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ARRANGEMENT FOR CONTROLLING A.C. CIRCUITS

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Fig. 1

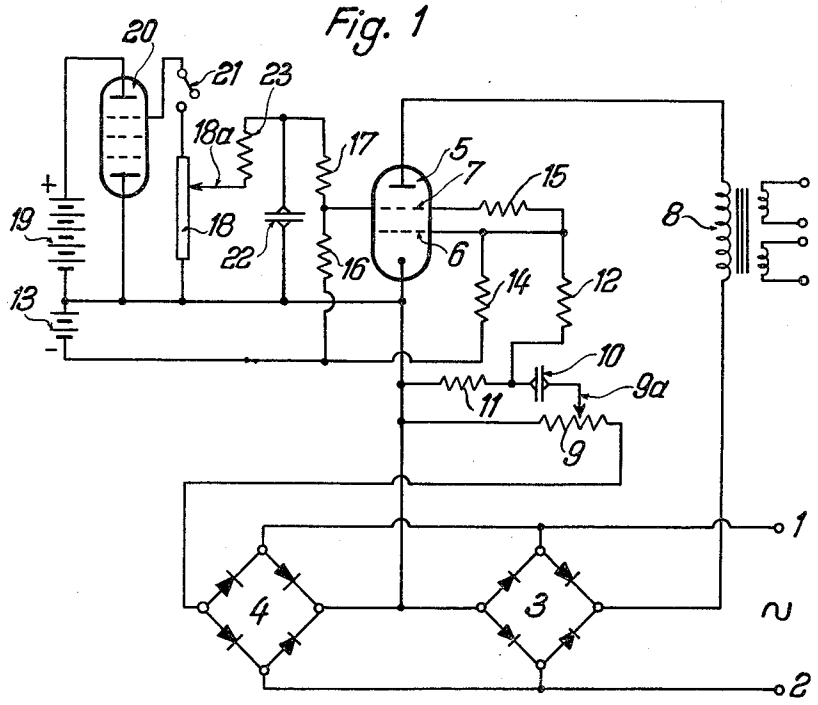
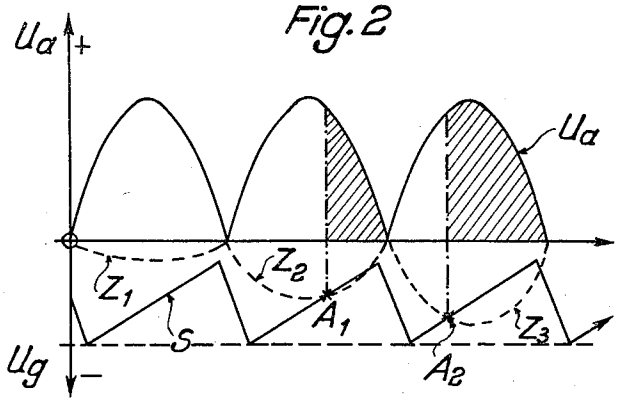


Fig. 2



Inventor:
Erwin Berweger
by: Michael S. Striker
Attorney

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ARRANGEMENT FOR CONTROLLING A.C. CIRCUITS

Erwin Berweger, Dietikon, Zurich, Switzerland, assignor to H. A. Schlatter Aktiengesellschaft, Zollikon, Zurich, Switzerland

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The present invention refers to arrangements for controlling A.C. circuits, and more specifically to arrangements of this type including a gas-filled glow-discharge tube as a means of control.

Conventionally, A.C. circuits are controlled by means of gas-filled glow-discharge tubes in accordance to a method which may be called "ignition point shift control" and in which the controlling factor influences the phase at which the anode current is caused to start due to ignition of the gas discharge. If in the application of this method the form of the A.C. voltage curve is considered and the location of the point or moment of ignition along this curve is taken into consideration, the current in the particular tube will continue to flow after the moment of ignition, within each particular cycle, up to the moment when the said curve passes the next time through the zero line. The ignition of the tube is effected by the igniting grid thereof, which is usually supplied with an A.C. potential; along the above-mentioned A.C. curve the point of ignition can be shifted either by vary ing the amplitude of the A.C. voltage, or by varying the phase difference existing between the above-mentioned control A.C. voltage and the anode A.C. voltage. Frequently the control A.C. potential is introduced in form of a sawtooth A.C. potential which pulsates at the same frequency as the anode voltage so that in the diagram very clear intersections between, on the one hand, the curve indicating the ignition potentials, and on the other hand, the control A.C. potential are obtained.

