June 7, 1955 J. L. ANDREWS 2,710,323

ELECTRIC BURNER SWITCH

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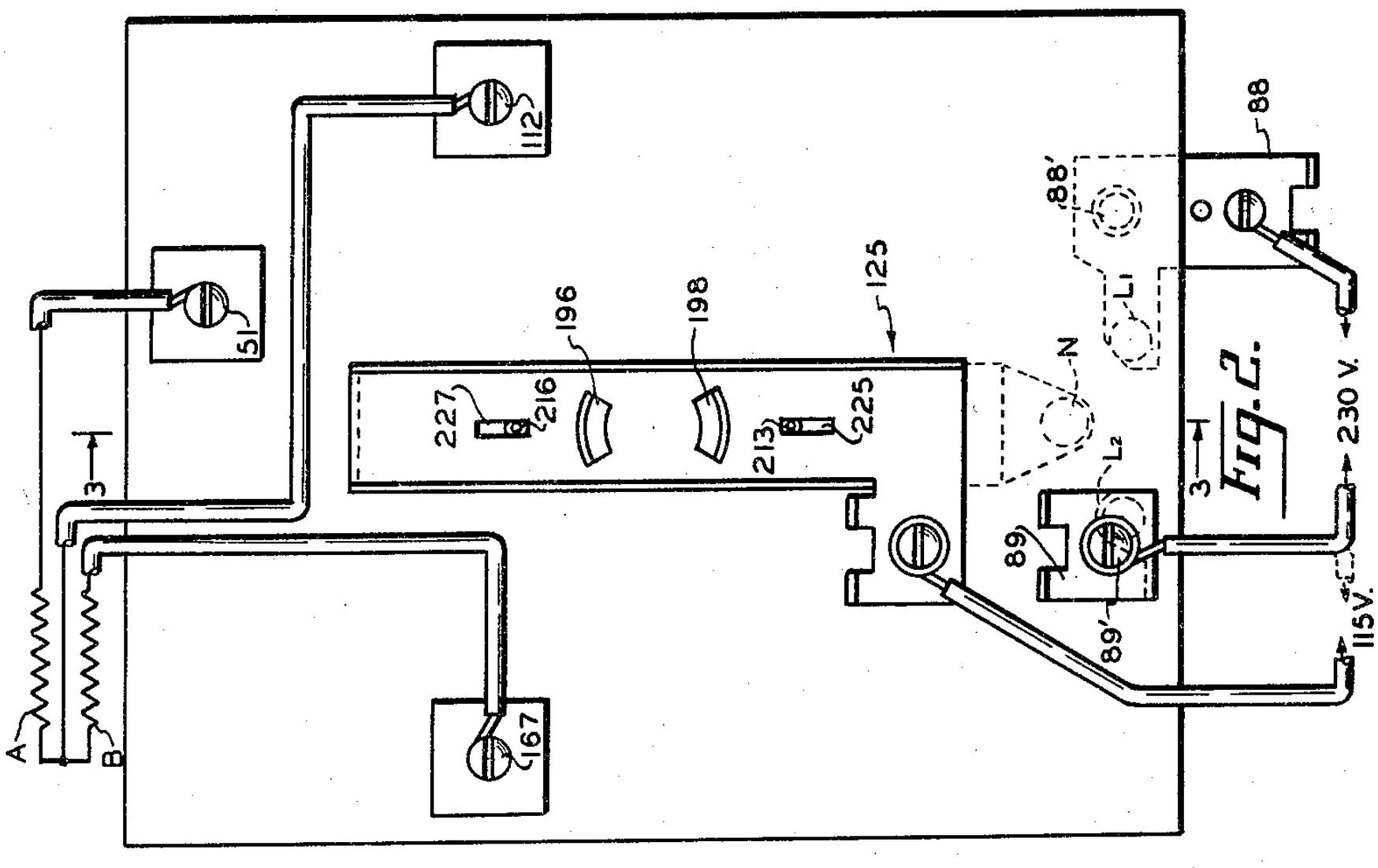

Fig. 2.

