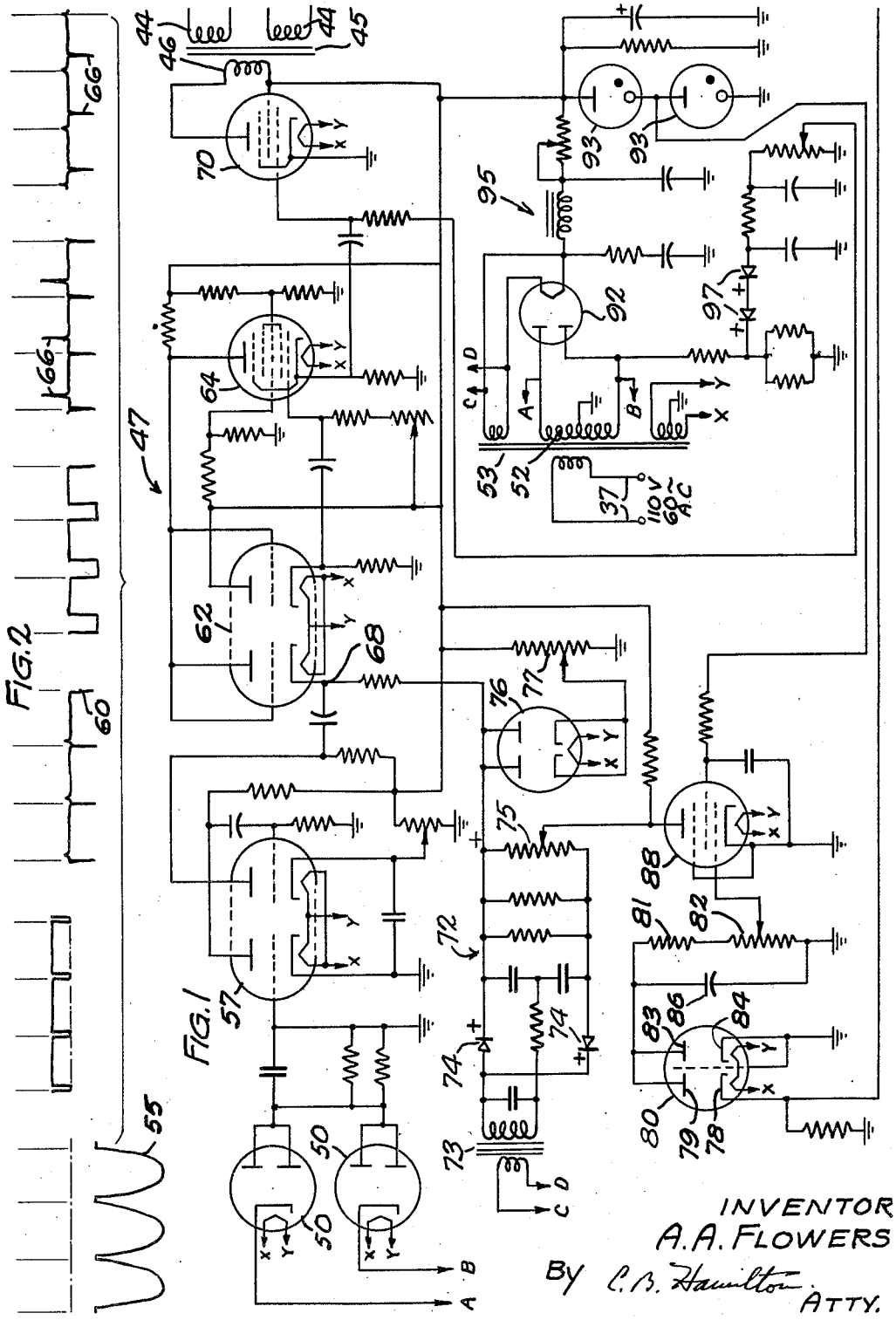
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SYSTEM FOR AUTOMATICALLY AGING A MAGNETRON AND SUPPRESSING ARCING THEREOF

