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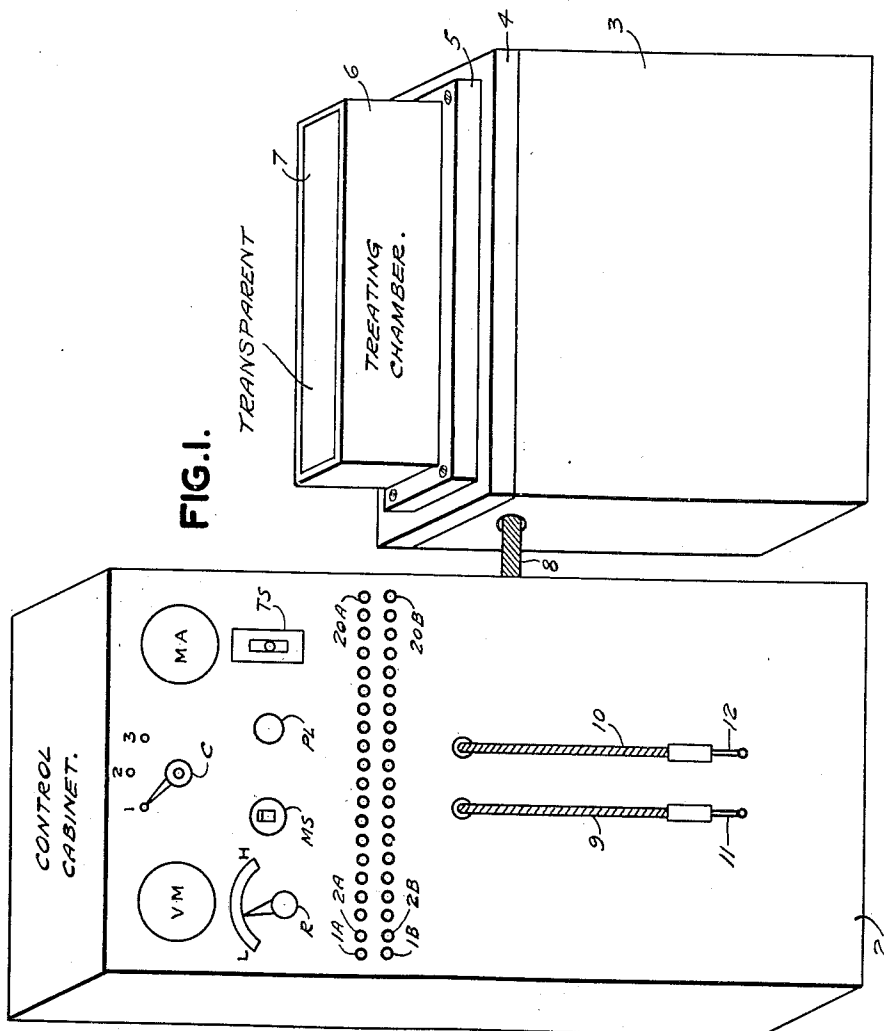
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2,388,945

FILAMENT TREATING SYSTEM

Filed Oct. 2, 1942

5 Sheets-Sheet 1



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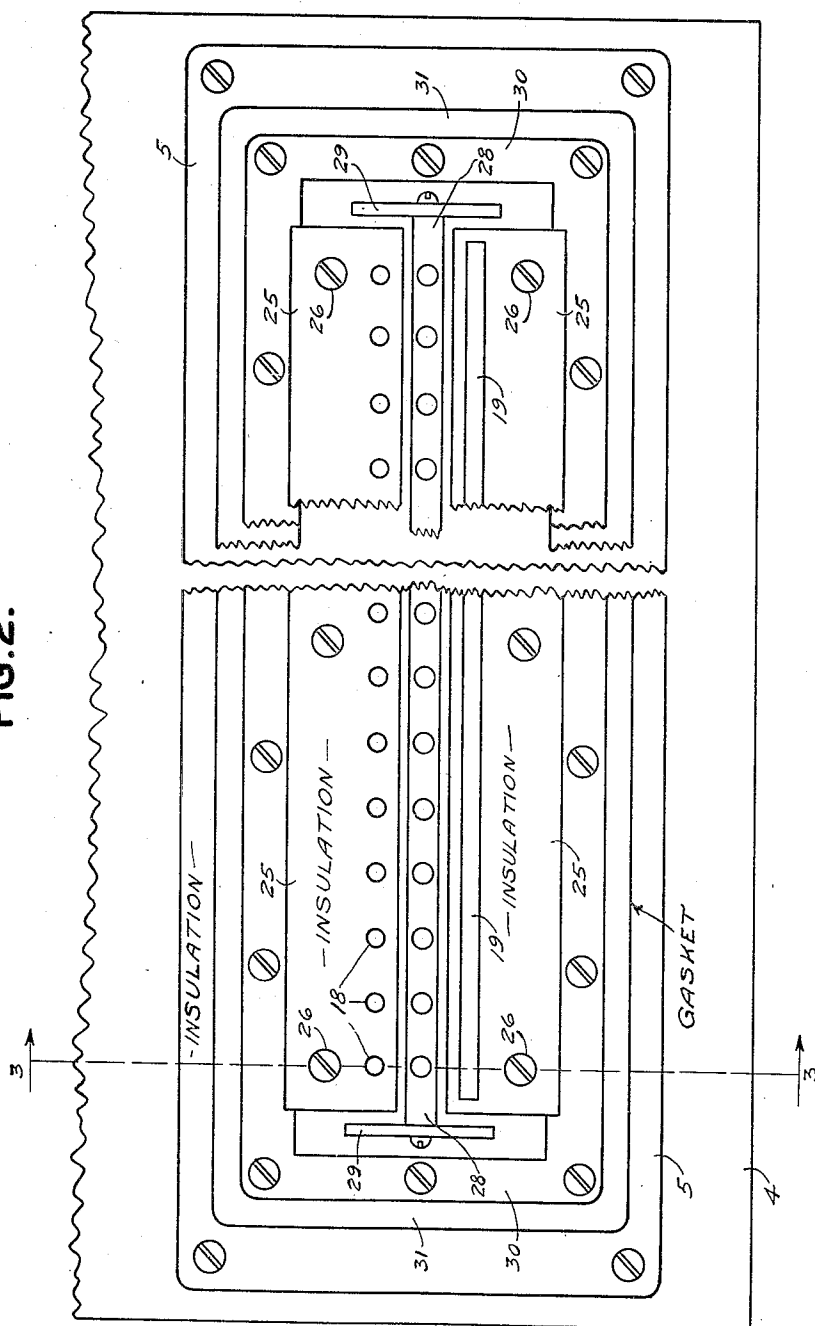
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FILAMENT TREATING SYSTEM