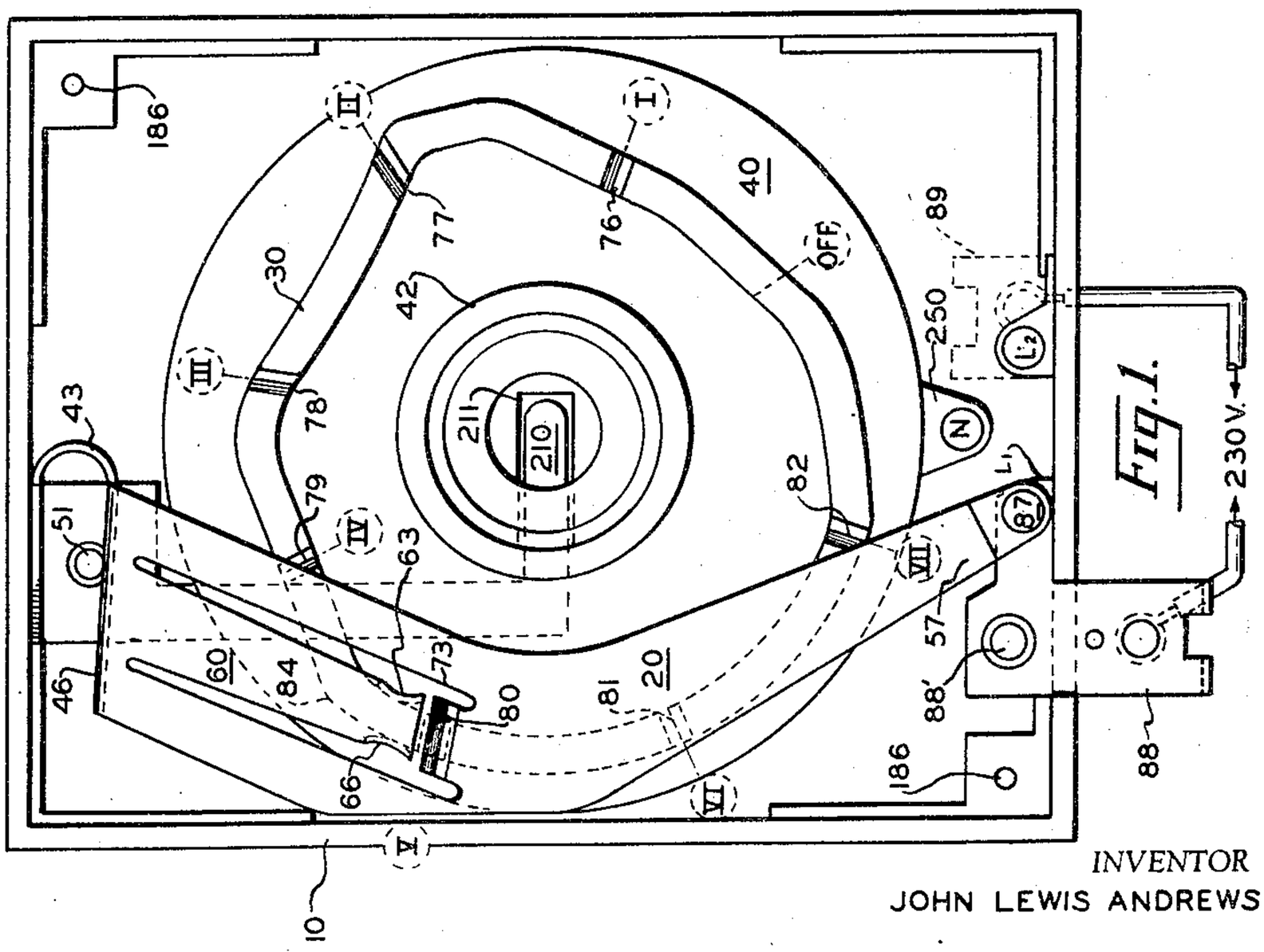

Fig. 1.

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ELECTRIC BURNER SWITCH

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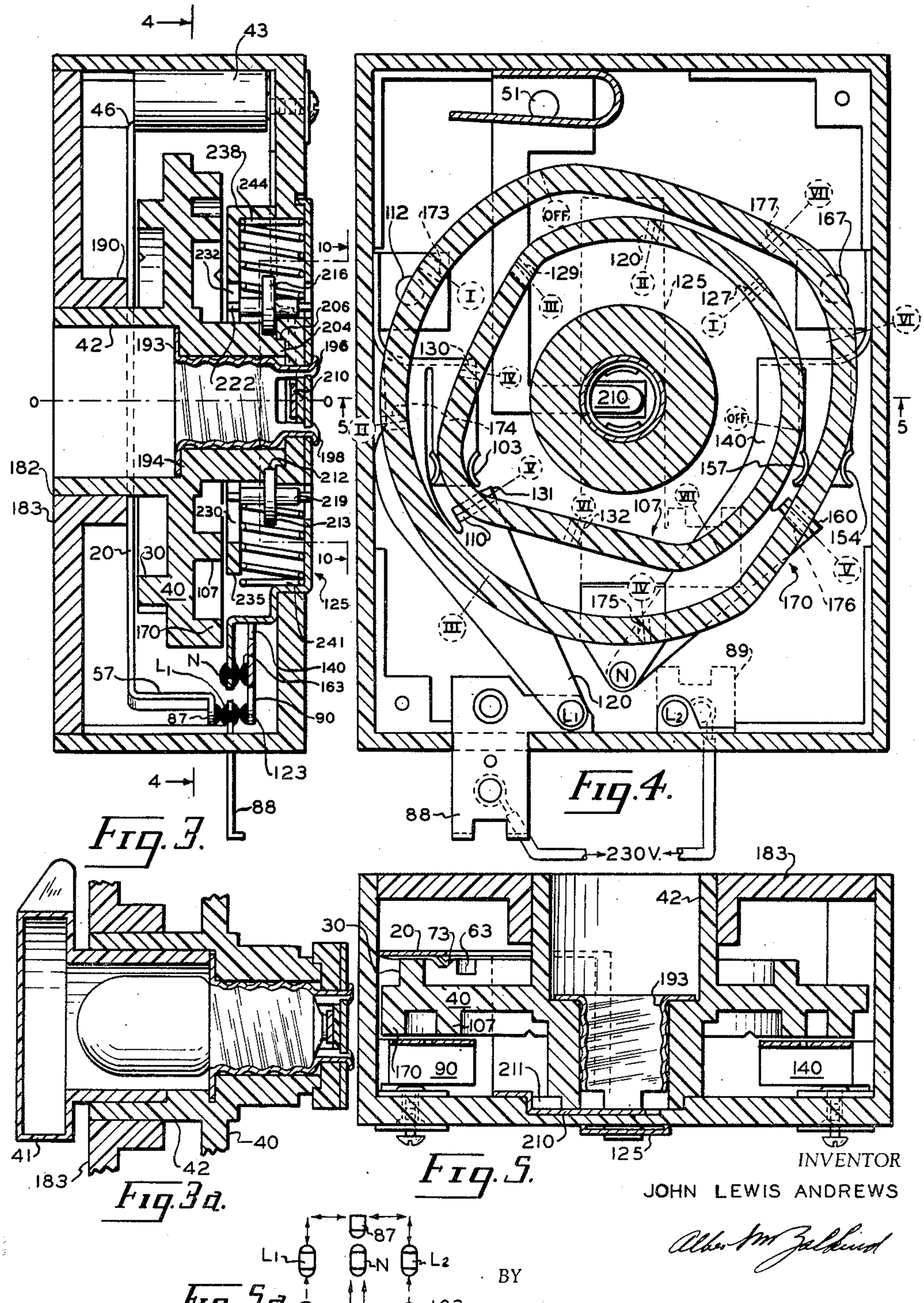

Fig. 4.

Fig. 3.

Fig. 3a.

Fig. 5.

Fig. 5a.

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ELECTRIC BURNER SWITCH

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Fig. 6.