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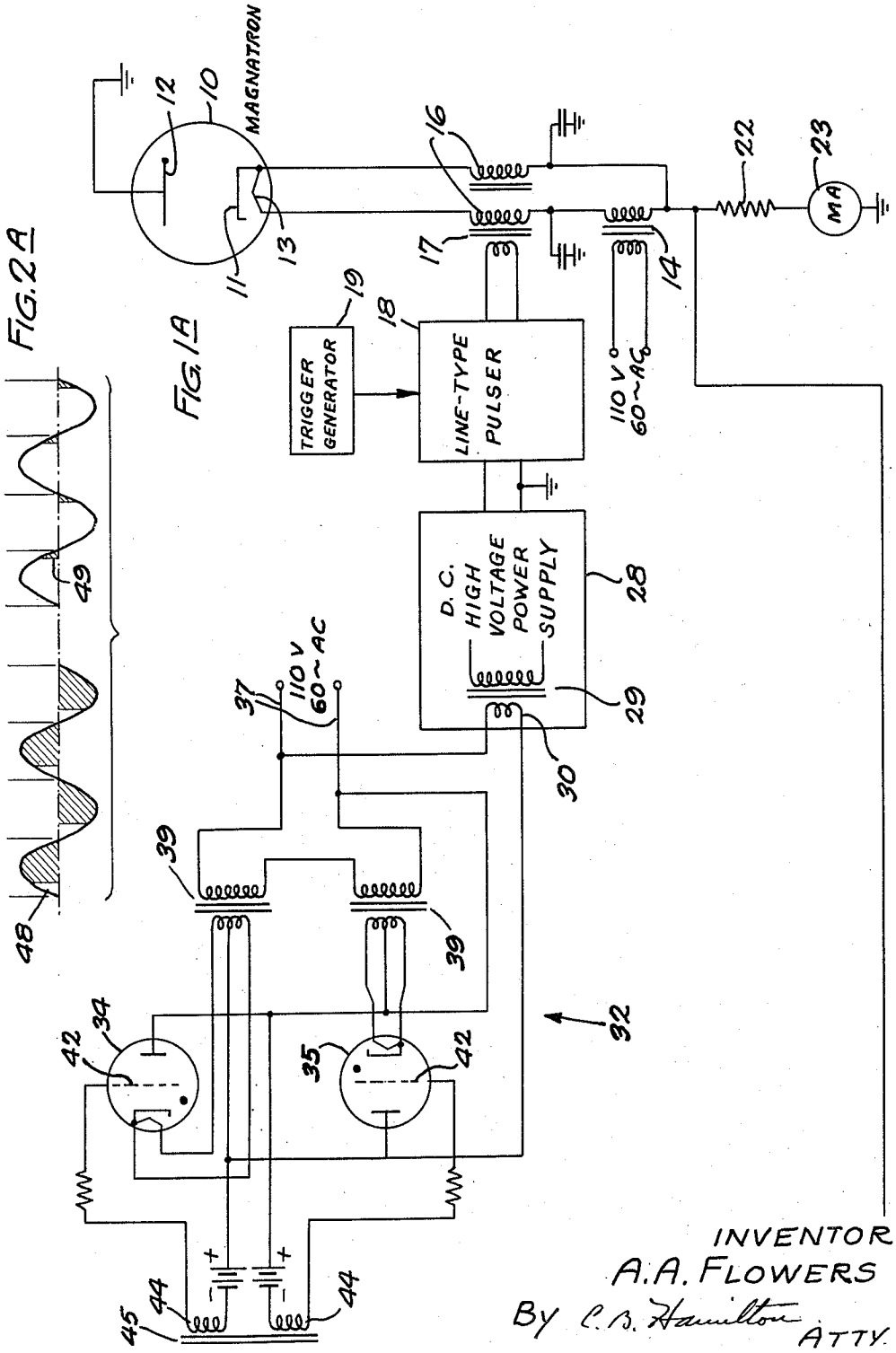


FIG. 2A

FIG. 1A

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SYSTEM FOR AUTOMATICALLY AGING A MAGNETRON AND SUPPRESSING ARCING THEREOF

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8 Claims. (Cl. 316—27)

This invention relates to an electronically controlled variable power supply for aging magnetrons and more particularly to a system for automatically aging a magnetron and suppressing the arcing thereof.

