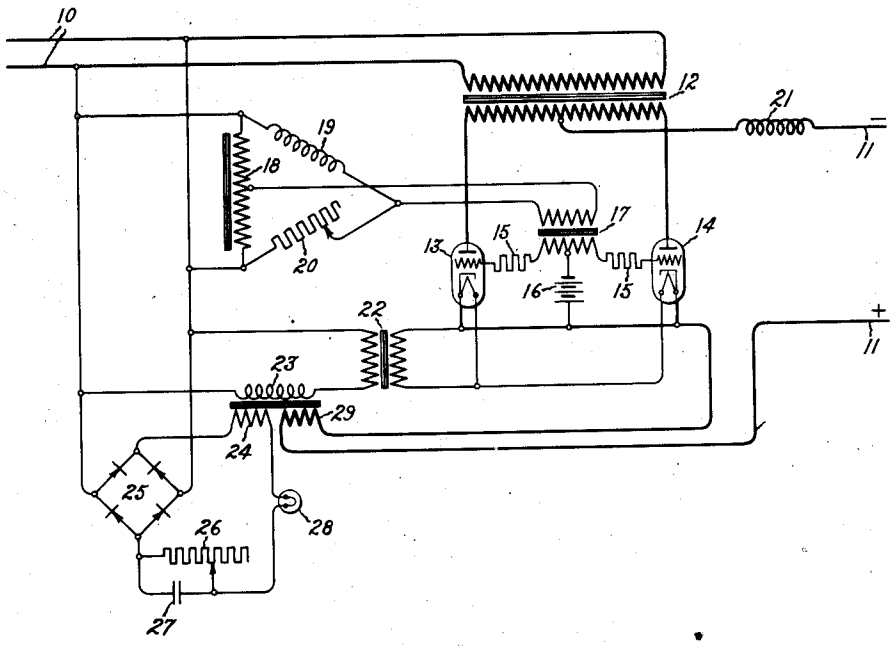
May 14, 1935. B. A. CASE 2,001,567

ELECTRIC VALVE TRANSLATING CIRCUIT

Filed Dec. 22, 1933



Inventor:
Byron A. Case,
by Harry E. Dunham
His Attorney.

Patented May 14, 1935

2,001,567

UNITED STATES PATENT OFFICE

2,001,567

ELECTRIC VALVE TRANSLATING CIRCUIT

Byron A. Case, Fort Wayne, Ind., assignor to General Electric Company, a corporation of New York

Application December 22, 1933, Serial No. 703,565

3 Claims. (Cl. 175—363)

My invention relates to electric valve translating circuits and more particularly to such circuits utilizing valves of the thermionic cathode type.

Electric discharge devices, or valves, of the thermionic cathode type, either directly or indirectly heated, have come to be used extensively in many electric translating circuits for the control, transmission, or conversion of electrical energy. In many of these circuits, the life of the electric valve becomes an important consideration. It has been found that the life of such electric valves may be materially lengthened if their thermionic cathodes are operated at a substantially constant temperature which is just sufficient to provide adequate electron emission for the ordinary operating conditions of the device. However, it is well known that an increase in the load current carried by a thermionic cathode electron discharge device is effective to increase the temperature of the cathode, and this is true whether the cathode is of the directly or the indirectly heated type, although the phenomena which give rise to this increase in temperature are different in the two cases.

It is an object of my invention therefore to provide an improved electric valve translating circuit, including an electric valve of the thermionic cathode type, in which the temperature of the cathode of the valve will be maintained substantially constant irrespective of the operating conditions of the system of which it is a part.

It is another object of my invention to provide an improved electric translating system including an electric valve of the thermionic cathode type in which the energization of the thermionic cathode is decreased in accordance with increases in the load current of the system.

In accordance with one embodiment of my invention, the thermionic cathode of an electric discharge device included in an electric translating circuit is energized from a source of alternating current through a saturable reactor. The reactor is provided with a saturating winding which is constantly energized with a unidirectional current, as for example, by means of an auxiliary rectifying device operating from the source of alternating current. The saturable reactor is also provided with an auxiliary saturating winding which operates differentially with respect to the first saturating winding and is energized in accordance with the load current transmitted by the system. With such an arrangement, an increase in load on the system tends to desaturate the reactor and thus increase its impedance, which, in turn, is effective to decrease the energization of the thermionic cathode of the electric valve. This decrease in the energization of the thermionic cathode with increases in load current of the system tends to compensate for the heating effect of the increased load current of the system and thus maintain the temperature of the cathode substantially constant.

For a better understanding of my invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims. The single figure of the drawing is a schematic representation of my invention as applied to the control of the cathode heating of an electric discharge valve rectifier.