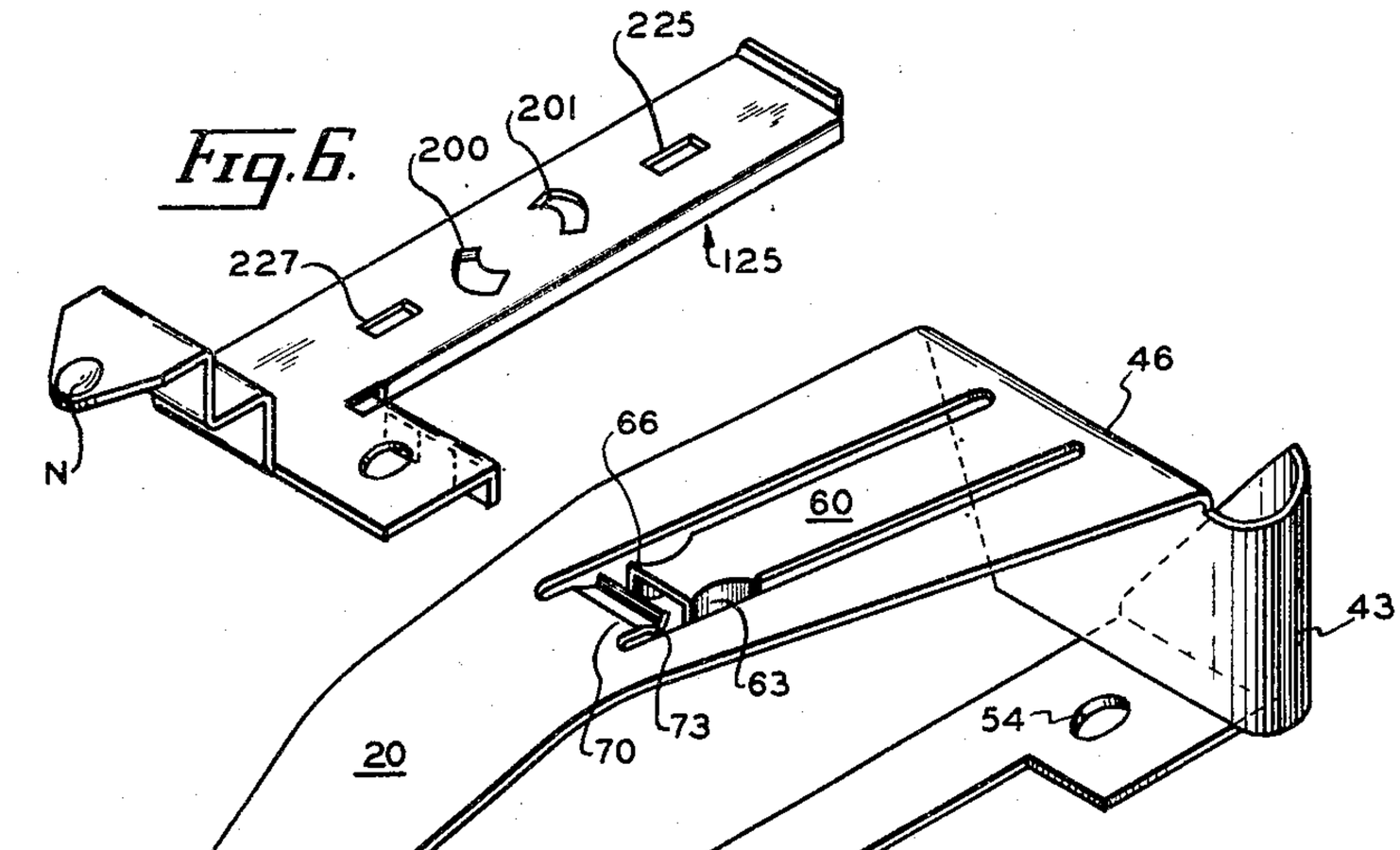


Fig. 7.

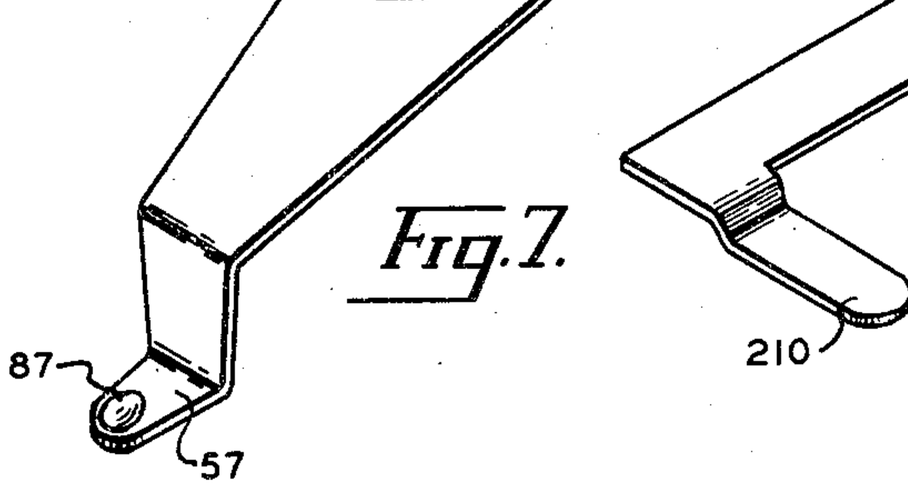


Fig. 8.

