

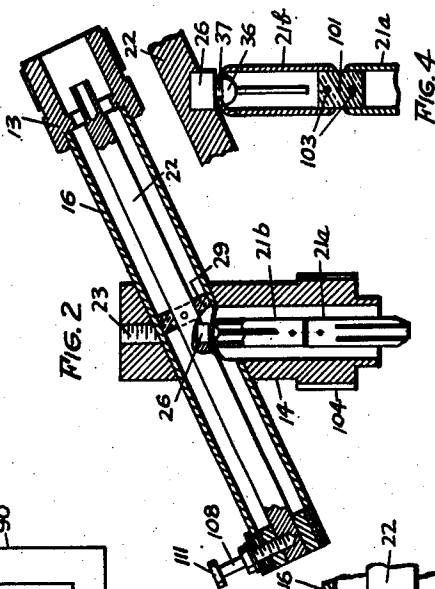
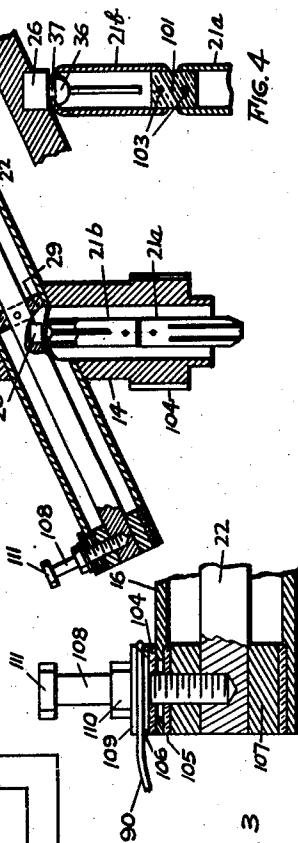
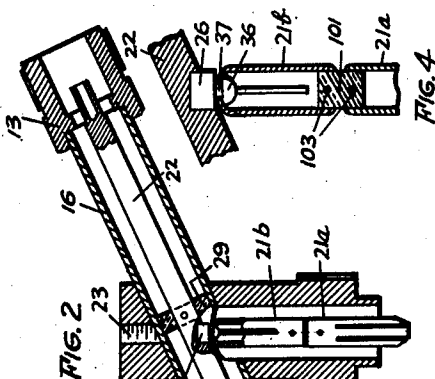
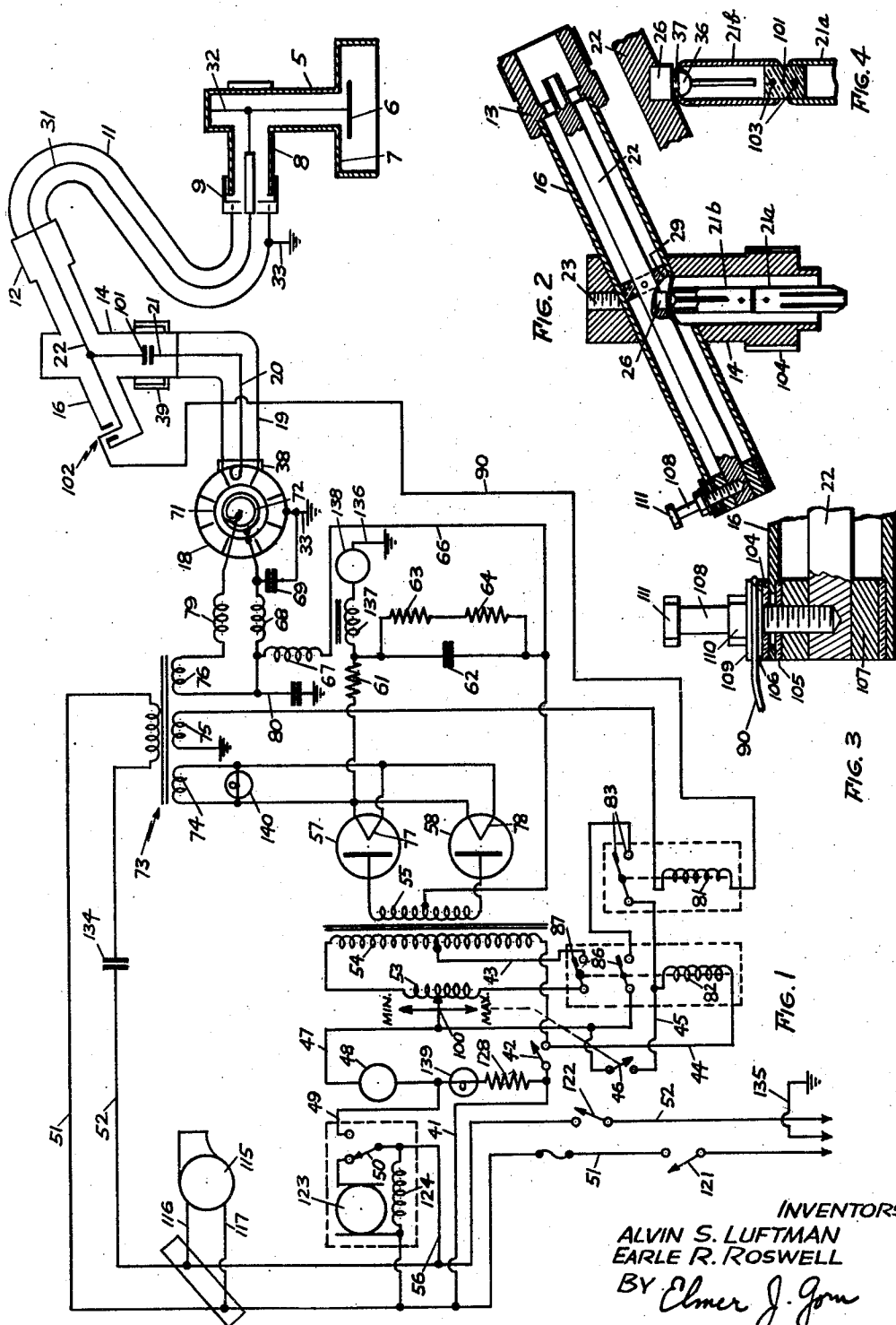
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DIATHERMY POWER CONTROLS