Referring now more particularly to the drawing, there is illustrated an electric valve translating system for transmitting energy from a single phase alternating current supply circuit 10 to a direct current load circuit 11. This system includes a transformer 12 having a primary winding connected to the system 10 and a secondary winding provided with an electrical midpoint connected to one side of the circuit 11 and with end terminals connected to the other side of the circuit 11 through electric valves 13 and 14 connected in a conventional manner to secure full wave rectification. The electric valves 13 and 14 are each provided with an anode and a thermionic cathode which may be of either the indirectly heated type, as illustrated, or the directly heated type. Electric valves 13 and 14 may also be provided with control electrodes, in case it is desired to control the energy transmitted in the system. In this case, the control electrodes are connected to the common cathode circuit through current limiting resistors 15, a bias battery 16 and the secondary winding of a control transformer 17. The primary winding of the transformer 17 may be energized from the alternating current circuit 10 through any suitable phase shifting arrangement such as an impedance phase shifting circuit comprising a midtapped inductive winding 18, a reactor 19, and a variable resistor 20, the primary winding of the transformer 17 being connected between the midpoint of the winding 18 and the junction between the reactor 19 and resistor 20 in a well known manner. If desired, a smoothing reactor 21 may be

included in the direct current circuit of the system.

The heaters of the thermionic cathodes of the electric valves 13 and 14 are connected to be energized from the circuit 10 through a transformer 22, in series with the primary winding of which is connected a saturable reactor 23. The reactor 23 is provided with a saturating winding 24 connected to be energized from any suitable source of unidirectional current substantially constant in magnitude, as for example, from a contact rectifier bridge 25 energized from the circuit 10. If desired, a current adjusting resistor 26 and filtering capacitor 27 may be included in the energizing circuit of the saturating winding 24, and in some cases it may be desirable to include a ballast lamp 28, such as an iron wire filament in a hydrogen atmosphere, or some other well known constant current device, to compensate for the effect of variations in the supply voltage on the saturation of the reactor 23. The reactor 23 is also provided with a saturating winding 29, which acts differentially with respect to the saturating winding 24 and is connected in series with the unidirectional current circuit 11 of the system.

The general principles of operation of the above described rectifying apparatus per se is well understood by those skilled in the art, and need not be explained in detail. Electric valves 13 and 14 conduct alternately and the average energization of the load circuit 11 may be controlled by varying the resistor 20 which is effective to vary the phase of the alternating potentials impressed upon the control electrodes of the valves 13 and 14 and thus to vary the portions of the cycles of alternating potential during which these valves are conductive, as is well understood by those skilled in the art.

As stated above, variations in the load current of the system, as effected by the above described operation or by variations in the connected load on the system, are effective to vary the temperature of the cathodes of the electric valves 13 and 14, increases in load current tending to increase the temperature of the cathodes. The above described circuit, however, compensates for this tendency of the cathode to increase in temperature with increase in load current. For example, consider the operation of the system under a very light load when the energization of the saturating winding 29 in series with the load circuit 11 is very small. Under these conditions, the energization of the saturating winding 24 through the rectifier bridge 25 is effective to saturate substantially the reactor 23 and reduce its reactance to a minimum, thus energizing the transformer 22 to a maximum and heating the cathodes of the electric valves 13 and 14 to a proper operating temperature to secure adequate electron emission for ordinary operating conditions of the system. In case the load current of the system increases, the energization of the saturating winding 29 will similarly increase, which, acting differentially with respect to the saturating winding 24 tends to desaturate the reactor 23 and to increase its impedance. Obviously, an increase in the impedance of the reactor 23 is effective to decrease the energization of the transformer 22, and the cathode heaters of the electric valves 13 and 14, to compensate for the effect of the increased load current on the cathode temperatures. In this manner the temperature of the cathodes of the electric valves 13 and 14 may be maintained substantially constant or may be made to increase only very slightly with increases in load current on the system, in accordance with the requirements of the particular apparatus. Obviously, adjusting the resistance 26 in series with the main saturating winding 24 will vary the temperature regulation characteristics of the cathodes of the electric valves 13 and 14, and, as stated above, the ballast lamp 28 will tend to maintain the energization of the saturating winding 24 substantially constant irrespective of variations of the supply voltage.

While I have described what I at present consider the preferred embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention, and I therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric translating system including a source of alternating current and an electric valve provided with a thermionic cathode, a circuit for energizing said cathode from said source including a saturable reactor, means for normally constantly saturating said reactor, and means responsive to an electrical condition of said system for modifying the saturation of said reactor to regulate the heating of said cathode.

2. An electric translating system including a source of alternating current and an electric valve provided with a thermionic cathode, a circuit for energizing said cathode from said source including a saturable reactor, a constantly energized saturating winding for said reactor, and means responsive to the load current of the system for saturating said reactor differentially with respect to said saturating winding.

3. An electric translating system including a source of alternating current and an electric valve provided with a thermionic cathode, a circuit for energizing said cathode from said source including a reactor provided with a saturating winding, rectifier means connected to substantially constantly energize said saturating winding from said source, and an auxiliary saturating winding for said reactor connected to act differentially with respect to said first mentioned winding and energized in accordance with the load current of the system.

BYRON A. CASE.