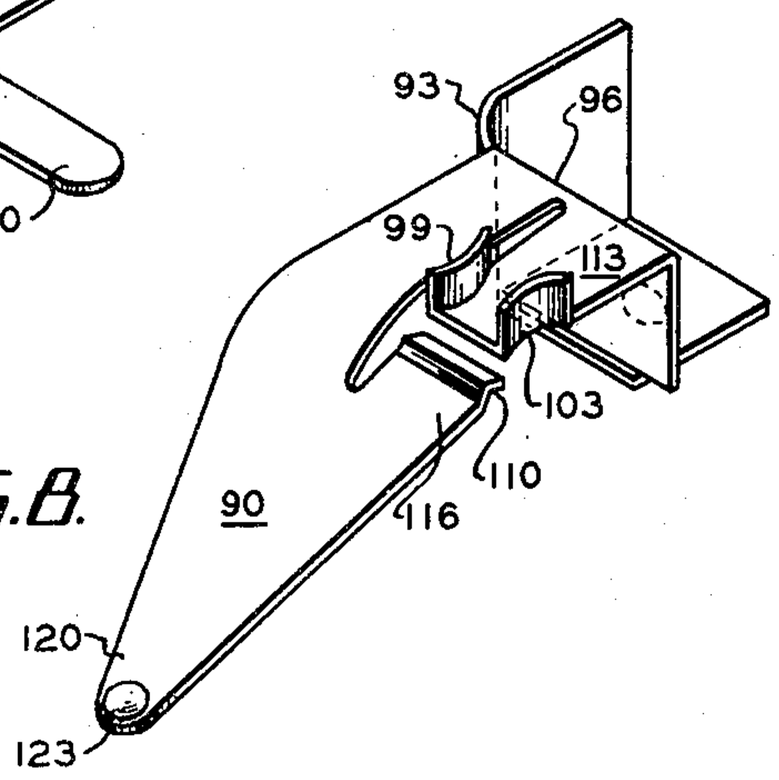
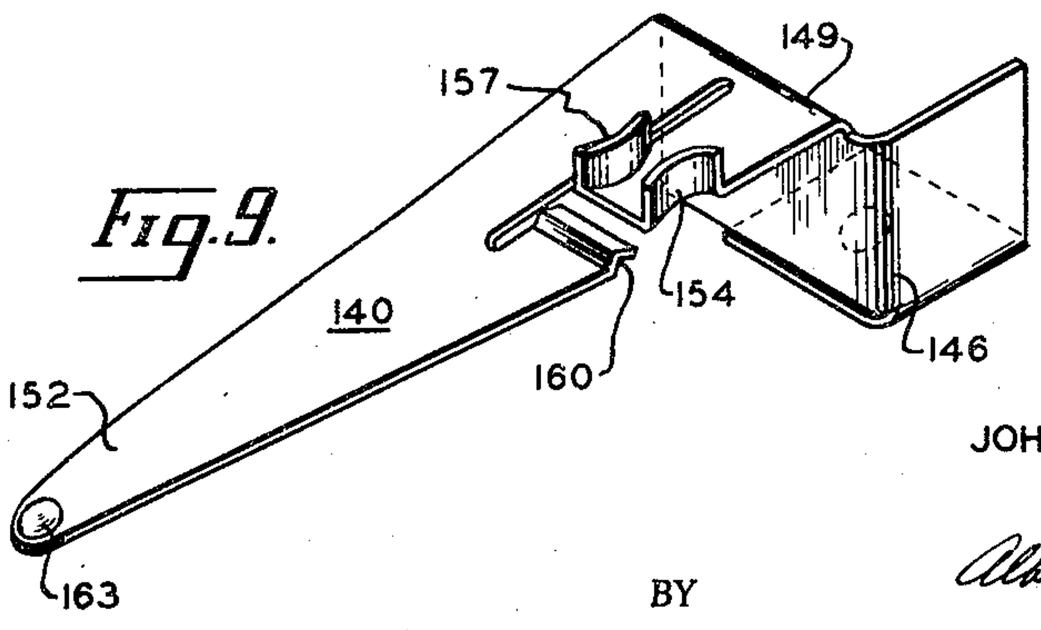


Fig. 9.



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ELECTRIC BURNER SWITCH

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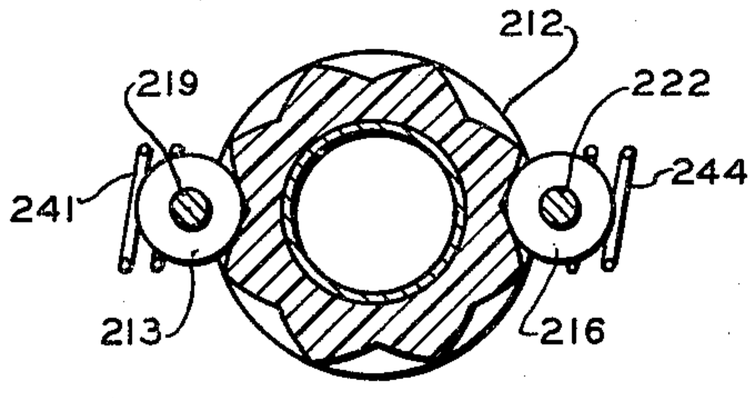
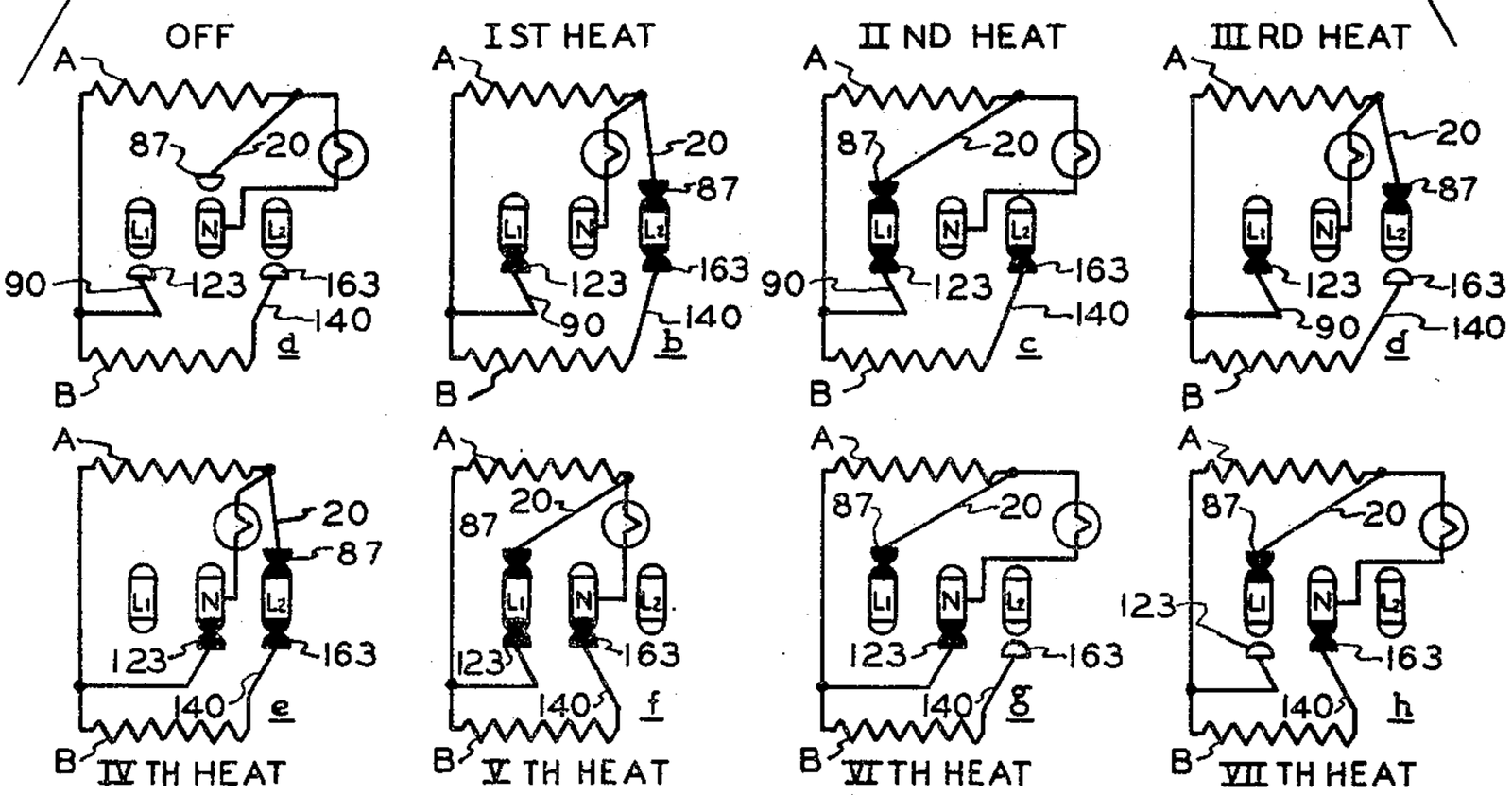


