March 31, 1970 F. A. YARGER 3,503,403

POWER SUPPLY

Filed April 27, 1967

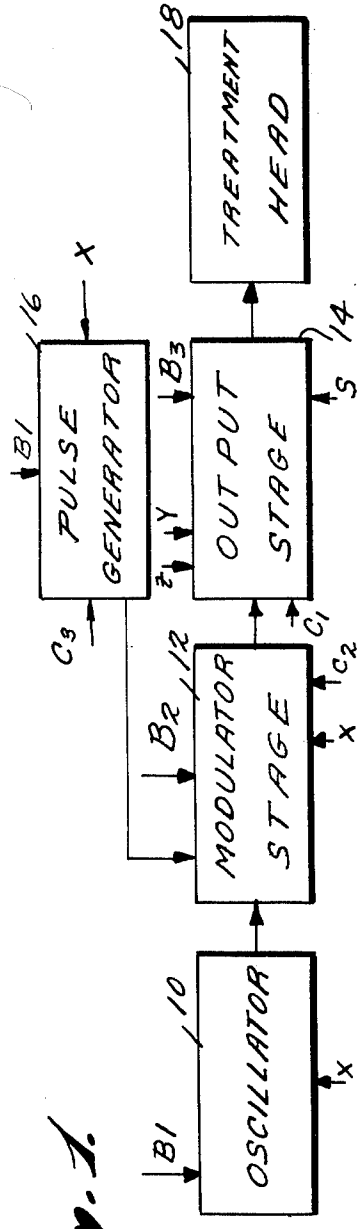


Fig. 1.

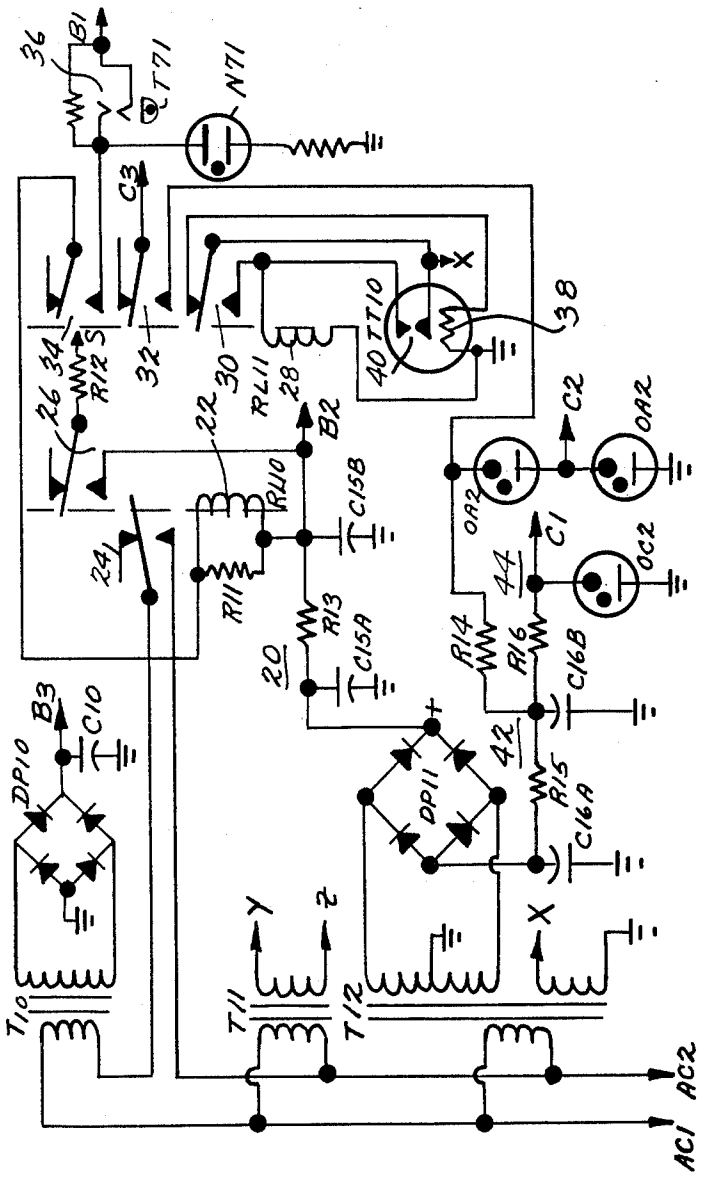


Fig. 2.