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5 Sheets-Sheet 2

Fig. 2.



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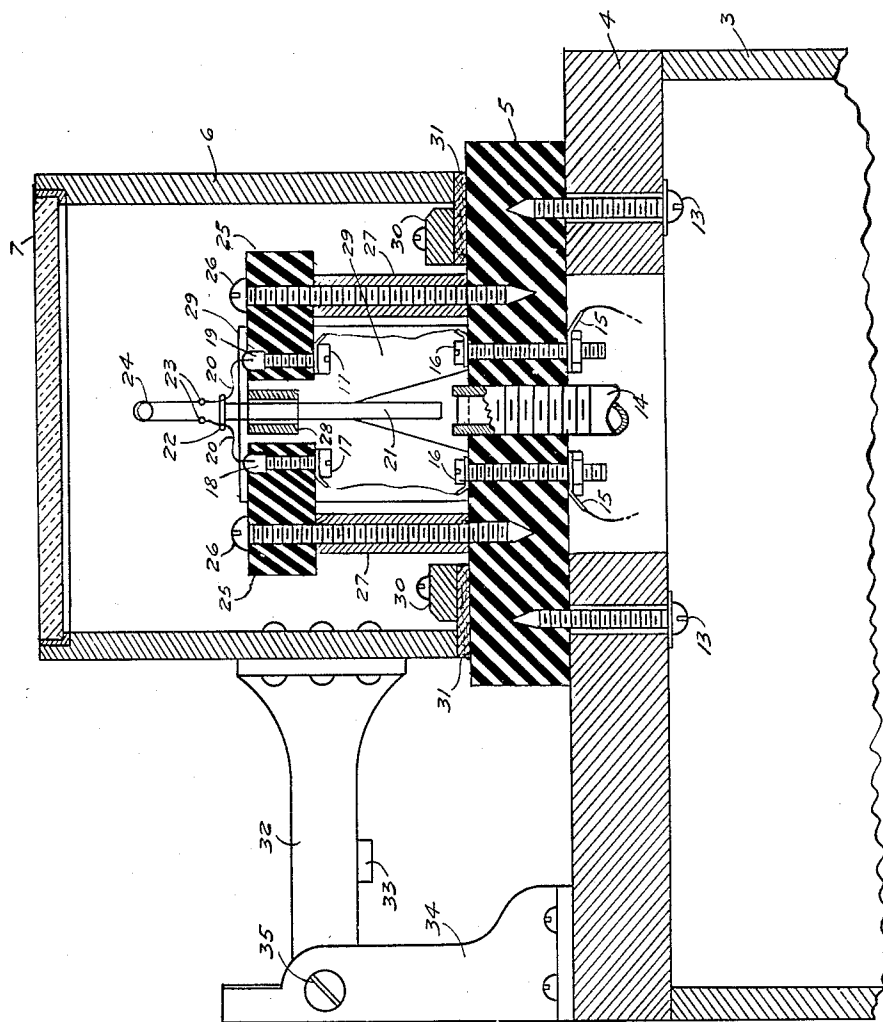
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FILAMENT TREATING SYSTEM

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5 Sheets-Sheet 3

FIG. 3.