During the last stages of the evacuation of a magnetron, pulses of high voltage are applied thereto to age it. Arcing occurs in the magnetron at irregular intervals during the aging thereof and it is essential to cut off or reduce the high voltage pulses to the magnetron during arcing in order to avoid damage thereto.

An object of the invention is to provide a system for automatically aging a magnetron and suppressing the arcing thereof.

Another object of the invention is to provide an improved electronically controlled variable electrical power supply.

A system illustrating certain features of the invention for automatically aging a magnetron and suppressing arcing thereof may include a pair of thyratrons having their cathodes and plates connected to a source of alternating current and having their grids connected to a pulsing circuit capable of producing triggering pulses whose positions can be varied in each half cycle of the alternating current for firing the thyratron at controlled points for varying the length of the intervals during which the thyratrons conduct. The positioning of the triggering pulses is varied by the application of an adjustable control voltage to the pulsing circuit by a control device for determining the level of power output of the thyratrons by which power is applied to a magnetron pulsing device for aging the magnetron, and control means connected to the magnetron is adapted to apply an arcing signal to the control device for effecting an immediate reduction in the power output of the thyratrons and in the magnetron pulsing device for extinguishing the arc after which the power output of the thyratrons is automatically restored to its former level.

Other objects and advantages of the invention will become apparent by reference to the following detailed description and the accompanying drawings illustrating a preferred embodiment thereof, in which:

Figs. 1 and 1*a* comprise a circuit diagram of one embodiment of the invention; and

Figs. 2 and 2*a* show a series of the wave forms and pulses developed in various portions of the circuit.

Referring to the drawings, 10 represents a magnetron having a cathode 11 and an anode 12, the anode and outer case of which are grounded. A cathode heater 13 of the magnetron is heated by current from a transformer 14 connected to a suitable power line and the leads of the heater 13 are individually connected to a pair of secondaries 16 of a transformer 17, the primary of which is connected to a line type pulsing device 18 which cooperates with a trigger generator 19 for supplying power pulses of high voltage to the magnetron for aging it. A resistor 22 and a milli-ammeter 23 are connected to the magnetron cathode heater 13 in series with the secondaries of the transformers 14 and 17. The

pulsing device 18 is supplied with high voltage current from a D. C. high voltage power supply unit 28 which receives and rectifies a high voltage alternating current from a transformer 29, the primary 30 of which is connected to a variable power supply unit 32.

The power supply unit 32 comprises a pair of thyratrons 34 and 35 hooked back to back with the cathodes and the anodes thereof connected to the primary 30 and to a suitable source of alternating current such as a 110 volt 60-cycle A. C. power line 37 for applying pulses of electrical potential of alternately opposite polarity to the cathodes and anodes of the thyratrons at a rate of 120 alternations per second. The power line 37 also supplies power to a pair of heater transformers 39 for heating the cathodes of the thyratrons 34 and 35. The control grids 42 of the thyratrons are individually connected to the secondaries 44 of a transformer 45, the primary 46 of which is connected to a pulsing circuit 47 for supplying sharp pulses for triggering the thyratrons at various controlled points during the cycles and cause them to conduct alternately on alternate cycles.

The thyratron tubes 34 and 35 conduct over portions of each cycle as determined by the point at which the trigger pulses appear on the grids thereof. If the triggering pulses are delayed for a short period of time as indicated at 48 in Fig. 2*a*, the thyratrons conduct near the beginning of each cycle, thus passing a heavy current to the high voltage transformer 29, and if the triggering pulses are delayed for a long period of time as indicated at 49 in Fig. 2*a*, the thyratrons conduct near the end of each cycle, thus passing very little current to the transformer 29.

The pulsing circuit 47, which is made up of a plurality of well known pulse forming circuit components, comprises a pair of rectifying tubes 50—50 connected to the secondary 52 of a transformer 53, the primary of which is connected to the power line 37. The 60-cycle alternating current from the line 37 is rectified into unidirectional pulses 55 at 120 cycles per second which are modified by a two-stage voltage amplifier tube 57 to form the sharp pulses 60. The pulses 60 are applied to and trigger a Phantastron voltage-controlled time delay circuit including the vacuum tubes 62 and 64 and the networks associated therewith for further modifying the pulses to produce sharp triggering pulses 66. The Phantastron circuit is characterized by the fact that it operates to produce each of the sharp pulses 66 in each of the cycles in variable time delayed relation to the initiation of the cycle and that the time delay of the pulses are controlled and varied by the application and variation of positive voltage to the element 68 of the tube 62, at which point the pulses 60 are also applied. A high voltage at this point produces a long delay and a low voltage produces a short delay. The sharp triggering pulses 66 are applied to tube 70 which inverts them and applies them to the grids 42 of the thyratrons 34 and 35 through transformer 45.