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United States Patent Office 3,503,403
Patented Mar. 31, 1970



3,503,403

# POWER SUPPLY

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Filed Apr. 27, 1967, Ser. No. 634,354
Int. Cl. A61n 1/00
U.S. Cl. 128—421 6 Claims

## ABSTRACT OF THE DISCLOSURE

Power supply for pulse generators used in electrotherapeutic apparatus. A timer delay tube provides a 90-second interval which must elapse before bias voltages are applied to the output stage of the pulsed radio frequency generator. The timer delay tube is energized in such a way that, if momentary shorting of its contacts should occur, it will immediately cause a relay to be activated while at the same time cause itself to be de-energized, thereby preventing any possible damage to the output tubes due to successive momentary closure of the contacts of the timer delay tube. Upon energization of the relay controlled by the timer delay tube, bias voltage is applied to the output stage and thus the equipment becomes operative but only after the filaments of the output stage tubes have been heated over the 90-second time interval mentioned above.

This invention relates to an improved power supply and, in particular, a power supply for electrotherapeutic apparatus wherein provision is made for heating the filaments of the tubes of the final stages of the pulse generating equipment for a predetermined interval of time before applying biasing voltages to these tubes and thereby protecting the tubes from damage. Accordingly, a timer tube or other appropriate timing means is used in the present invention to establish the above-mentioned predetermined warm-up time interval. It is one object of this invention to provide an improved power supply for electrotherapeutic apparatus wherein the timer tube filament is on only during warm-up.

Biasing voltage are not applied to some circuits of the electrotherapeutic apparatus during warm-up in the present invention. Thus, circuits such as the oscillator are not on continuously. Hence, needless wear of the apparatus does not result. Accordingly, it is a further object of this invention to prevent application of biasing voltages to various portions of the electrotherapeutic apparatus during warm-up.

With respect to the above-mentioned timer tube, its contacts have a tendency during the last few seconds of its predetermined timing period to successively close for brief instances of time, that is, flutter. This tendency can result in damage to the tubes of the final stages wherein the biasing voltage is successively applied for brief instances of time, if the power supply circuitry is improperly designed.

Thus, it is a further object of this invention to provide a power supply for electrotherapeutic apparatus wherein a timer tube is employed and where the contacts thereof positively make upon momentary shorting thereof, thereby preventing the above-mentioned flutter and thus preventing damage to the final stage tubes.

It is a further object of this invention to provide a power supply for electrotherapeutic apparatus wherein a predetermined warm-up interval occurs no matter how short a period of time the machine is turned off.

Other objects and advantages of this invention will become apparent upon reading the appended claims in



conjunction with the following detailed description and the attached drawings, in which:

FIGURE 1 is a block diagram illustrating means for generating pulsed radio frequency signals which are employed in an electrotherapeutic treatment apparatus; and

FIGURE 2 is a schematic diagram of an improved power supply for the circuitry shown in FIGURE 1.

Referring to FIGURE 1, there is shown an oscillator **10**, a modulator stage **12** which is driven by the oscillator, and an output stage **14** which is, in turn, driven by the modulator stage. A pulse generator **15** is also connected to modulator stage **12** for modulating the output thereof, the modulated output being applied to treatment head **18**.

Referring to FIGURE 2, there is shown the improved power supply in accordance with this invention for the circuitry of FIGURE 1. Lines AC1 and AC2 are connected to transformers T10, T11 and T12. The secondary of transformer T10 is rectified by fullwave rectifier DP10 and supplied as the B3 bias signal or voltage to output stage **14** of FIGURE 1 after filtering in condenser C10. The details of a typical output stage **14** are shown in copending application Ser. No. 566,346, filed July 19, 1966, see circuit 148 of Figure 8 thereof. The B3 voltage is connected to the plates of parallel connected output tubes (shown in application Ser. No. 566,346), this voltage typically being between 220 to 2700 volts.

The output of secondary transformer T11 is connected to the filaments of the parallel tubes of the output stage **14**, this voltage typically being 13.5 volts AC. The transformer T12 has two secondary windings, the winding X providing the filament voltage for the tubes in oscillator **10**, power amplifier **12**, and pulse generator **16**. The second secondary winding of transformer T12 is connected to fullwave rectifier DP11. The positive terminal of rectifier DP11 is connected to a filter **20** comprising capacitors C15A and C15B and resistor R13. The filter, in turn, provides bias voltage B2 for modulator stage **12** of FIGURE 1, this voltage typically being 400 volts positive.