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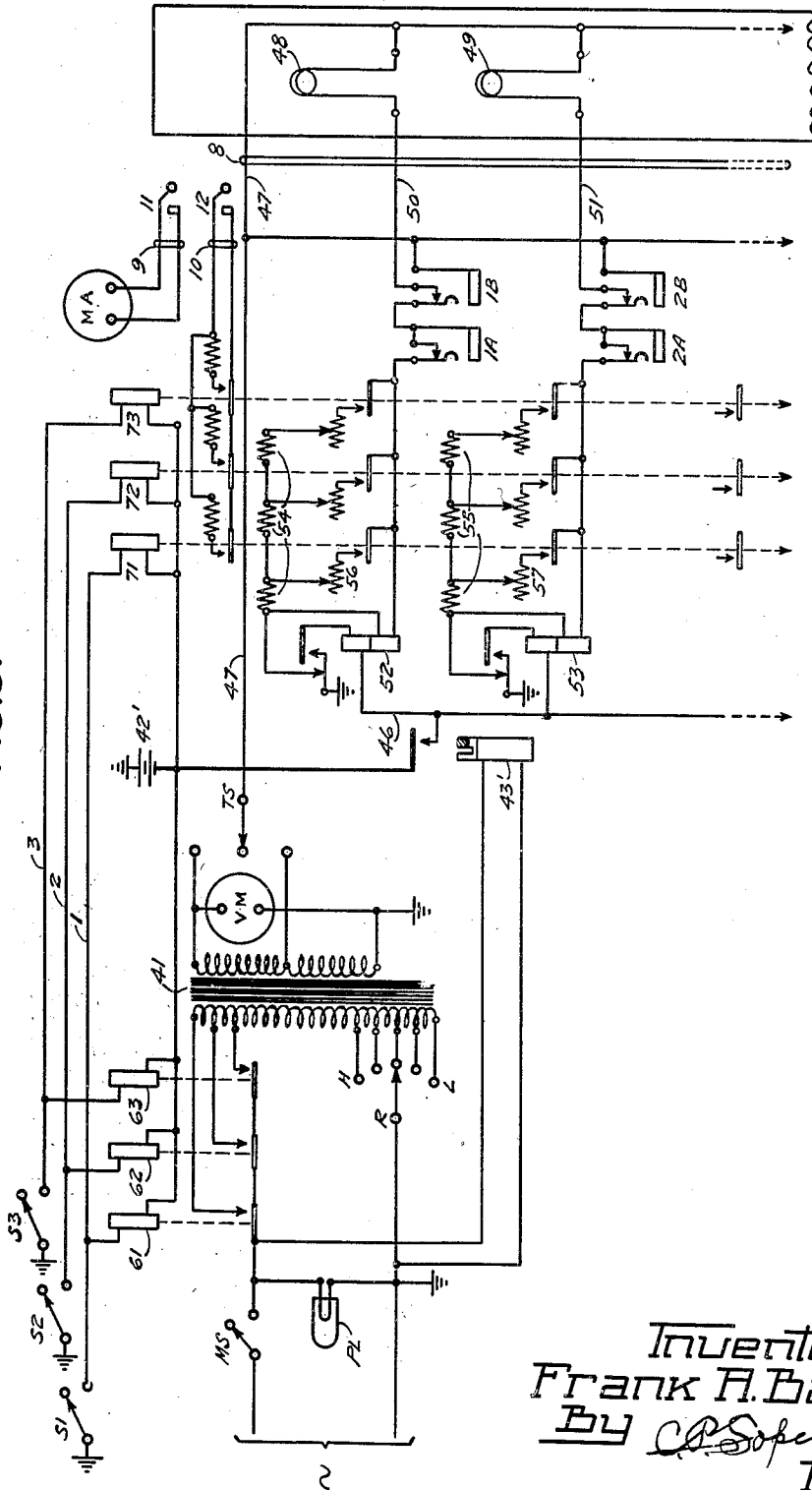
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FILAMENT TREATING SYSTEM

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5 Sheets-Sheet 5

FIG. 5.



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UNITED STATES PATENT OFFICE

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FILAMENT-TREATING SYSTEM

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Application October 2, 1942, Serial No. 460,729

12 Claims. (Cl. 315—364)

This invention relates to filament-treating systems. The main object is to provide a new and improved system for treating the filaments of carbon lamps during manufacture with a maximum of uniformity, and with a minimum of operations required of the treating operator.

GENERAL DESCRIPTION

Carbon-filament lamps are commonly used where their long life and other characteristics are of greater importance than efficiency in operating current. For example, they are extensively used in telephone switchboards and the like for signalling purposes. Such lamps are comparatively small in size, and are made in a number of filament types, differing in operating potential and current.

In the production of carbon-filament lamps for the noted purpose, a filament of the desired diameter is cut to the desired length; is bent or wound to the desired shape; and is attached, by electrically conducting cement, to the ends of a pair of wires imbedded in the flange of a glass tube to form what is referred to herein as a filament assembly. Such filament assemblies are placed in racks (of twenty, for example), and undergo electric treatment, one or more racks at a time.

The treating of the unenclosed filaments is accomplished within a chamber which is first exhausted to about 29 or 30 inches of mercury; filled with a non-oxidizing gas; and exhausted again, this time to about 27 inches of mercury, maintained during the electric treating period, during which current of a desired potential is passed through the filaments until the initially high resistance is thereby broken down to a desired lower value. By this treatment, the resistance of the filament is permanently lowered to a desired operating value, which remains substantially constant at any selected temperature at which it is measured.

Following the above treatment of a filament assembly, a glass envelope is attached to and sealed around the outside of the glass tube thereof, with lead-in wires extending through the base. The inside of the envelope is suitably exhausted through the tube, which is then sealed. The final step is to provide the sealed lamp with terminals to which the lead-in wires are secured, as by soldering.