FIG. 10.

FIG. 11.



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ELECTRIC BURNER SWITCH

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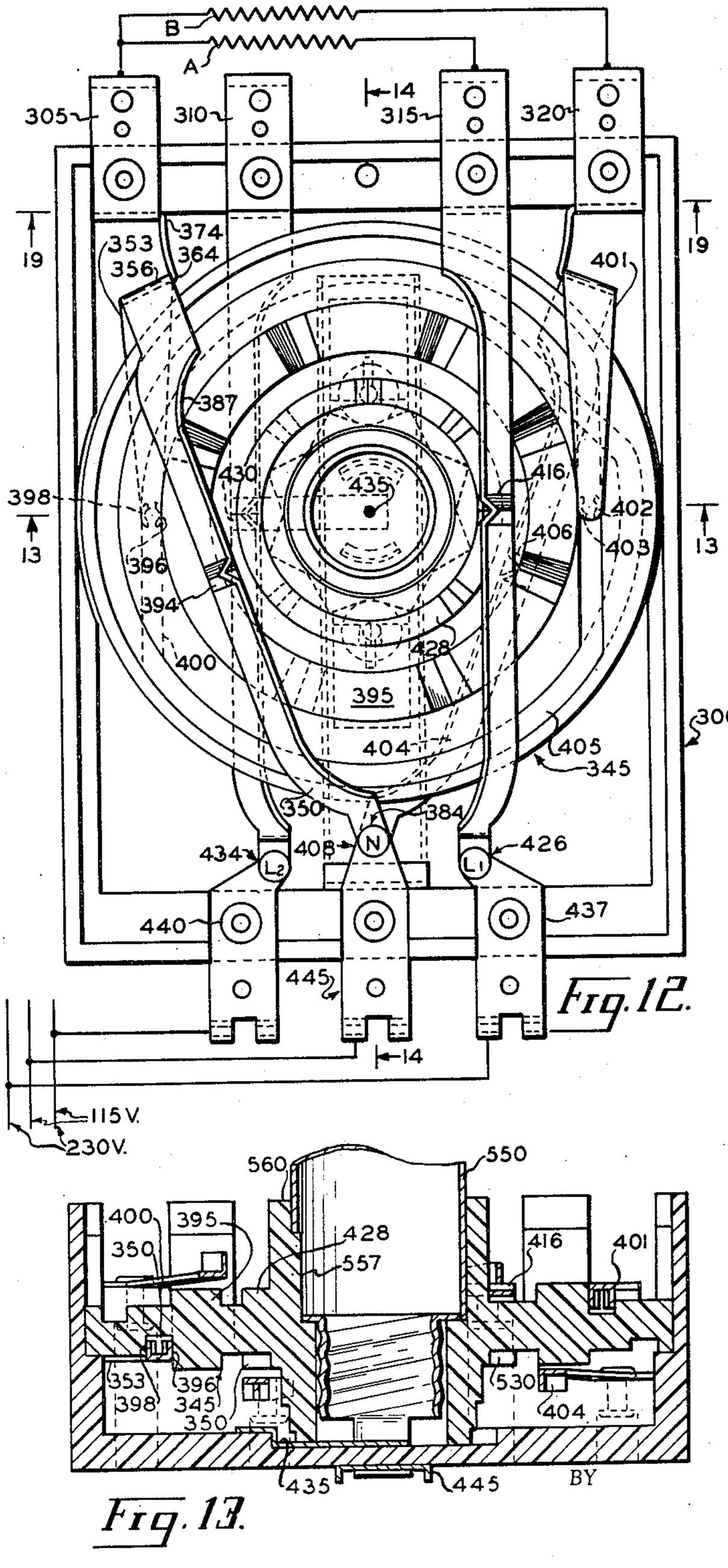

Fig. 12.