Relay or second relay means RL10 is also connected to filter **20** and includes coil **22** and contacts **24** and **26**, the contacts being shown in their normal position when relay RL10 is not energized. Relay or first relay means RL11 includes a coil **28** and contacts **30**, **32**, and **34**, these contacts also being shown for the de-energized condition of relay RL11. A timer switch T71 is connected to contacts **34**, the purpose of the timer being to regulate the amount of time pulsed electrotherapeutic energy is applied to the patient. The actuation of timer T71 closes contacts **36**. If contacts **34** are also closed, further bias signal or voltage B1 is applied to pulse generator **16**, this voltage typically being 300 volts.

As will be brought out in more detail hereinafter, delay timer tube TT10 is provided to prevent the application of the bias voltages B3 and S to output stage **14** for a predetermined time interval after the electrotherapeutic apparatus is turned on, typically this length of time being 90 seconds. Delay timer tube TT10 comprises a coil **38** and contacts **40**. These contacts will be closed after the voltage from the secondary winding X of transformer T12 has been placed thereacross for a period of time equal approximately to 90 seconds.

The S voltage for output stage **14** is connected through the contacts **26** of relay RL10. Contacts **26** and **24** will transfer, in a manner to be described in more detail hereinafter, after the beforementioned 90-second time interval has elapsed, the voltage S being provided to the screens of the parallel connected tubes (shown in application Ser. No. 566,346) of output stage **14**. Thus, protection

is provided for these tubes in that the filaments are turned on for 90 seconds.

The negative terminal of rectifier DP11 is connected to filter 42 which comprises capacitors C16A and C16B and resistor R15. Bias voltage C1 is delivered from a voltage divider 44 comprising resistor R16 and gas tube OC2, C1 typically being −75 volts. C1 is applied to output stage 14 to bias the grids of the parallel connected pair of tubes. Bias voltage C2, which is typically −150 volts, is connected from a voltage divider including resistor R14 and gas tubes OA2. Voltage C2 biases the grids of the parallel tubes of the modulator stage 12 of FIGURE 1. Resistor R14 is also connected to contacts 32, these contacts applying bias voltage C3 which is typically −300 volts, and which is employed by a sawtooth waveform signal generator and a single shot multivibrator of the pulse generator 16. For more details of the single shot multivibrator and the sawtooth generator, refer to the beforementioned copending application Ser. No. 566,346, FIGURE 2.

Having now described the circuitry of the invention, the operation thereof will now be given. Assuming terminals AC1 and AC2 are connected to an appropriate AC source, certain voltages will be immediately applied to the circuitry of FIGURE 1, these being B2, C1, C2, X, Y and Z. Thus the filaments of output tubes of modulator stage 14 are turned on immediately with the connection of terminals AC1 and AC2 to an appropriate source. However, the tubes of the stage 14 could be seriously damaged if the bias voltages B3 and S were applied before the filaments had been sufficiently heated; thus, delay timer tube TT10 is provided to prevent the application of these biasing voltages to stage 14 until this interval has elapsed. The timer switch T71 may be turned on either before or after the above-mentioned 90-second time interval has elapsed as will be discussed in more detail hereinafter.

The secondary winding X of transformer T12 heats the coil 38 of delay tube TT10 through the contacts 30 of relay RL11 as shown in FIGURE 2. During this time it can be seen that contacts 34 are such that relay RL10 cannot be energized even if timer switch T71 is turned on during the preliminary 90-second interval. Further contacts 32 are such that the bias voltage C3 is not applied to pulse generator 16.

After the 90-second interval has elapsed, the contacts 40 of tube TT10 close, thereby energizing the coil 28 of relay RL11 through contacts 40 of TT10. At the same time, the voltage from coil 38 is removed and therefore the contacts 40 open. However, coil 28 of relay RL11 remains energized because secondary coil X of transformer 12 is connected to coil 28 through the now transferred contacts 30. Thus there is no voltage applied to the coil 38 of timer tube TT10 after the initial 90-second period has elapsed and further if the apparatus is turned off, even shortly after the contacts 40 have opened, another full 90-second interval is required to restart the apparatus.

Typically the contacts 40 of delay timer tube TT10 will tend to momentarily contact or flutter during the last three seconds of the 90-second interval. This flutter or momentary shorting of the contacts 40 can cause damage to the output tubes of output stage 14. However, the present arrangement of timer tube TT10 is such that any momentary shorting of the contacts 40 will activate relay RL11, which stays energized thereby providing positive closure on contacts 30–34. Thus, the above-mentioned type of damage to the tubes of the modulator stage 14 is prevented.