It has been common practice to treat the filament assemblies simultaneously in one or more racks by connecting the filaments in series and applying current thereto from a suitable direct-current generator until the high initial resistance

is broken down to the desired value. This former arrangement is open to a number of objections:

(1) None of the serially connected filaments can be treated if one of them is broken or if the terminal wire of any seal fails to make contact within the treating chamber; (2) dangerously high potentials are required, ranging in practice from one to six thousand volts, for example; and (3) such group treatment necessarily results in comparatively wide resistance variations from filament to filament, for the only resistance which can be determined is that of the series-connected group.

In view of the foregoing, a further object of the invention is to provide a filament-treating system in which the treating of the filaments is terminated individually, responsive in each case to the concerned filament having reached the desired condition of treatment; that is, responsive to the resistance of the filament having been lowered to the desired value, as indicated by the resulting increase of the flow of treating current therethrough.

A further object is to provide a filament-treating system of the foregoing character which is readily adjustable to treat a group of filaments of any one of a number of different types, requiring different treating potentials and different strengths of treating current.

A still further object is to provide a filament-treating system in which the filaments undergoing treatment derive their current in parallel from a comparatively low-voltage source, whereby the operator is not exposed to high potentials.

In the carrying out of the foregoing and other objects of the invention, a separate branch circuit has been provided for each filament to be treated at a given time;

Each branch circuit includes a test relay operable to terminate the treatment by opening the filament circuit responsive to the filament resistance having been lowered to the desired value;

Circuit arrangements have been provided for holding the test relays operated independently of the filament circuits, and for reliably restoring the test relays when the main circuit is opened by the operator after the last filament circuit has been opened;

Readily controllable switching means have been provided for altering the applied treating potential and the sensitivity of the test relays according to the type of filament to be treated; and

Means have been provided for regulating individually the sensitivity of the test relays for each position of the above switching means.

The drawings

Referring now to the accompanying drawings, comprising Figs. 1 to 5, they illustrate a specific embodiment and a desirable modification of the invention.

Fig. 1 shows one physical embodiment of the invention wherein a control cabinet adjustable for three types of filaments is interconnected with a single-rack treating chamber by the conductors in cable 8;

Fig. 2 is a plan view of the treating chamber of Fig. 1 with the enclosing cover 6 removed;

Fig. 3, taken along line 3—3 of Fig. 2, is a sectional view showing the arrangement within the chamber;

Fig. 4 shows the circuit arrangement of the control cabinet and treatment chamber; and

Fig. 5 shows a modification of the circuit arrangement of Fig. 4.

DETAILED DESCRIPTION

Control cabinet

The control cabinet, shown at 2 in Fig. 1, has mounted therein and on the face thereof equipment indicated schematically in Fig. 4. The equipment showing on the face of the control cabinet includes the voltmeter VM; the milliammeter MA; the control knob C, adjustable to a separate position for each type of filament being treated; the regulator knob R, adjustable by the operator from low position to high position to maintain a constant voltage during treatment; the main switch MS; the pilot lamp PL; the three-position (off, low, high) treatment switch TS; twenty pairs of switchboard jacks, 1A and 1B to 20A and 20B; milliammeter cord 9 and plug 11; and resistor cord 10 and plug 12.

The plug 11 is intended to be used to connect the milliammeter MA in series with any individual filament circuit, upon being inserted into the corresponding one of the jacks 1A to 20A, while the plug 12 is intended to be inserted into any one of the jacks 1B to 20B to substitute a resistor for the filament in any circuit to enable the test relay of that circuit to be adjusted.

Cable conductors 8 (Figs. 1 and 4) connect the control cabinet 2 with the treating chamber.

Treating chamber

As seen in Figs. 1 to 3, the treating chamber includes a base portion 5, mounted on the table portion 4 of treating cabinet 3, and a hinged cover 6, having a glass observation window 7.

As seen in Figs. 2 and 3, the base 5 of the treating chamber is surmounted by a sealing gasket 31, held in place by the gasket retainer 30. When the cover 6 is in place, as shown in Fig. 3, the lower surface thereof makes sealing contact with the upper surface of the gasket 31. The cover 6 is preferably hinged to the rear portion of table 4 by a pair of laterally spaced hinges, one of which is shown in Fig. 3. This hinge comprises an arm 32, riveted or otherwise secured to the cover 6; the hinge upright 34, secured to the table portion 4; and a pivot member 35, hinging parts 32 and 34 together. Stop member 33, fixed to arm 32, engages the upper extension of upright 34 to arrest the backward movement when cover 6 has been rotated upward and backward through an angle in excess of ninety degrees.

Base 5 is preferably composed of a slab of insulating material. It may be affixed to table portion 4, as by screws 13, over an opening or slot in table portion 4 of a sufficient width and length

to accommodate the lead-in wires and their terminals 15, as well as the exhaust pipe 14, the end portion of which is shown in the drawings. The exhaust pipe 14, in practice, leads to valve equipment not shown herein, selectively controlling communication with an exhaust pump, a supply of non-oxidizing gas (such as gasoline vapor), a vent to atmosphere.

One of the filament assemblies is shown in position for treatment in Fig. 3. This assembly includes the glass tube 21 with a flange formed at the upper end thereof, in which a pair of filament-extension leads 20 are imbedded. The filament 24 is cemented at points 23 to the upper ends of leads 20.