It is a main object of the present invention to provide for an arrangement for controlling A.C. circuits by means of a gas-filled glow-discharge tube the arrangement being particularly simple and efficient, resulting in a very reliable performance.

It is another object of the present invention to provide an arrangement as set forth which is in addition capable to compensate to a very substantial degree the effects of fluctuations of the line voltage on the controlled circuit.

It is still another object of this invention to provide a control arrangement which is particularly suitable for controlling electrical welding machinery because this arrangement would permit obtaining a gradual increase and decrease of the controlled current (slope control).

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a diagram of an arrangement constituting one embodiment of the invention; and

FIG. 2 is a diagram to illustrate the performance of the arrangement and in particular the relation of the various potentials utilized in this arrangement.

The embodiment illustrated by FIG. 1 represents an arrangement which has been proven particularly advantageous for generating the ignition impulses for the ignitrons of an electronically controlled electric welding apparatus, some of the details of the shown circuits being specifically designed for the above-mentioned particular application thereof.

The A.C. line voltage is introduced into this arrangement at the terminals **1**, **2** and from there to two full-wave rectifiers **3**, **4**, respectively, of which the first one, marked **3**, is intended to furnish a pulsating anode voltage to the cold cathode glow-discharge tube **5**. The particular tube **5** is equipped with two grids **6** and **7**. Connected in its anode circuit is a transformer **8** which may be used for transmitting the ignition impulses originating in the tube, either directly or through interposed thyratrons to two ignitrons of the electric welding apparatus connected therewith.

The second rectifier **4** feeds the potentiometer **9** with a pulsating D.C. voltage which is modified by the impedance circuit **10**, **11** and is thereby converted into a sawtooth pulsating potential which pulsates in synchronism with the anode voltage of the tube **5**. It is advisable to make the time factor of the impedance circuit portion **10**, **11** approximately $\frac{1}{15}$ of a half cycle of the line voltage. The sawtooth voltage is transmitted to the igniting grid **6** by way of the resistor **12**.

The igniting grid obtains a negative bias potential from the battery **13** by way of the resistor **14**. A part of the sawtooth voltage acting on the igniting grid **6** is simultaneously transmitted to the control grid **7** through the resistor **15**. The control grid **7** is connected to a point between the resistors **16** and **17** which are in circuit with the tap **18***a* of a potentiometer **18**, across which a stabilizer tube **20**, fed by a battery **19**, produces a constant voltage drop as soon as the switch or contact **21** is closed.

The operation of the above arrangement is as follows: The rectifier **3** produces in the anode circuit of the glow-discharge tube **5** a pulsating potential which is illustrated in FIG. 2 by the voltage curve U*a*; in its application to the transformer **8** this pulsating voltage is tantamount to an A.C. voltage of a frequency twice that of the line A.C. voltage, and this voltage is applied to the above-mentioned thyratrons or ignitrons which are connected to the secondary windings of the transformer **8**. A pulsating voltage of a similar curve shape is produced by the rectifier **4** at the potentiometer **9**. This last-mentioned pulsating potential is converted in a manner known per se, by the impedance circuit portion **10**, **11** into a pulsating voltage having a sawtooth wave form which pulsates at the same frequency as the anode voltage U*a* and appears at the igniting grid **6** as a pulsating voltage of the shape indicated in the diagram of FIG. 2 by the curve S. This sawtooth voltage is applied to the igniting grid **6** through the resistor **12** and appears at the same time at the control grid **7** via the second resistor **15**. As long as the switch **21** is in open position however, the two grids **6** and **7** are subject to so strong a negative bias potential fed by the resistors **14** and **16** that the tube **5** cannot ignite.

However as soon as the contact **21** is closed a positive bias potential appears at the tap **18***a* of the potentiometer **18** which bias potential is transmitted through the resistor **17** to the control grid **7**. The diagram of FIG. 2 contains curves Z in dotted lines. These curves indicate the threshold value of the igniting potentials for the igniting grid **6** in such a manner that whenever this particular threshold value is exceeded in positive direction, ignition takes place. However, if and when the potential of the control electrode **7** is caused to rise in positive direction then the values or ordinates of the ignition curve Z are shifted in negative direction. In this manner the ignition curve may change from the shape Z_1 to the shape of Z_2; in this case the curve Z_2 is intersected by the sawtooth curve S in the intersection point A_1, so that the tube **5** will ignite at the phase indicated by the point A_1 and an igniting impulse is produced in the two secondary windings of the transformer **8**. This impulse will then ignite

that one of the two thyratrons or ignitrons connected therewith, which during the particular half cycle permits the passage of the current.