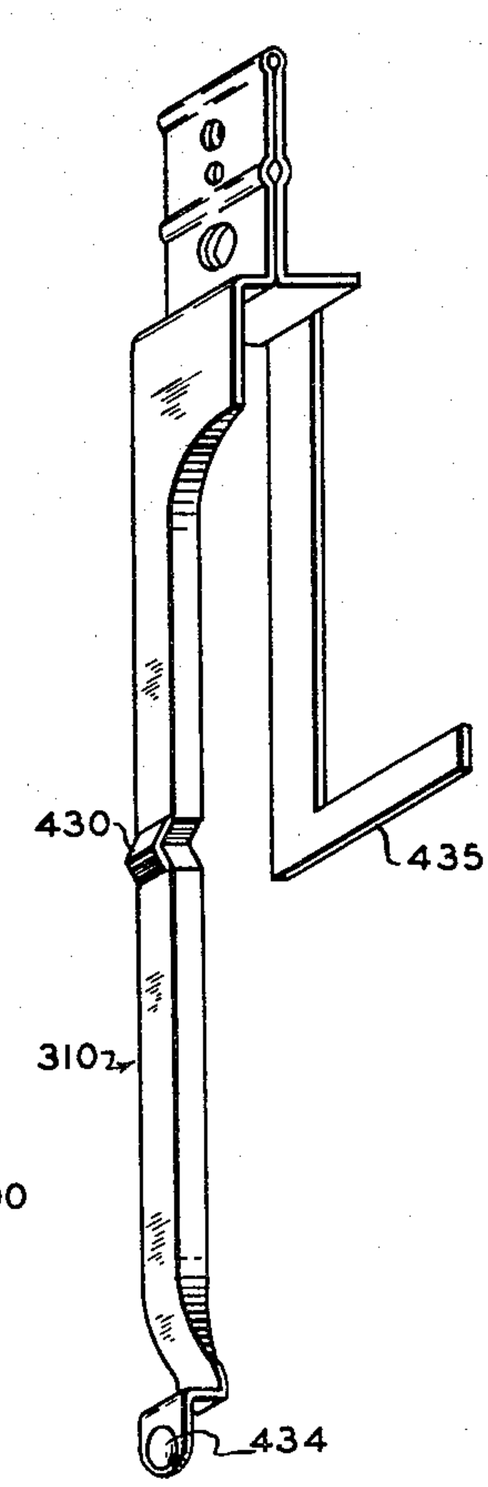

Fig. 12a.

Fig. 13.

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ELECTRIC BURNER SWITCH

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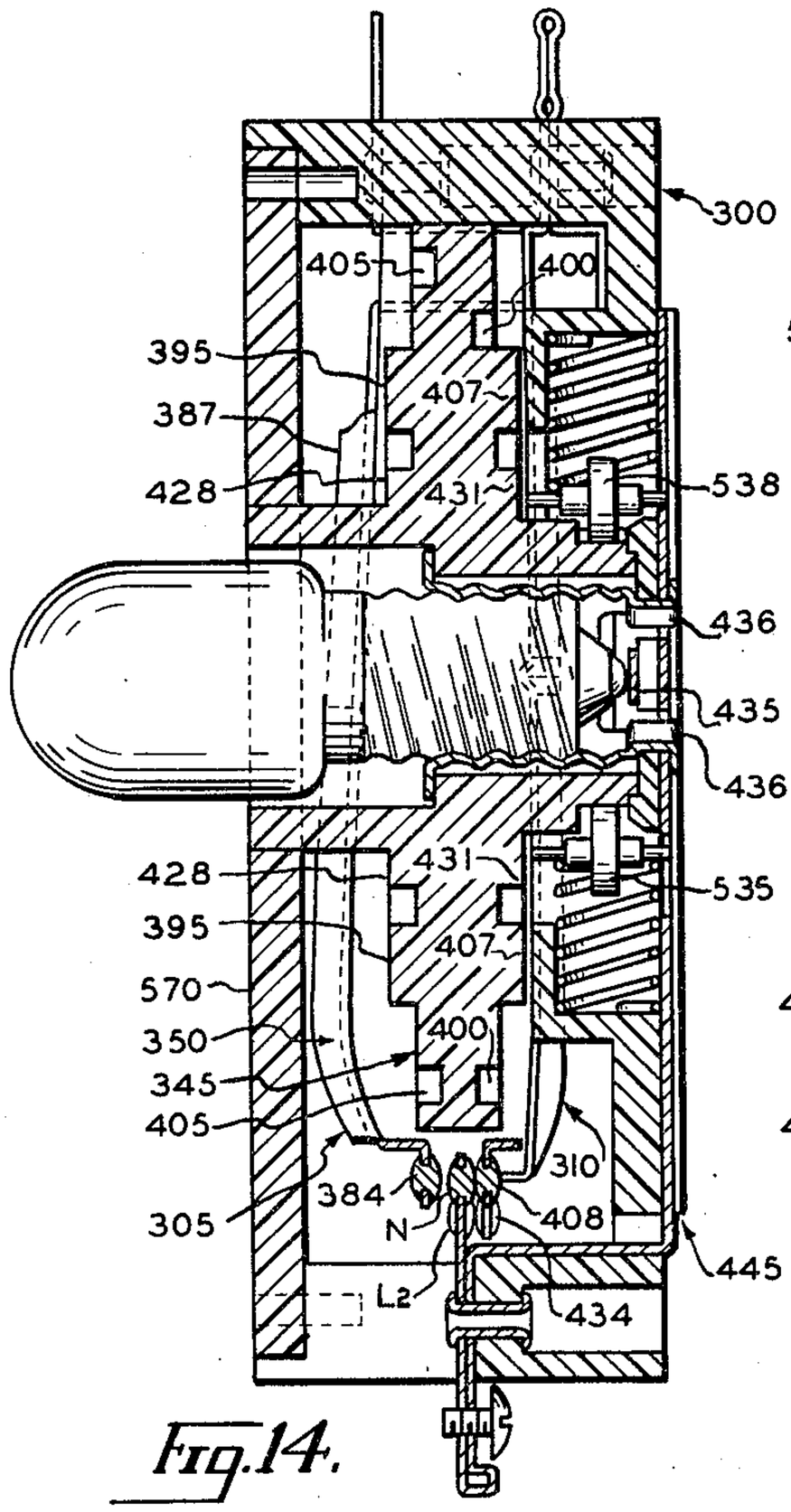

Fig. 14.