One of the racks in which the filament assemblies are placed for treatment is shown in top view at Fig. 2 and in cross-section in Fig. 3. This rack includes a horizontal bar 28, secured between supporting end portions 29. Bar 28 is provided with a row of vertical openings, usually twenty, to accommodate as many filament assemblies in the position indicated in Fig. 3. The illustrated treating chamber is equipped to accommodate one rack of filament assemblies, but wider treating chambers providing for two or more racks to be placed therein side by side may be used.

In order to provide for the electrical connections within the chamber to the filament-extension leads 20 of the assemblies, a pair of elevated terminal tables 25, composed of insulating material, are provided. These tables may be supported by sleeves 27, through which screws 26 pass, to hold the parts 25 firmly in place with respect to the base 5. At the rear of each upright opening in the rack 28, there is a tapped opening 18 in the rear terminal table 25. A screw 17 enters each opening 18 from below, but stops short of the upper end thereof, leaving a space into which mercury may be poured to form an individual mercury pool for each filament assembly undergoing treatment. Each such screw 17 is connected, by a vertically extending conductor, with a corresponding screw 16. Screws 16 pass through the base 5, and are provided with terminal lugs 15, to which conductors of cable 8 may be attached.

The common connection to all of the filaments undergoing treatment at one time is provided by an elongated mercury pool lying within trench 19 in the front one of terminal tables 25. Connection from below with this common conducting pool is made by the associated screw 17, connected in turn by a vertically extending conductor with its respective screw 16 passing through the base 5 to make external contact with common conductor 47 of cable 8.

The circuit arrangement

Referring now particularly to Fig. 4, which shows one embodiment of the circuit arrangement incorporating the features of the invention, a pair of leads are shown incoming from the left from a source of alternating current. These leads supply current to the primary winding of transformer 41, whose secondary winding supplies alternating current for treating the filaments. The main switch MS, having an "off" position and an "on" position is included in one of the leads from the power source.

A common operating shaft 60, for switches C1 and C2, and for a number of switches L1, L2, and so forth, is arranged to be controlled by the control knob C (Figs. 1 and 4). The control knob C, together with the attached shaft

60, can be adjusted to any one of the three positions to thereby bring each of the attached switches into the corresponding position. Switch C1, attached to common shaft 60, connects the supply conductor controlled by the main switch MS to the desired one of three taps of the primary winding of transformer 41, according to the voltage desired at the secondary winding of the transformer for the particular type of filament currently being treated. The regulator R (Figs. 1 and 4) is provided to shift the other power lead from one tap to another of the primary of the transformer to maintain the desired treating voltage, as indicated by the voltmeter VM bridged across the outside terminals of the secondary winding of transformer 41. The taps connected to the contacts of the switch R are preferably connected close together in the primary winding of transformer 41 to enable a close regulation of the secondary voltage to be obtained by the treating operator.

The treating switch TS is preferably a three-position switch. It is illustrated in its neutral position. It has a low position in which common conductor 47 is connected to a mid-tap on the secondary winding to supply reduced potential to the filaments about to be treated to cause them to glow sufficiently to indicate that their respective circuits are closed. The switch TS has an upper position in which it applies the full potential of the secondary winding to conductor 47 for treatment of the filaments 48, 49, and so forth.

Individual test relays 52, 53, and so forth, are provided in the control cabinet, the lower or test winding of each of the relays being connected in series with the corresponding one of the individual treating leads 50, 51, and so forth, in cable 8. Each of these relays is adjusted to respond when the comparatively high initial resistance of the associated filament has been lowered to the desired value. Upon responding, each test relay will open the treating circuit, including the circuit of its own lower winding, and will maintain itself operated and the filament circuit open, by closing a direct-current locking circuit through its upper winding.

The locking circuits of the test relays derive rectified current from conductor 46, supplied from the center-tapped secondary winding of transformer 42 by way of the full-wave rectifier 43. A large-capacity condenser 44 is provided to maintain potential on conductor 46 during reversals of the alternating current. The primary winding of transformer 42 is supplied with current through the incoming power leads and the main switch MS. Thus, when the main switch MS is opened, conductor 46 is deenergized, along with conductor 47, whereupon all of the locked relays 52, 53, and so forth, restore.

The test relays are preferably sufficiently sensitive that they operate responsive to less current than that which flows through a properly treated filament of the type requiring the least current. Accordingly, the test relays can be adapted to respond at the desired point for each type of filament being treated by shunting the lower or test winding of each of the test relays through a resistor of the proper value. For this purpose, three-section resistors 54, 55, and so forth, are associated respectively with relays 52, 53, and so forth. The first section of any such resistor is adapted to shunt sufficient current away from the associated test winding to adapt the relay

for use in connection with the type of filament drawing the largest current; the first two sections in series are adapted to shunt a lesser amount of current away from the test winding to adapt the relay to respond to the type of filament drawing the intermediate value of current; and the three sections in series are adapted to shunt away a sufficiently small amount of current from the associated test winding to render the test relay sufficiently sensitive for operation in connection with the type of lamp filament drawing the lowest amount of current.

The switches L1, L2, and so forth, affixed to the common shaft 60, serve to connect one, two, or three sections of the resistors, respectively, in shunt of the relays 52, 53, and so forth.

