Jan. 10, 1956 K. W. HESS 2,730,659

RECTIFYING APPARATUS

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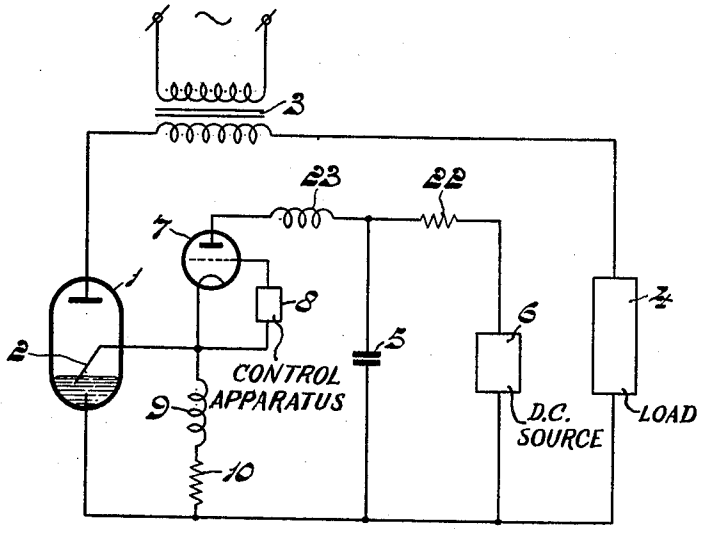

Fig. 1

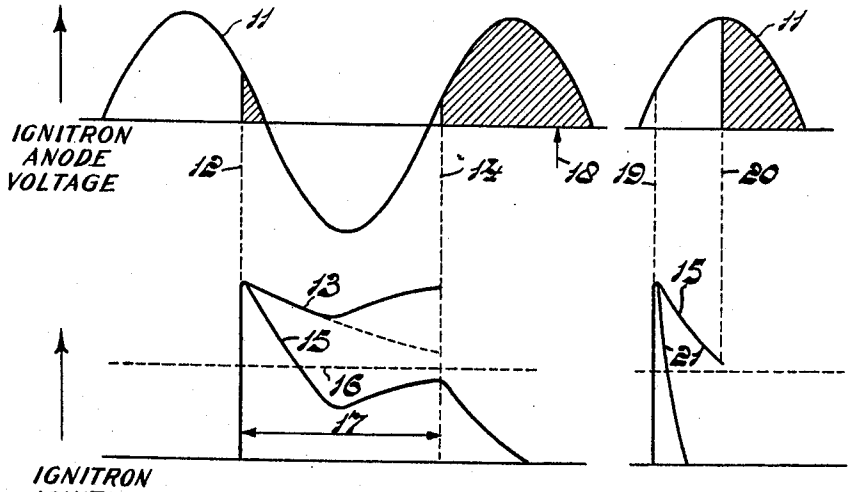

Fig. 2

Fig. 3

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RECTIFYING APPARATUS

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5 Claims. (Cl. 315—168)

This invention relates to an electrical apparatus for rectifying an alternating voltage, more particularly to an electrical apparatus for rectifying an alternating voltage of the type utilizing an ignitron tube.

Electrical apparatus of the foregoing type generally comprise an ignition-voltage source for supplying ignition pulses having a steep wave-front and a duration in excess of 100 microseconds to the ignition electrode of the ignitron.

In such apparatus, in the event that ignition does not take place at the desired moment, that is to say substantially at the moment at which the steep-wave front pulse is supplied to the ignition electrode or within a period of 100 microseconds thereafter, the high ignition voltage may decrease comparatively slowly due to the high resistance of the ignition electrode and the electrode will be gradually heated by the passage of current. This results in the conditions for ignition becoming more favourable, consequently, ignition may take place in the subsequent positive half wave of the anode voltage if the ignition voltage still has a sufficiently high value. This is more particularly disadvantageous if the desired moment of ignition is chosen at the descending portion of the positive half wave of the anode voltage where a relatively small current is required for the load. In such a case, the tube may ignite at the ascending portion of the subsequent positive half wave, so that a considerably greater, unwanted current pulse is suddenly transmitted to the load with detrimental effects.