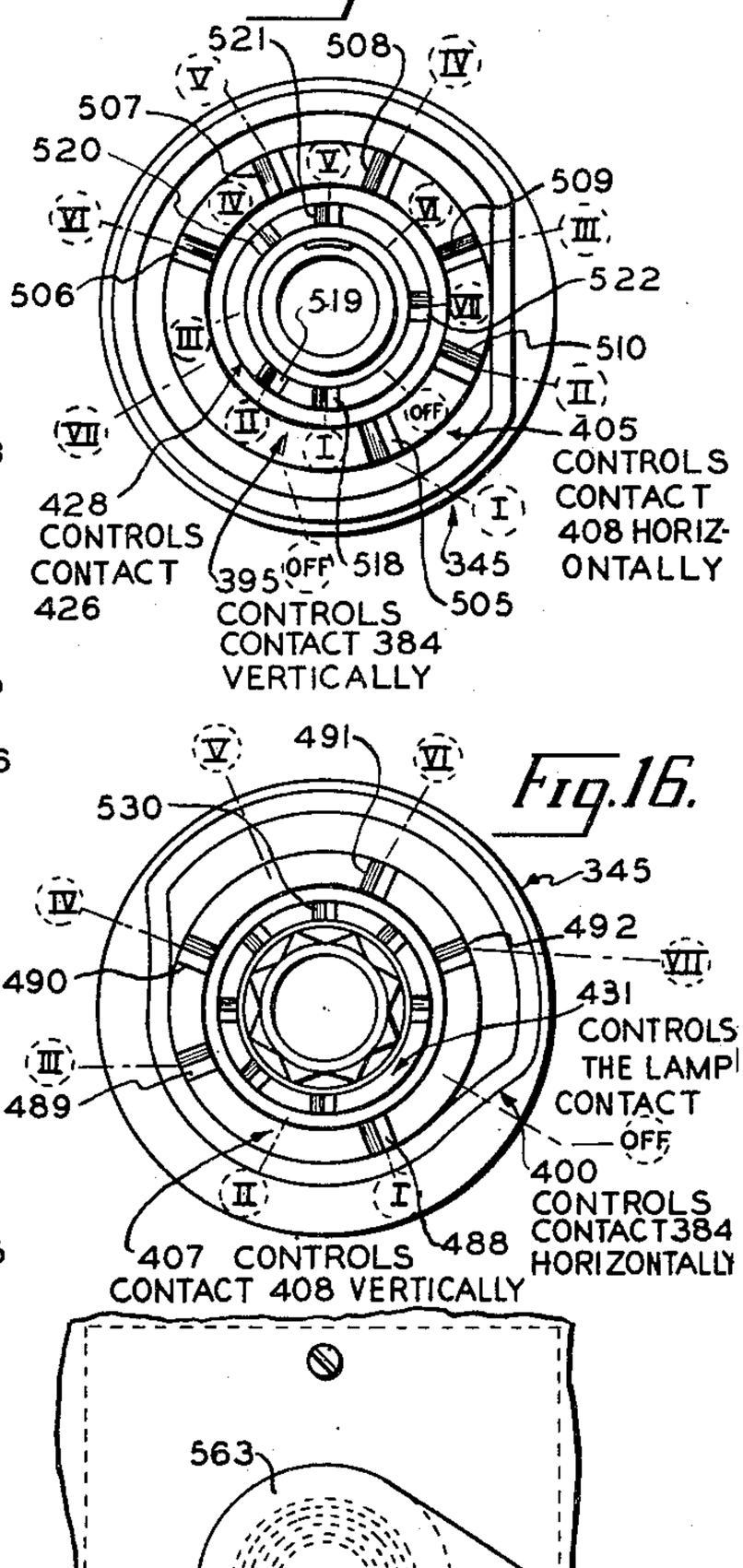

Fig. 15.

Fig. 16.

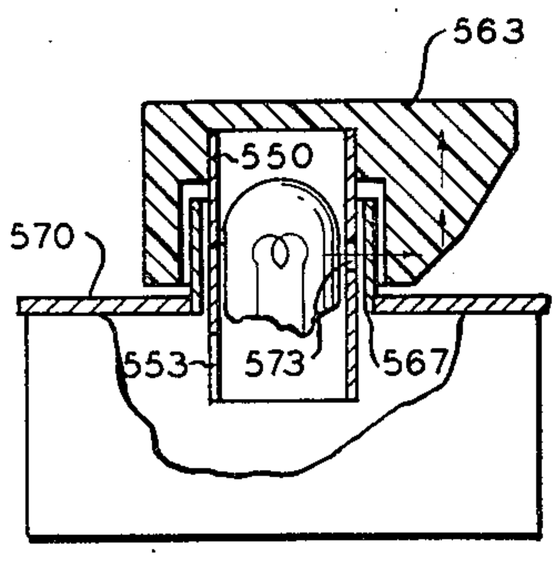

Fig. 17.

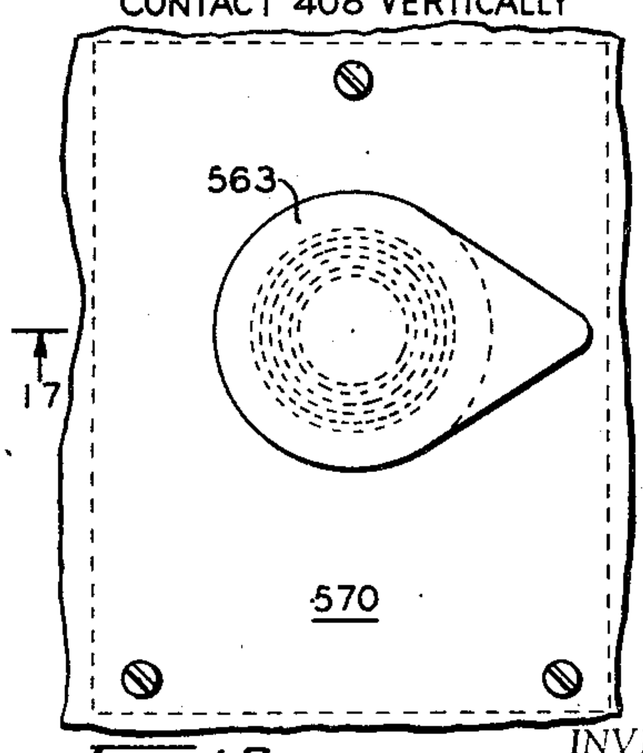

Fig. 18.