For each position of a switch such as L1 and L2, there is an adjustable series resistor, such as 56 and 57, associated with the #1 position of switches L1 and L2 respectively. These individual, adjustable resistors enable the sensitivity of each test relay to be adjusted individually in very small increments for each position of the associated switch L1 and L2, corresponding to a separate type of filament undergoing treatment. The inherent individual differences in sensitivity amongst the various test relays may be thus adequately compensated for in each position of the common shaft 60 and attached switches, enabling substantially complete uniformity in operation to be realized.

Adjusting the test relays

After installation of the equipment represented diagrammatically in Fig. 4, and before any filament assemblies are placed in the treating chamber, the test relays are preferably adjusted, first mechanically, and then electrically, as follows:

The relays may first be inspected for approximate mechanical adjustment within the operating range, including adjustment of the stroke of the armature proper (not shown) and the adjustment of the tension of the main contact spring (or armature spring) shown in each case immediately above the test relay.

The individual resistors, such as 56 and 57, associated with each of the positions of the switches such as L1 and L2, are preferably set to their points of minimum resistance to thereby lower the resistance of all the shunt paths to a minimum, giving the test relays minimum sensitivity in all positions of the common control knob and attached shaft.

With the knob C set in position 1 as illustrated, all of the switches C1 and C2 and L1, L2, and so forth, are set in position 1, adapting the circuit conditions for treating filaments of the first type. The plug 11 of cord 9 may now be inserted into jack 1A to connect the milliammeter MA serially in the filament-treating lead 50 associated with the first filament circuit, including the test winding of relay 52. Plug 12, attached to cord 13, may next be inserted into jack 1B, thereby inserting the first section of the three-section resistor associated with switch C2 between conductor 47 and the test winding of relay 52, in substitution for filament conductor 50. The first section of the resistor associated with switch C2 is preferably calibrated to have the exact resistance value down to which it is desired that the filaments of the first type be brought by the treating process.

The main switch MS may now be closed to energize the primary windings of transformers 41 and 42, and the regulator R may be adjusted to supply the exact potential across the terminals

of the secondary winding of transformer 41, required to treat the first type of filament. Under this condition, when the switch TS is brought to its upper position, conductor 47 is energized with the treating voltage used for the first type of filament. This causes current to flow, by way of contacts of jack 1B, plug 12, and cord 10, through the #1 section of the resistor associated with switch C2; by way of contacts of jack 1A, plug 11, and cord 9, through the milliammeter MA; and through the lower or test winding of test relay 52, to ground by way of the normally closed contacts controlled by relay 52. The value of this current flow is shown by milliammeter MA.

With switch L1 in position 1, and resistor 56 adjusted to minimum value, a sufficiently large portion of the total current is shunted away from the test winding of relay 52, through resistor 56 and the first section of resistor 54, that relay 52 fails to operate.

With the voltage on conductor 47 (as shown by the voltmeter VM) kept constantly at the desired value, the adjustment of resistor 56 is changed to slowly increase the resistance thereof, until relay 52 operates. The setting of adjustable resistor 56 is left at that point, for the current flowing at the moment of operation of relay 52 (in series with section 1 of the resistors associated with switch C2) is the current flow at which it is desired that relay 52 will operate thereafter when filaments of the first type are being treated.

Upon the partial operation of relay 52, the armature spring thereof first engages its associated make contact spring, thereby closing a self-locking circuit including the upper winding thereof. Direct current now flows from conductor 46, through the upper winding of relay 52, to ground through the associated armature spring and make contact. The upper winding of the relay is preferably designed to provide a comparatively powerful energization to complete the operation of the then partially operated relay 52, and to hold the relay operated reliably and steadily (by direct current) thereafter.

Upon the final operating movement of relay 52, the normally closed contacts thereof are opened, thereby opening the initial energizing circuit of the relay, terminating the current flow through the test winding of the relay, the milliammeter MA, and section 1 of the resistor associated with switch C2.

The operator may now open the main switch M, deenergizing conductors 46 and 47. Relay 52 restores responsive to the deenergization of conductor 46.

The control knob C may now be advanced from position 1 to position 2, actuating the common shaft 60 to advance switches C1 and C2 and switches L1, L2, and so forth, from position 1 to position 2.

Switch C1 prepares for applying to conductor 47 the treating voltage required for the second type of filaments, while switch C2 disconnects the first section and substitutes the second section of the associated resistor, preferably calibrated to the exact resistance value desired for treating the second type of filaments. Switch L1, for example, changes the shunt connections around the test winding of relay 52 to include the first and second sections of resistor 54 in series, and the associated individual variable resistor.

The operator may now reclose the main switch MS, thereby reenergizing conductors 46 and 47.

Conductor 47 is now energized with the potential required for the treating of filaments of the second type, as shown by the reading of the voltmeter VM. The reading of the milliammeter MA indicates the current-flow value for filaments of the second type.

The individual resistor associated with position 2 of switch L1 may now be adjusted slowly to increase the value thereof until the point is reached at which relay 52 again operates and locks as above described. This terminates the adjustment of relay 52 for the treating of the second type filament.

The main switch MS may now be opened to deenergize conductors 46 and 47 and again restore relay 52, following which the control knob C is advanced to third position and the switch MS is again closed.

Adjustment of relay 52 for terminating the treatment of filaments of the third type is accomplished by slowly increasing the resistance setting of the individual resistor associated with the third point of switch L1 until relay 52 operates for the third time.