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DIATHERMY POWER CONTROLS

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5 Claims. (Cl. 128—422)

This invention relates to diathermy machines, and particularly to the control of the supply of operating power to such machines.

The invention is herein illustrated as applied to a diathermy machine having an applicator in the form of an antenna type terminal to the central conductor of a coaxial cable receiving energy from a microwave generator of the magnetron classification. However, it is to be understood that the invention is applicable to other types of diathermy machines, and to other types of energy generators and transmitters.

The invention resides in the herein disclosed method and apparatus for protecting the power generating and transmitting elements of a diathermy system against damage by overloading, particularly during intervals when the normal outlet path for the generated oscillations is in a state of temporary interruption.

In the illustrated embodiment, the protection is afforded by means operating automatically to interrupt all (or practically all) flow of energization current to the generating element of the system, whenever diathermy application is suspended.

The invention in one of its aspects also includes certain herein-disclosed structural features facilitating achievement of the described objectives, particularly in the matter of dual utilization of microwave transition structure for both high and low energy conduction; also in the matter of ready assembly and accessibility of the parts constituting the illustrated means for effecting automatic interruption of the flow of excitation current to the oscillation energy generator.

These and other characteristics of the invention will become more apparent as the description thereof progresses, reference being had to the accompanying drawings, wherein:

Fig. 1 is a diagram of electrical components and connections suitable for practice of the invention; and

Figs. 2, 3, and 4 are sectional views of components of Fig. 1.

Referring first to Fig. 1, numeral 5 designates the housing of a manually portable fixture carrying an antenna 6 and a circular reflecting surface 7 for directing radio frequency energy toward an area on the body of a patient for diathermic therapeutic purposes; the fixture having a laterally disposed tubular portion 8 serving as a connector plug for ready attachment to and detachment from a socket element 9 mounted on one end of a coaxial flexible cable 11 whose opposite end carries a fitting 12 attachable to a coupling element 13 (Fig. 2) secured to one end of a tubular assembly 16 obliquely mounted in a junction assembly 14; the assemblies 14 and 16 together constituting a transition apparatus (shown more fully in Fig. 2) of proper wave length for transferring the output of the magnetron microwave generator 18 to antenna 6 by way of the interconnected central conductor segments 21 and 22 of the assemblies 14 and 16, respectively.

As shown best in Fig. 2, a set-screw 23 secures tube 16 within an obliquely extending hole cut through the

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plug 14, the tube being first positioned within the plug at the point where junction button 26 is in alignment with the longitudinal axis of the plug 14. Button 26 is first integrated with a metallic spindle 22 supported centrally of tubular housing 16 with the aid of a transverse spacer 29 of insulating material, the spindle 22 serving as one of the central conductor segments above referred to, and being socketed at its upper end to receive the central conductor 31 of the coaxial cable whose outer wrapping 11 is of flexible metallic shielding material suitable for connection to coupling 9, and for grounding the coaxial line, as indicated at 33.

