplying said keep-alive circuit, and automatic means whereby said auxiliary converter operates only under predetermined electrical conditions in said alternating-current source.

7. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter provided with controlling devices for automatically connecting said converter to said source and to said circuit, an auxiliary transformer for supplying said controlling devices and a time-controlled device for automatically connecting said auxiliary transformer to said source.

8. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter provided with controlling devices for automatically connecting said converter to said source and to said circuit, an auxiliary transformer for supplying said controlling devices, and a clock-controlled switching device for automatically connecting said auxiliary transformer to said source.

9. The combination with an alternating-current source and a direct-current consuming circuit, of a main vapor converter provided with a keep-alive circuit, an auxiliary converter for supplying said keep-alive circuit and a time-controlled device for automatically connecting said auxiliary converter to said source.

10. The combination with an alternating-current source and a direct-current consuming circuit, of a main vapor converter provided with a keep-alive circuit, controlling devices for automatically connecting said converter to said source and to said circuit, a transformer for supplying said controlling devices, an auxiliary converter connected thereto for supplying said keep-alive circuit and a time-controlled device for automatically connecting said transformer to said source.

11. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter, and means for automatically connecting said vapor converter to said source, when the voltage of said circuit falls and remains below a minimum value for a predetermined period.

12. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter, means for automatically connecting said vapor converter to said source, and other means for automatically disconnecting said converter from said source when the output of said converter falls and remains below a minimum value for a predetermined period.

13. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter, means for automatically connecting said vapor converter to said source when the voltage of said circuit falls and remains below a minimum value for a predetermined period, and other means for automatically disconnecting said converter from said source when the output of said converter falls and remains below a minimum value for a predetermined period.

14. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter the anodes of which are provided with a cooling system, means for automatically connecting said converter to said source and other means dependent upon the temperature in said anode-cooling system for automatically disconnecting said converter from said source.

15. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter connected thereto and provided with a cooling system, and a thermostatic device located in said system and adapted to automatically disconnect said converter from said source when the temperature in said system falls below a predetermined value.

16. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter connected thereto and provided with a cooling system, and a thermostatic device located in said system and adapted to automatically disconnect said converter from said source when the temperature in said system exceeds a predetermined value.

17. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter connected thereto and provided with a cooling system, and a thermostatic device located in said system and adapted to automatically regulate the temperature in said system and to automatically disconnect the said converter from said source when the temperature in said system exceeds or falls below certain predetermined values.

18. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter connected thereto and provided with a cooling system, and a thermostatic device located in said system and adapted to automatically actuate means for raising the temperature in said system and to disconnect the converter from said source when the temperature in said system falls below a predetermined value.

19. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter connected thereto and provided with a cooling system, and a thermostatic device located in said system and adapted to automatically actuate means for raising the temperature in

said system when it falls below a predetermined value and to disconnect the converter from the said source when the temperature in said system falls below a second predetermined value lower than the first.

20. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter connected thereto and provided with a cooling system, and a thermostatic device located in said system and adapted to automatically actuate means for lowering the temperature in said system and to disconnect the converter from said source when the temperature in said system exceeds a predetermined value.

21. The combination with an alternating-current source and a direct-current consuming circuit, of a vapor converter connected thereto and provided with a cooling system, and a thermostatic device located in said system and adapted to automatically actuate means for lowering the temperature in said system when it exceeds a predetermined value and to disconnect the converter from said source when the temperature in said system exceeds a predetermined value higher than the first named value.

22. The combination with a vapor converter provided with an anode-cooling system comprising a reservoir provided with a heating coil, of a thermostatic device located in said system for energizing said heating coil when the temperature in said system falls below a predetermined value.

23. The combination with a vapor converter provided with an anode-cooling system and a source of cooling fluid, of a thermostatic device located in said system for automatically connecting said cooling system to said source when the temperature in said system exceeds a predetermined value.

24. The combination with a vapor converter provided with an anode-cooling system provided with a reservoir and a source of cooling fluid, of a thermostatic device located in said system for automatically connecting said reservoir to said source when the temperature in said system exceeds a predetermined value.

25. The combination with a vapor converter provided with a cooling system and an auxiliary control circuit, of an electromagnetically operated valve adapted to be opened by the energization of said circuit for connecting said cooling system to said source and means for energizing said control circuit only during certain intervals.

26. The combination with a vapor converter provided with a cooling system, a circulating pump therefor, a fluid source, and an auxiliary control circuit, of means dependent upon the energization of said control circuit for operating said pump and for connecting said system to said source, and other means for energizing said control circuit only during certain intervals.

In testimony whereof I have hereunto subscribed my name this 30th day of August, 1916.

EDWARD P. DILLON.