Since the shape of the ignition curve Z depends upon the bias potential of the grid **7**, the shape of this curve can be modified and, when the switch **21** is closed, change from the form or shape Z_1 to the shape Z_2 and from this one to the shape Z_3, simply by moving the tap **18***a* of the potentiometer **18** in the direction towards the switch **21**. By doing so logically the location of the intersection point A_1 is shifted to A_2, so that the phase at which ignition takes place is shifted in forward direction so as to occur earlier while the positive bias potential on the grid **7** is increased.

If a condenser **22** and a resistor **23**, as indicated in FIG. 1 with dotted lines, is interposed between the potentiometer tap **18***a* and the control grid **7**, then the potential at the control grid **7** will be caused to increase only with some delay after the switch **21** has been closed. Consequently the change of shape of the igniting curve of FIG. 2 from the shape Z_1 to say the shape Z_3 takes place only gradually and also the location of the intersection point A in this case shifts gradually in steps amounting to smaller phase angle differences. The same occurs in reverse form in sequence when the switch **21** is opened. Since therefore in this manner a correspondingly slow increase or decrease of the welding current controlled by the above-described arrangement is obtained, the very simple arrangement described permits a so-called "slope control" of the welding equipment. The time factor of the impedance circuit portions **22**, **23** must of course exceed the duration of the half cycle of the anode voltage furnished from the line at the terminals **1**, **2**, by a multiple thereof and should amount to at least three times said half cycle. It can be seen that the amplitude of the sawtooth curve S can be adjusted by moving the potentiometer tap **9***a*, while the adjustment of the control of the output can be achieved exclusively by the movement of the potentiometer tap **18***a*. Consequently the entire operation of the whole arrangement can be controlled by two control buttons acting on the potentiometers **9** and **18**, respectively.

A particular advantage in the application of the present invention to electrical welding equipment consists in the fact that it is even capable of compensating to a very substantial degree the effects of fluctuations of the line voltage on the welding circuit. Since the positive bias potential for the grid **7** is stabilized, this bias will constitute an increasing fraction of the anode potential when the line voltage is decreasing. The intersection points A are therefore progressively advanced so as to occur earlier while the line voltage is decreasing or dropping, so that at the same time the control of the tube **5** results in an increased output which is responded to by the connected thyratrons or ignitrons. In fact, if the individual resistances are suitably selected it is possible to prevent to a great degree a dropping of the welding output otherwise caused by dropping of the line voltage.

The arrangement and circuit illustrated by FIG. 1 can be modified in various ways without leaving the framework of the present invention. For instance, in practice the batteries **13**, **19** will be replaced in most cases by other rectifiers which may be fed by separate windings of a transformer. The stabilizer tube **20** can be dispensed with if the just-described compensation for fluctuations of the line voltage is not required or desired. Besides, the stabilizing arrangement which was described above as being of electronic nature, could as well be replaced by a magnetic stabilizing system. Also, instead of the circuit elements **4**, **9**, **10**, **11** a different circuit of known nature may be used for creating at the igniting grid **6** the above-described sawtooth voltage S. Moreover, the transmission of this sawtooth pulsating potential to the control grid **7** is advisable but not absolutely necessary. It is however important that the frequency of the sawtooth potential is identical with that of the A.C. potential applied to the tube **5**. However there may be a phase shift between them. Finally, the tube **5** could also be equipped with a hot cathode and in this case be directly connected to the A.C. power supply so that the rectifier **3** can be dispensed with. Since the tube acts itself as a rectifier the only disadvantage in this case would be that only every second half cycle is subjected to the above-described controls and therefore the transformer **8** would be able to transmit the control only to a single thyratron or ignitron connected therewith.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of control arrangements for A.C. circuits differing from the types described above.