A power level control unit 72 comprising a transformer 73, selenium rectifiers 74, a filter network associated therewith, and a power level control 75, is connected to the element 68 of the Phantastron circuit for applying various D. C. voltages thereto for varying the intervals of time delay of the triggering pulses and thereby controlling the output of the variable power supply unit 32. The power level control 75 may be set to apply a predetermined voltage to the pulsing circuit 47 to control the normal power output of the power supply 32 and the power input to the magnetron 10. A rectifying tube 76 acts as a "clamp" for limiting the maximum excursion of the voltage at element 68 to the approximate set value across part of potentiometr 77.

Means are provided for utilizing the current produced

by the arcing of the magnetron to apply additional voltage to the element 68 of the Phantastron circuit for increasing the interval of time delay of the triggering pulses 66 and effecting a reduction in the voltage level of the power pulses applied to the magnetron. The magnetron anode current flows through the resistor 22 and the milliammeter 23 in a downward direction and arcing current flows therethrough erratically in an upward direction whenever the tube arcs. This negative arcing signal is applied to and passes through diode elements 78 and 79 of a rectifying tube 80 and appears across resistors 81 and 82. The diode elements 83 and 84 of the tube 80 short out any normal anode current signal that might have gotten through elements 78 and 79.

The resistors 81 and 82 and a condenser 86 form a time constant network to provide a delayed or gradual recovery of the circuit after an arc occurs. The negative arcing signal is applied to the grid of a tube 88 which amplifies and inverts it to a positive signal which is then applied to the element 68 of the tube 62 in series with the voltage from the power supply 72. This momentary increase in control voltage applied to the element 68 of the Phantastron circuit as a result of arcing of the magnetron effects an immediate reduction in the output of the power unit 32 and a corresponding reduction of input power to the magnetron. After the arc has been extinguished the pulse delay of the Pantastron pulsing circuit returns to its former value which is determined by the setting of the power level control 75. The arcs vary in size and the control system is actuated thereby to produce a corresponding proportional variation in the level of the power input to the magnetron so that when a small arc occurs, a small reduction in the power level is effected to extinguish the arc, and when a large arc occurs, a large reduction is produced to suppress the arc.

The transformer 53 and tthe tubes 92, 93, and 94 and the network associated therewith constitute a high voltage supply 95 for supplying the required positive potentials for the control circuit, and the selenium rectifiers 97 and the network associated therewith constitute a negative bias supply which supplies bias for the tube 70.

From the above description of the invention it will be seen that an effective variable power supply unit is provided by the novel arrangement of thyratrons connected to an alternating current power line and to a pulsing circuit capable of producing triggering pulses whose positions can be varied in each half cycle of the alternating current by the application of an adjustable control voltage to the pulsing circuit by the power level control 75 for firing the thyratrons at controlled points to vary the length of the periods of conduction thereof.

It will also be seen that means are provided for utilizing the arcing signal as a control voltage and applying it to the pulsing circuit 47 to effect an immediate reduction in power output of the variable power supply unit 32 and in the power input to the magnetron. By this system a magnetron can be aged in at a desired power level with no damage resulting from arcing because the power level at which the magnetron is operating is reduced quickly and automatically whenever an arc occurs, and after the arc is extinguished the power level is automatically raised to its former level.

It is to be understood that the above-described arrangements are simply illustrative of the application of the principles of this invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. In a system for aging an electronic tube and suppressing arcing thereof the combination of a source of current, means for interrupting said source of current for predetermined controllable intervals at a regular predetermined frequency to vary the power output thereof, control means including a voltage-controlled time-delay pulsing circuit for varying the length of said intervals to control said power output, means for intermittently applying said power output to the tube being aged to render said tube conductive, means connected to the pulsing circuit and to the tube to send an arcing signal to said pulsing circuit when arcing occurs in the tube to reduce the power thereto for suppressing the arc, and means for blocking to the control means signals in said last-mentioned means due to the intermittent application of power to said tube.