The button 26 has a head 36 and a neck portion 37 adapted to receive the resilient gripping end portion of the hollow metallic central conductor segment 21b (Figs. 2 and 4) which is the conducting continuation of segment 21a and the magnetron output conductor 20. Conductor 20 is shown as sheathed in coaxial cable 19 whose ends 38 and 39 attach to the magnetron and junction assembly housings 18 and 14, respectively, as indicated. Alternatively, outer conductor 19 may be in the form of a rigid metallic conduit, if the location of the junction assembly 14, 16 is closely adjacent the magnetron assembly 18.

Lines 51 and 52 constitute a source of alternating current of suitable voltage (110 volts, for example) for energization of the magnetron 18 by way of a variable autotransformer combination illustrated at 53, 54, and 55, which combination operates to supply a controllably variable A. C. voltage for rectification in units 57 and 58 and for stabilization through the instrumentality of the RC network indicated at 61, 62, 63 and 64, the resulting controlled voltage being applied to the cathode 71 of the magnetron by way of lead 66, inductance 67, and L-C couple 68 and 69. The cathode heater coil 72 derives its heating current from the secondary segment 76 of a second transformer 73 whose primary winding is supplied by the line 51, 52. Another segment 74 of this transformer secondary serves as the source of supply of heating current to the cathodes 77 and 78 of the rectifier units 57 and 58, respectively. The circuit to heater 72 includes an inductance 79 and a capacitance-controlled grounded lead 80.

The means for automatically interrupting operation of the magnetron 18 is shown as embodied in a pair of relays 81 and 82 and control means for said relays, said control means including the above-described inter-connected conductors 21 and 22 and parts associated therewith. Relay 81 has its winding energized by the segment 75 of the secondary winding of transformer 73, and its contacts 83 are in series relation to the winding of relay 82, so that flow of current through relay 81 closes the contacts 83 and thereby completes a circuit for flow of current through relay 82 after the latter has been initially energized by way of the circuit traceable as follows: from source 51 through conductor 41, manual control switch 42, conductor 44, relay winding 82, conductor 45, initially closed micro-switch 46, conductor 47, thermostat 48, conductor 49, time delay switch 50, and lead 56 running back to the negative side 52 of the power source.

The resultant energization of relay 82 produces closure of relay contactors 86 and 87, the former thereupon acting as a holding contactor for the relay circuit, while contactor 87 operates to complete a branch circuit leading to the transformer primary 54. The transformer secondary 55 thereupon becomes effective to energize the magnetron 18 by way of the components heretofore described. Meanwhile the reopening of micro-switch 46 (as herein-after described) is of no effect upon relay 82, as the latter holds itself in closed-circuit condition through the action of its holding contactor 86, in series with contactor 83 of the normally constantly energized relay 81.

It will be noted that the circuit from transformer sec-

ondary segment 75 to relay 81 includes conductor 90 leading to central conductor 22 of the junction assembly, and that the circuit is completed by way of conductors 22 and 31, the latter being grounded through the physically connected housing of the diathermic ray director 5 and the cable 11, as indicated at 32 and 33 in Fig. 1. It follows that the physical severance of the grounding circuit, as by detachment of the director from the cable coupling 9, will automatically create an open-circuit situation. Such a situation would quickly destroy the magnetron in the absence of some means for interrupting the magnetron energizing circuit. The relay 81 and its circuit constitute such means, since the said circuit is automatically interrupted at relay contact 83 by the physical act of detaching unit 5 from the cable terminal coupling 9. Interruption of the relay circuit permits relay contact 83 to reopen (by reason of its resiliency or bias to the open position), thus interrupting current flow through relay 82. Cessation of current flow through relay 82 causes relay switches 86 and 87 to reopen, thus de-energizing transformer 54, 55 and hence the magnetron energizing circuit. Thus the magnetron becomes quiescent, and hence protected, until the ray director 5 (or some counterpart of it) is re-attached to the cable coupling 9, to restore the ground connection for re-energization of the relay 81 by re-completing its supply circuit.

The points where lines 20 and 90 enter the assemblies 14 and 16, respectively, are protected by the use of capacitive couplings, as indicated at 101 and 102, respectively, in Fig. 1. Figs. 2, 3 and 4 show the physical details of these capacitive couplings. Capacitance 101 is in the form of a pellet 150 of dielectric material straddling the sequential conductor segments 21a and 21b and secured thereto by fastening means 103, the conductor segment 21a being hollow and longitudinally slotted (as is also the segment 21b) for automatic reception and retention of the magnetron output conductor 20 when the magnetron output conduit terminal 39 is brought into attaching engagement with fluted shoulder 104 of the assembly 14. Capacitance 102 is in the form of insulating washer 104 and insulating sleeve 105 straddling the cylindrical wall of tubing 16, said parts abutting the metallic parts 106 and 107, respectively. Part 107 is the end wall of tubing assembly 16, and part 106 is part of the terminal connector assembly for receiving and retaining the lead 90 in electrical continuity with spindle 22. The other parts of this terminal connector assembly include the screw 108, the clamping washer 109, the nut 110, and the screw head 111. Parts 107 to 111, inclusive, are metallic, while parts 104 and 105 are non-metallic.