While the invention has been illustrated and described as embodied in control arrangements for A.C. circuits comprising a gas-filled glow-discharge tube, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Wtihout further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An arrangement for controlling alternating current circuits, particularly those of resistance-welding apparatus, comprising, in combination, a power supply furnishing a pulsating potential; a gas-filled glow-discharge tube operatively connected to said power supply and having an igniting grid and at least one separate control grid; means connected with said power supply and with said igniting grid for producing a negative sawtooth pulsating potential and for impressing said sawtooth potential on said igniting grid; a source of direct current connected to said control grid for imparting a positive bias potential to said control grid; means for varying said positive bias potential; and output means in circuit with said gas discharge tube, whereby the output of said arrangement can be controlled by varying said positive direct current potential.

2. An arangement for controlling alternating current circuits, particularly those of resistance-welding apparatus, comprising, in combination, a power supply furnishing a pulsating potential; a gas-filled glow-discharge tube operatively connected to said power supply and having an igniting grid and at least one separate control grid; means connected with said power supply and with said igniting grid for producing a negative sawtooth pulsating potential and for impressing said sawtooth potential on said igniting grid; a source of direct current connected to said control grid for imparting a positive bias potential to said control grid; means for superimposing part of said sawtooth potential on said positive bias potential of said control grid; means for varying said positive bias potential; and output means in circuit with said gas discharge tube, whereby the output of said arrangement can be controlled by varying said positive direct current potential.

3. An arrangement for controlling alternating current circuits, particularly those of resistance-welding apparatus, comprising, in combination, a power supply furnishing a pulsating potential; a gas-filled glow-discharge tube operatively connected to said power supply and having an igniting grid and at least one separate control grid; full wave rectifier means connected in circuit with said power supply and with said gas discharge tube for furnishing to said tube a pulsating direct current potential having twice the frequency of said pulsating potential fur-

nished by said power supply; means connected with said power supply and with said igniting grid for producing a sawtooth pulsating potential and for impressing said sawtooth potential on said igniting grid; a source of direct current connected to said control grid for imparting a positive bias potential to said control grid; means for varying said positive bias potential; and output means in circuit with said gas discharge tube, whereby the output of said arrangement can be controlled by varying said positive direct current potential.

4. An arrangement for controlling alternating current circuits, particularly those of resistance-welding apparatus, comprising, in combination, a power supply furnishing a pulsating potential; a gas-filled glow-discharge tube operatively connected to said power supply and having an igniting grid and at least one separate control grid; means connected with said power supply and with said igniting grid for producing a negative sawtooth pulsating potential and for impressing said sawtooth potential on said igniting grid; a source of direct current connected to said control grid for imparting a positive bias potential to said control grid; said source of direct current including means for stabilizing said positive bias potential; means for varying said positive bias potential; and output means in circuit with said gas discharge tube, whereby the output of said arrangement can be controlled by varying said positive direct current potential.

5. An arrangement for controlling alternating current circuits, particularly those of resistance-welding apparatus, comprising, in combination, a power supply furnishing a pulsating potential; a gas-filled glow-discharge tube operatively connected to said power supply and having an igniting grid and at least one separate control grid; means connected with said power supply and with said igniting grid for producing a negative sawtooth pulsating potential and for impressing said sawtooth potential on said igniting grid; a source of direct current connected to said control grid for imparting a positive bias potential to said control grid, said source of direct current including an impedance circuit portion controlling said positive bias potential and having a time factor which is at least equal to three times a half-cycle of the anode potential of said tube; means for varying said positive

bias potential; and output means in circuit with said gas discharge tube, whereby the output of said arrangement can be controlled by varying said positive direct current potential.

6. An arrangement for controlling alternating current circuits, particularly those of resistance-welding apparatus, comprising, in combination, a power supply furnishing a pulsating potential; a gas-filled glow-discharge tube operatively connected to said power supply and having an igniting grid and at least one separate control grid; full wave rectifier means connected in circuit with said power supply and with said gas discharge tube for furnishing to said tube a pulsating direct current potential having twice the frequency of said pulsating potential furnished by said power supply; means connected with said power supply and with said igniting grid for producing a sawtooth pulsating potential and for impressing said sawtooth potential on said igniting grid; a source of direct current connected to said control grid for imparting a positive bias potential to said control grid, said source of direct current including means for stabilizing said positive bias potential, said source of direct current further including an impedance circuit portion controlling said positive bias potential and having a time factor which is at least equal to three times a half-cycle of the anode potential of said tube; means for superimposing part of said sawtooth potential on said positive bias potential of said control grid; means for varying said positive bias potential; and output means in circuit with said gas discharge tube, whereby the output of said arrangement can be controlled by varying said positive direct current potential.

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