2. In a system for aging an electronic tube and suppressing arcing thereof the combination of a source of current, means for interrupting said source of current for predetermined controllable intervals at a regular predetermined frequency to vary the power output thereof, control means including a voltage-controlled time-delay pulsing circuit for varying the length of said intervals to control the level of said power output, means for applying said power output to the tube being aged to render said tube conductive, means connected to the pulsing circuit and to the tube for selectively applying to said pulsing circuit only the signals developed when arcing occurs in the tube while the tube is conductive to reduce the power level for suppressing the arc, and a network in said last-named means for effecting a gradual return of the power output to said normal level after an arc is suppressed.

3. A system for aging an electronic tube and for suppressing arcing therein comprising a source of current, voltage responsive means for controlling and adjusting the power output thereof, means for intermittently applying said power output to the tube being aged to render it conductive, and means interconnecting the tube and the control means for applying to said control means the arcing signal of said tube when arcing occurs therein to reduce the power to the tube for suppressing the arc and for blocking to said control means signals due to intermittent application of power to said tube.

4. A system for aging an electronic tube and for suppressing arcing therein comprising a source of current, voltage controlled means for interrupting said current at regular intervals for predetermined periods of time to control the level of power output thereof, means for applying said power output intermittently to the tube being aged to render it conductive, means interconnecting the tube and the control means for applying to said control means the arcing signal of said tube when arcing occurs therein to reduce the power to the tube for suppressing the arc, means for blocking to said control means signals in said last-named means due to the intermittent application of power to the tube, and means for effecting a gradual return of the power output to its former level after an arc is suppressed.

5. A system for automatically aging a magnetron and suppressing the arcing thereof comprising a source of alternating current, thyratron means connected to said source of alternating current, voltage controlled adjustable pulsing means for triggering said thyratron, means for selectively applying voltages of various magnitudes to said pulsing means to adjust the power output of said thyratron means, a device connected to said thyratron means for applying electrical pulses to the magnetron to render it conductive, an element connected to said magnetron for developing voltages therein in response to the application of electrical pulses to the magnetron in response to arcing thereof, circuit means connected to said element and to said pulsing means for applying to said pulsing means the voltages developed in said element due to arcing to effect a reduction in the power output of said thyratron means, and means in said circuit means for blocking to the pulsing means the voltages developed in said element due to the application of pulses to the magnetron.

6. In a system for aging a magnetron and suppressing

arcing thereof, a device for applying electrical pulses to the magnetron to render it intermittently conductive, a variable power supply for said pulsing device having a voltage responsive control for adjusting the power level thereof, circuit means interconnecting the magnetron and the control for impressing an arcing signal of the magnetron onto said control to lower the power level of the power supply, and means for blocking to said control any signal in said circuit means due to the pulses applied to the magnetron.

7. In a system for aging a magnetron and suppressing arcing thereof, a device for applying electrical pulses to the magnetron to render it intermittently conductive, a variable power supply for said pulsing device having a voltage responsive control for adjusting the power level thereof, means for selectively applying voltages of various magnitudes to the voltage responsive control of said power supply to vary the power level thereof, and means interconnecting the magnetron and the voltage responsive control for selectively applying to said control only signals due to arcing of the magnetron when the magnetron is conductive for lowering the power level of the power supply.

8. In a system for aging a magnetron and suppressing arcing thereof, a device for applying electrical pulses to

the magnetron; a variable power supply for said device comprising a source of alternating current, a pair of thyratrons connected back to back, a transformer having a primary connected in series with said thyratrons to said source of alternating current, and a voltage-controlled adjustable pulsing means for triggering the thyratrons to render them conductive; selectively operable means for applying voltages of various magnitudes to the voltage controlled adjustable pulsing means to vary the power level of the power supply; means interconnecting the magnetron and the voltage controlled adjustable pulsing means for impressing arcing signals of the magnetron onto the pulsing means for reducing the power level of the power supply; and means for blocking to the pulsing means any signals in said last-named means due to the pulses applied to the magnetron.

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