When relay RL11 is energized, contacts 30, 32 and 34 transfer from the position shown in FIGURE 2. The effect of the transfer of contacts 30 has been discussed above. The effect of the transfer of contacts 32 is to apply the bias voltage C3 to the pulse generator 16 and the effect of the transfer of the contacts 34 depends on the condition of timer switch T71. If this switch has not been turned on during the preliminary 90-second warm-up interval, nothing further occurs to effect the operation of the apparatus. Gas tube N71 lights up at this time to alert the operator that the warm-up period is over and that the timer switch T71 may now be actuated. As soon as the contacts 36 of switch T71 are closed by the operator, the voltage at the output of filter 20 is applied through relay RL10, contacts 34 and contacts 36 to provide the bias voltage B1 to oscillator 10. At the same time relay RL10 is energized, thereby transferring contacts 24 and 26. With contacts 24 transferred, transformer T10 is energized thereby supplying bias voltage B3 to output stage 14. Also, bias voltage S is applied to output stage 14 through contacts 26.

Hence, it can now be seen how the improved power supply circuit shown in FIGURE 2 provides protection of the circuitry of FIGURE 1.

Numerous modifications of the invention will become apparent to one of ordinary skill in the art upon reading the foregoing disclosure. During such a reading, it will be evident that this invention has provided a unique power supply for accomplishing the objects and advantages herein stated. Still other objects and advantages, and even further modifications will be apparent from this disclosure. It is to be understood, however, that the foregoing disclosure is to be considered exemplary and not limitative, the scope of the invention being defined by the following claims.

What is claimed is:

1. A power supply for electrotherapeutic apparatus which includes a modulating signal source, an oscillator, an output stage, and a modulator responsive to the oscillator and the modulating signal source to provide a modulated signal to said output stage, said power supply comprising:

a bias signal supply for said output stage;

means for establishing a predetermined time interval including a timer delay tube having a plurality of contacts and means for energizing said timer delay tube;

switching means for applying at least one bias signal from said bias signal supply to said output stage, said switching means being responsive to said predetermined time interval establishing means to switch said bias signal to said output stage after said predetermined time interval has elapsed; and

means for positively applying said bias signal to said output stage upon momentary shorting of the contacts of said timer delay tube thereby preventing damage to the output tubes of the output stage.

2. A power supply, as in claim 1, including means for disconnecting the timer delay from the energizing means therefor after said predetermined interval of time has elapsed.

3. A power supply for electrotherapeutic apparatus which includes an output circuit for producing pulses of electromagnetic energy which are applied to a patient, the output circuit including at least one tube having at least a plate, cathode, and filament, said power supply comprising:

means for applying an energizing signal to said filament;

means for applying a bias signal to said plate;

means for preventing the application of said bias signal to said plate until a predetermined interval of time has elapsed from the initial application of said energizing signal to said filament where said preventing means includes a timer delay tube having a coil and a plurality of contacts for establishing said predetermined time interval; and

where said bias signal preventing means includes means for producing a further bias signal; first relay means in circuit with said timer delay tube, at least one set of contacts of said first relay means connecting a

further bias signal to said electrotherapeutic apparatus when said first relay means is energized and the coil of said first relay means being energized when the contacts of said timer delay tube close after said predetermined time interval.

4. A power supply as in claim 3 where said first relay means includes a second set of contacts through which the coil of said timer delay tube is energized during said predetermined time interval, said second set of contacts transferring when said first relay means is energized and holding said first relay means in its energized condition whereby said timer delay tube coil is de-energized after said predetermined time interval elapses.

5. A power supply as in claim 3 including timer switching means for establishing the length of time said electromagnetic pulses are applied to said patient, said timer switching means being connected to said one set of contacts of said first relay means for preventing the application of said further bias signal to said electrotherapeutic apparatus until said timer switching means is actuated.



6. A power supply as in claim 5 where said bias signal preventing means includes second relay means connected to said one set of contacts of said first relay means, at least one set of contacts of said second relay means connecting said bias signal to said plate of said tube when said second relay means is energized and the coil of said second relay means being energized when said first relay means is energized and said timer switching means is actuated.

**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,751,374 | 3/1930 | Waltemath | 328—259 X |
| 2,823,678 | 2/1958 | Luftman et al. | 128—422 |
| 3,181,535 | 5/1965 | Milinowski | 128—422 |


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