The main switch MS is now opened; the knob C may be restored to position 1; and the plugs 11 and 12 may be transferred from jacks 1A and 1B to jacks 2A and 2B, following which the above electrical relay adjustment is repeated for relay 53.

The remaining relays (not shown) may be similarly electrically adjusted individually for the three types of filaments to be treated.

Operation

With all of the test relays adjusted mechanically and electrically as above described, and with the plugs 11 and 12 withdrawn from the switchboard jacks, the operator may treat the filaments of a rack of assemblies as follows:

With the hinged cover 6 of Figs. 1 and 3 swung upwardly and backwardly to give access to the treating chamber, the operator may place a rack 28, 29 filled with filament assemblies (type one, for example) into the position indicated in Figs. 2 and 3. One terminal conductor 20 of each assembly makes contact with common conductor 49 through mercury pool 19, while the other terminals make contact with individual conductors 50, 51, and so forth, through individual pools 18.

The cover 6 may now be closed as shown in Figs. 1 and 3, following which the treating chamber is exhausted through tube 14; filled with a non-oxidizing gas (such as gasoline vapor); and again exhausted.

With the control knob C set in the position (1) corresponding to the type of filament now about to be treated, and with the treating switch TS in neutral position, the operator may close the main switch MS, thereby energizing the direct-current locking conductor 46 by way of transformer 42 and rectifier 43, and preparing to energize treating conductor 47.

The operator now adjusts the regulator R, if necessary, to bring the reading of the voltmeter to the exact value desired for treating the filaments of the concerned type, following which he actuates the treating switch TS to its lower position to apply reduced potential to conductor 47. Current thereupon flows through each of the filaments 48, 49, and so forth, sufficiently to cause them to glow dimly as an indication that their respective circuits are closed. The operator may note which, if any, of the filaments fail to glow.

and then proceed with the treatment of the remaining ones.

The treating switch TS is moved to its upper position, thereby applying the full treating voltage for the concerned filament type to conductor 47. The current flow may be sufficient to cause the potential across the secondary winding of transformer 41 to be lowered somewhat. If so, the operator suitably readjusts the secondary potential by the regulator R.

The filaments such as 48 and 49 glow comparatively brightly during treating, and the brightness of their glow increases progressively as the initial high resistance is broken down. After a period of some seconds, the filaments reach the desired resistance. Each of the corresponding relays 52 and 53 thereupon operates as previously explained to close its own self-locking circuit, over conductor 46, and open the treating circuit.

The operator should observe the reading of the voltmeter VM during treating, changing the position of the regulator switch R to compensate for the increasing power consumed as the filament resistances are lowered, until the test relays begin to operate, and to compensate thereafter for the decreasing flow of current until the treatment of all the filaments has been terminated.

In practice, a period of from nine to twelve seconds usually suffices to complete the treatment of all the filaments. The end of the treating period may be observed through window 7 (Figs. 1 and 3) when the last filament is open-circuited and extinguished by the described operation of its associated one of the relays 52, 53, and so forth.

Following treatment of the group of filaments, the operator may restore treating switch TS to neutral position and open the main switch MS, whereupon the locked-up test relays restore responsive to conductor 46 becoming deenergized.

The tube 14 shown in Fig. 3 may now be vented to atmosphere to permit normal air pressure to enter the treating chamber, following which the cover 6 is swung back out of the way; the treated rack of filament assemblies is removed; and another rack is placed in the chamber.

When the treated rack is removed, any filament assembly of which the filament failed to glow, upon the previously noted placing of treating switch TS in its lower position, may be set aside for inspection concerning the cause of the failure.

When it is desired to treat filaments of the second type, control knob C is brought from position 1 to position 2. Switch C1 thereupon suitably alters the upper connection to the primary winding of transformer 41 to provide the desired treating voltage at the secondary winding thereof, while the switches L1, L2, and so forth, suitably alter the shunt connections around the test windings of the relays.

In treating filaments of the third type, control knob C is brought to position 3, to cause the corresponding treating potential to be applied, and to condition the test relays for response to the current value at which treatment of the third type of filaments is to be terminated.

The modified circuit arrangement

As noted, Fig. 5 shows a modification of the circuit arrangement of Fig. 4. In the modified circuit arrangement, control knob C, with its common shaft 60 and attached switches, is replaced by the separate switches S1 to S3, preferably mounted on the face of the control cabi-

net of Fig. 1, and by relays 61 to 63 and 71 to 73, which are preferably mounted within the control cabinet. Relays 61 to 63 replace the switch C1 of Fig. 4, while relays 71 to 73 replace switch C2 and switches L1, L2, and so forth.

Battery 42', maintained charged in any desirable manner, may be provided to furnish direct current for operating relays 61 to 63 and 71 to 73. This battery may also be used, as indicated, to energize the locking conductor 46.

Switch S1 may be closed to condition the circuits for treating filaments of the first type. When this occurs, relay 61 operates to connect the corresponding one of the upper group of taps of the primary winding of transformer 41, while relay 71 operates to place the first section of resistors 54, 55, and so forth, in shunt of the respective windings of the test relays, by way of individual adjustable resistors 56, 57, and so forth. At the same time, relay 71 bridges the first section of the calibrated resistor across the cord conductors 13 and test plug 12 to enable the adjustment of the test relays, for treating type 1 filaments, to be made initially, or checked later.