According to the invention, an impedance is connected in parallel with the ignition electrode and the cathode of the ignitron tube, which impedance, when an igniting pulse is supplied to the igniting electrode, has a value at which, if there is no ignition at the desired moment, the igniting voltage within a period from the desired moment of ignition to the beginning of the subsequent positive half wave of the anode voltage will decrease to a value such that ignition by this pulse cannot take place in this subsequent half wave.

When the desired moment of ignition is chosen at the ascending portion of the positive half wave, it is also possible that ignition, instead of at this moment, takes place at a later moment in the same half wave, for example, in the vicinity of the peak of the half wave, since the value of the ignition voltage after this short period due to leakage by way of the said impedance has not decreased sufficiently to prevent ignition at this moment. However, according to a further feature of the invention, the value of the impedance is chosen to be such that the ignition voltage from the desired moment of ignition has decreased to the value at which ignition cannot take place in the same half wave within a period of 200 microseconds. In this case, a retarded ignition in the same half wave will in practice no longer occur, more particularly, if the duration of this period is fixed at 100 microseconds.

The impedance is preferably constituted by the series combination of an inductance and a resistor.

The invention will now be described with reference to the accompanying drawing in which:

Fig. 1 shows an apparatus according to the invention; and

Figs. 2 and 3 illustrate the operation of the apparatus shown in Fig. 1.

In Fig. 1 an ignitron **1** having a resistance ignition electrode **2** is connected by way of an alternating voltage source **3** to a load **4**, which requires a determined amount of current. To provide this required current, the ignitron must be ignited at a predetermined moment in the positive half wave of the anode voltage. In Fig. 1, the igniting pulse for igniting the ignitron is provided by an ignition voltage source comprising a condenser **5**, which has preliminarily been charged, by way of a resistor **22**, from a direct current source of potential **6** and which is suddenly discharged at the desired moment through a small inductance **23**, a controlled auxiliary discharge tube **7** and the ignition electrode **2**. The conduction of tube **7** is controlled by means of a control apparatus **8** included in the grid circuit of the tube **7**. To explain the operation of such a circuit, which is frequently unsatisfactory, it is at first assumed that inductance **9** (air choke) and resistor **10**, connected in series therewith, are not provided.

In Fig. 2, the positive half wave of the anode voltage of the tube **1** is designated **11**. The desired moment of ignition lies at **12**, that is to say in the descending portion of the half wave. The tube **1** ignites at the moment **12** when the auxiliary tube **7** begins to conduct, causing the charged condenser to become connected to the ignition electrode **2**. If, now, ignition of the tube **1** does not take place, the voltage variation of the ignition electrode **2**, is, for example, as indicated by **13** in Fig. 2. The voltage slowly decreases since the tube **7** remains conducting and the high resistance of the electrode **2** allows the passage of a small current only. Subsequently, the voltage increases again, since the condenser **5** is recharged from the source **6** for the subsequent ignition at **18** in the subsequent positive half wave. Consequently, the temperature of the electrode increases and the conditions for ignition are improved, so that it is then possible for the ignition to take place at the moment **14**, for example, at the beginning of the subsequent positive half wave instead of at **18**. Consequently, a much stronger current pulse will be transmitted to the load **4**. It is also possible that, due to the current passing through the ignition electrode **2**, a cathode spot is formed on the cathode even during the negative half wave before the moment **14**, with the result that the high resistance at the ignition electrode **2** is decreased to such extent that a short-circuit occurs, so that the potential source **6** will also be short-circuited, which may cause this source and the auxiliary tube **7** to be damaged.

If, in accordance with the invention, a suitably chosen inductance **9** and resistor **10** are connected in parallel with the ignition electrode **2** and the cathode of the ignitron, the voltage variation at the electrode **2** becomes, for example, as indicated by **15** in Fig. 2. Assuming the minimum voltage necessary for ignition to be represented by the dotted line **16**, values for the inductance **9** and the resistance **10** are chosen such that the voltage **15** becomes smaller than the voltage **16** within the period **17**. Consequently, it is assured that ignition will take place at **18** instead of at **14**.