Microswitch 46 is closed only when auto-transformer adjuster arm 100 is in a minimum voltage position, the mode of operation of the auto-transformer and its switch 46 being a part of the subject matter of United States patent application, Serial No. 407,430, filed February 1, 1954 by Alvin S. Luftman, John T. Goodway and Charles H. Peterson, and assigned to the assignee of the instant patent application. Opening of switch 46 (as by shifting arm 100 to any other position) does not affect the circuit relationships, as the current path through switches 83 and 86 parallels that through switch 46; hence it continues to function regardless of the opening of switch 46. However, the emergency opening of relay switch 83, as above described, will prevent recycling the magnetron until arm 100 is again returned to the safe (minimum voltage) position to reclose switch 46.

Switch 50 is initially in its left-hand position, but moves to the right-hand position within a predetermined time interval following closure of switches 121 and 122 to commence the cycle. During this preliminary interval, timing motor 123 (with its field winding 124) is energized by way of connections 124, 50 and 56. When the pre-set period has elapsed, switch 50 snaps over to the

right-hand position (in a manner well known in the art), thus de-energizing motor 123 and establishing the circuit previously traced through conductor 49.

Blower motor 115, supplied by taps 116 and 117, may be included if a stream of cooling air is desired. Condenser 134 is matched to transformer 73 to provide constant voltage output over the frequency and voltage range of the transformer. Lines 51, 52 are shown as supplemented by a grounded third lead 135. Network 61-64 also includes a grounded lead 136, an inductance 137, and a meter 138. Other indicating elements, in the form of pilot lamps, are shown at 139 and 140. These parts 138, 139 and 140 facilitate visual checking of the operation of the respective circuit components adjacent thereto. A resistor 128 may be included in series with lamp 139 for voltage limiting purposes, if so desired.

This completes the description of the particular embodiments of the device disclosed herein. However, many modifications thereof will be apparent to persons skilled in the art without departing from the spirit and scope of this invention. Accordingly, it is desired that this invention be not limited by the particular details of the embodiment described herein except as defined by the appended claims.

What is claimed is:

1. In a diathermy machine having an energy applicator, an oscillation generating element electrically connecting with said applicator, means including a severable joint interposed in the electrical connections between said generating element and said applicator, an energizing circuit connected to said generating element for applying operating voltages to said generating element, and means including at least one electromagnetic relay connected between said applicator and said energizing circuit for interrupting the operation of said energizing circuit in response to removal of said applicator by opening of said severable joint.

2. In a diathermy machine having a removable applicator, an oscillation generating element, a microwave transition guide electrically connecting said oscillation generating element with said applicator, means including a severable joint interposed in the electrical connections between said transition guide and said applicator, means for energizing said generating element, means connected between said applicator and said energizing means for interrupting the operation of said energizing means in response to removal of said applicator, said means including a relay element controlling flow of current in said energizing means, and capacitive coupling means integrated with said transition guide at points intermediate said relay element and said severable joint.

3. In combination, an oscillation generating element, an energy applicator electrically connected to said generating element, means including a severable joint interposed in the connection between said generating element and said applicator, means connected to said generating element for supplying energization thereto, and means connected between said applicator and said energizing means for interrupting the operation of said energizing means in response to severance of said severable joint.

4. In combination, an oscillation generating element, an energy applicator electrically connected to said generating element, said applicator comprising a coaxial transmission line having its center conductor connected to its outer conductor to form a short circuit for direct current energy and relatively low frequency energy but not for high frequency energy, means including a severable joint interposed in the connection between said generating element and said applicator, means connected to said generating element for supplying energization thereto, and means connected between said applicator and said energizing means for interrupting the operation of

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said energizing means in response to severance of said severable joint.

5. In combination, an oscillation generating element, an energy applicator electrically connected to said generating element, means including a transition element interposed in the connection between said generating element and said applicator, energizing means connected to said generating element, means connected to said transition element and operative to interrupt said energizing means in response to severance of the connection between said applicator and said generating element, a capacitive coupling in the connection between said generating ele-

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ment and said transition element, and an electrical connection between said transition element and said interrupting means.

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