When switch S1 is restored and switch S2 is operated, relays 61 and 71 restore and relays 62 and 72 operate. The circuits are thereby conditioned for the treating of filaments of the second type.

With switches S1 and S2 restored, the operation of switch S3 results in the operation of relays 63 and 73 to condition the circuits for treating filaments of the third type.

In the modified circuit arrangement, when the main switch MS is closed, the shaded-pole alternating-current relay 43' responds by connecting the free pole of battery 42' to the common locking conductor 46 so as to provide for locking the test relays operated. When the main switch MS is subsequently opened, relay 43' restores to deenergize conductor 46, permitting the locked test relays to restore.

Except as noted, the circuit arrangement of Fig. 5 corresponds to that of Fig. 4.

The test windings of test relays (52, 53, and so forth) used in the disclosed system preferably have an impedance, to alternating current of the frequency used, which is low compared to the lowest treated filament resistance. When this condition obtains, the shunting resistors (such as 54 and 55) and the associated individual adjustable resistors are comparatively low in resistance. Then, the effect on the total flow of current caused by the variations from relay to relay in the setting of the individual adjustable resistors is practically negligible. Observance of this precaution renders it unnecessary to provide further switch arms for connecting adjustable compensating resistors directly in series with the windings of relays 52 and 53, thus maintaining the circuit arrangement comparatively simple.

I claim:

1. In a system for treating a group of filaments by the passage of electric current therethrough, a treating circuit including a common current source and a separate parallel branch for each filament, means for energizing said circuit and all its said branches at the beginning of the treating of said filaments, and means for separately and individually opening the branch circuits as the individual filaments become fully treated.

2. In a filament-treating system as set forth in claim 1, means for regulating the potential of said current source to compensate for the de-

creasing load as the filament circuit paths are opened one after another.

3. In a filament-treating system as set forth in claim 1, separate means in each said branch for indicating when the current flow therein reaches a predetermined value responsive to the filament being treated therein becoming fully treated.

4. In a filament-treating system as set forth in claim 1, separate means in each branch of said circuit responsive to the current flow in such branch reaching a predetermined value responsive to the filament being treated therein becoming fully treated for terminating the current flow in such branch.

5. In a filament-treating system as set forth in claim 1, separate means in each branch of said circuit responsive to the current flow in such branch reaching a predetermined value responsive to the filament being treated therein becoming fully treated for terminating the current flow in such branch, and locking means thereupon rendered effective for maintaining the current flow terminated in such branch until the main circuit is opened.

6. In a filament-treating system as set forth in claim 1, each branch circuit including a test relay operable responsive to the current flow in such branch circuit reaching a predetermined value responsive to the filament being treated therein becoming fully treated, and means responsive to the operation of any one of said test relays for opening the concerned branch circuit.

7. In a filament-treating system as set forth in claim 1, each circuit branch including a test relay operable responsive to the current flow therein reaching a predetermined value responsive to the filament being treated therein becoming fully treated, locking circuits corresponding respectively to said branch circuits, and means responsive to the operation of any one of said test relays for closing the corresponding locking circuit and opening the corresponding branch circuit.

8. In a filament-treating system as set forth in claim 1, each circuit branch including a test relay operable responsive to the current flow in such branch reaching a predetermined value responsive to the filament being treated therein becoming fully treated, each test relay having a normally open locking circuit, and means responsive to the operation of any test relay for closing its locking circuit and for opening the corresponding circuit branch.

9. In a system for treating a group of similar filaments by the passage of electric current there-through, a treating circuit including a common current source and a separate parallel branch for each filament, each branch including a test means for indicating that the treating current

therein has reached the required final value for the type of filament being treated, selecting means having positions corresponding respectively to said types of filaments; and means responsive to separate selecting means being placed in any one of said positions for predetermining the output potential of said current source, and for adjusting the sensitivity of each of said test means, according to the type of filament to which such position corresponds.

10. In a system for treating a group of similar filaments by the passage of electric current there-through, a treating circuit including a common current source and a separate parallel branch for each filament, each branch including a test means for indicating when the treating current therein has reached the required final value for the type of filament being treated, selecting means having positions corresponding respectively to separate types of filaments, and means responsive to said selecting means being placed in any one of said positions for adjusting the sensitivity of each of said test means according to the type of filament to which such position corresponds.

11. In a system for treating a group of similar filaments by the passage of electric current there-through, a treating circuit including a common current source and a separate parallel branch for each filament, each branch including a test means for indicating when the treating current therein has reached the required final value for the type of filament being treated, selecting means having positions corresponding respectively to separate types of filaments, means responsive to said selecting means being placed in any one of said positions for adjusting the sensitivity of each of said test means according to the type of filament to which such position corresponds, and means for individually varying the group-adjusted sensitivity of each of said test means for each of said positions of said selecting means.

12. In a system for treating a filament by the passage of electric current therethrough, a treating circuit including a current source, and a test means for indicating that the treating current has reached the required final value for the type of filament being treated, selecting means having positions corresponding respectively to separate types of filaments, means responsive to said selecting means being placed in any one of said positions for adjusting the sensitivity of said test means according to the type of filament to which such position corresponds, and means for individually varying the said adjusted sensitivity of said test means for each of said positions of said selecting means.

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