Fig. 3 illustrates the principle of the invention when it is desired to ignite the tube at the ascending portion of the half wave of the anode **1** voltage. In Fig. 3, with the same voltage variation of the line **15** at a desired moment of ignition **19** in the half wave **11**, in case of non-ignition at this moment, there is still a possibility

of ignition taking place, for example, at the moment **20**, so that the desired current strength is unduly small. To avoid this result, the values of the inductance **9** and of the resistor **10** are chosen to be so low that the voltage variation at the ignition electrode **2** becomes as indicated by **21** within a period of about 200 microseconds.

In a device constructed in practice, the capacity of the condenser **5** was about 10 μf. at a charging voltage between 300 and 500 volts. The inductance **23** was about 1 mh., the inductance **9** about 15 mh. and the resistor **10** was 25 ohms.

While I have thus described my invention with specific examples and embodiments thereof, other modifications will be readily apparent to those skilled in the art without departing from the spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. An apparatus for rectifying an alternating voltage comprising an ignitron having a cathode, an anode and a resistance ignition electrode, means to apply said alternating voltage to said anode relative to said cathode; and an ignition circuit for said ignitron including an ignition voltage source, means to apply the voltage from said source to said ignition electrode as an ignition pulse having a steep wave front and having a duration exceeding 100 microseconds, and an impedance connected between said electrode and said cathode, said impedance having a value at which upon failure of the ignitron to ignite at a predetermined instant following the application of said ignition voltage, said ignition voltage at said electrode is diminished to a level below that at which said ignitron can be subsequently ignited by said pulse.

2. An apparatus for rectifying an alternating voltage comprising an ignitron having a cathode, an anode and a resistance ignition electrode, means to apply said alternating voltage to said anode relative to said cathode; and an ignition circuit for said ignitron including an ignition voltage source, said ignition voltage source comprising a capacitor, a direct current source of potential, means to apply said source of potential across said capacitor to charge it to a given voltage, switching means constituted by a controllable discharge tube for connecting said charged capacitor across said cathode and said ignition electrode to provide an ignition pulse having a steep wave front and having a duration exceeding 100 microseconds, and an impedance connected between said electrode and said cathode, said impedance having a value at which upon failure of the ignitron to ignite at a predetermined instant following the application of said ignition voltage, said ignition voltage at said electrode is diminished to a level below that at which said ignitron can be subsequently ignited.

3. An apparatus for rectifying an alternating voltage comprising an ignitron having a cathode, an anode and a resistance ignition electrode, means to apply said alternating voltage to said anode relative to said cathode; and an ignition circuit for said ignitron including an ignition voltage source, means to apply the voltage from said source to said ignition electrode as an ignition pulse having a steep wave front and having a duration exceeding 100 microseconds, and an impedance connected between said electrode and said cathode, said impedance having a value at which upon failure of the ignitron to ignite at a predetermined instant following the application of said ignition voltage, said ignition voltage at said electrode is diminished to a level below that at which said ignitron can be subsequently ignited by said pulse within a period less than 200 microseconds.

4. An apparatus for rectifying an alternating voltage comprising an ignitron having a cathode, an anode and a resistance ignition electrode, means to apply said alternating voltage to said anode relative to said cathode; and an ignition circuit for said ignitron including an ignition voltage source, means to apply the voltage from said source to said ignition electrode as an ignition pulse having a steep wave front and having a duration exceeding 200 microseconds, and an impedance connected between said electrode and said cathode, said impedance having a value at which upon failure of the ignitron to ignite at a predetermined instant following the application of said ignition voltage, said ignition voltage at said electrode is diminished to a level below that at which said ignitron can be subsequently ignited by said pulse within a period of about 100 microseconds.

5. An apparatus for rectifying an alternating voltage comprising an ignitron having a cathode, an anode and a resistance ignition electrode, means to apply said alternating voltage to said anode relative to said cathode; and an ignition circuit for said ignitron including an ignition voltage source, means to apply the voltage from said source to said ignition electrode as an ignition pulse having a steep wave front and having a duration exceeding 100 microseconds, and an impedance connected between said electrode and said cathode, said impedance being constituted by an inductance and a resistance connected in series and having values at which upon failure of the ignitron to ignite at a predetermined instant following the application of said ignition voltage, said ignition voltage at said electrode is diminished to a level below that at which said ignitron can be subsequently ignited by said pulse.

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