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ELECTRIC BURNER SWITCH

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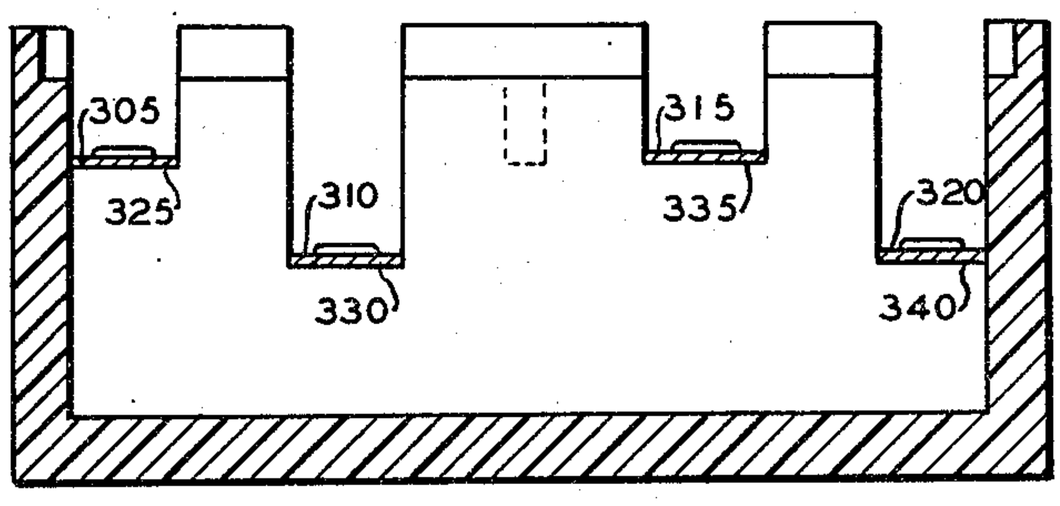

Fig. 19.

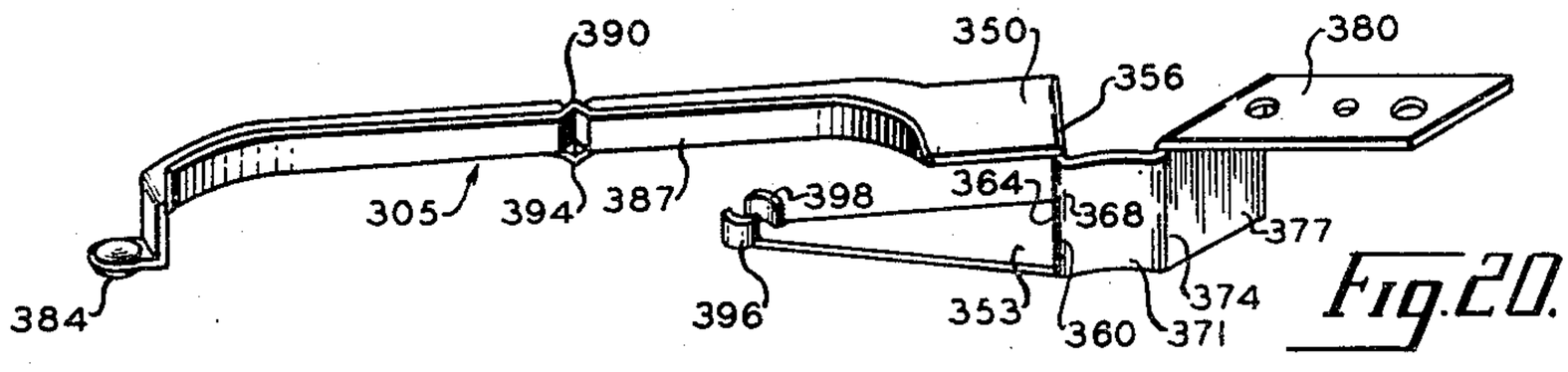

Fig. 20.

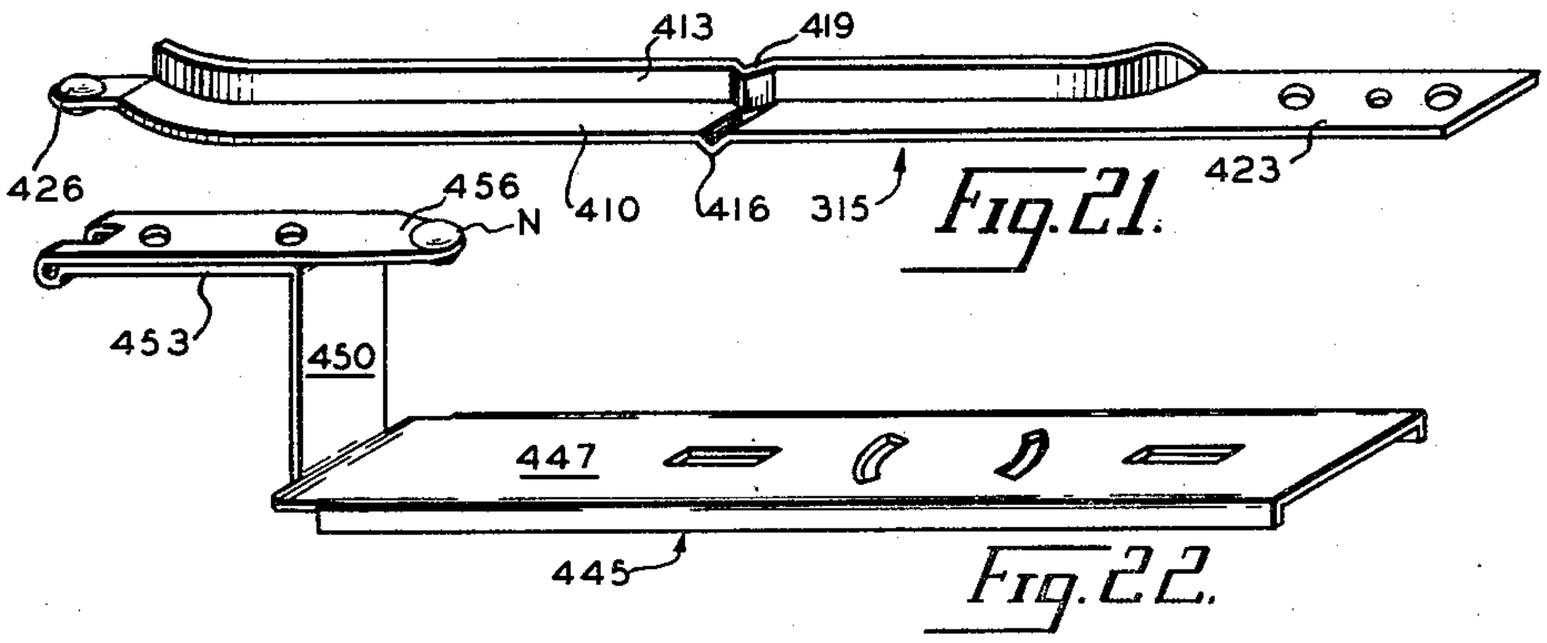

Fig. 21.

Fig. 22.

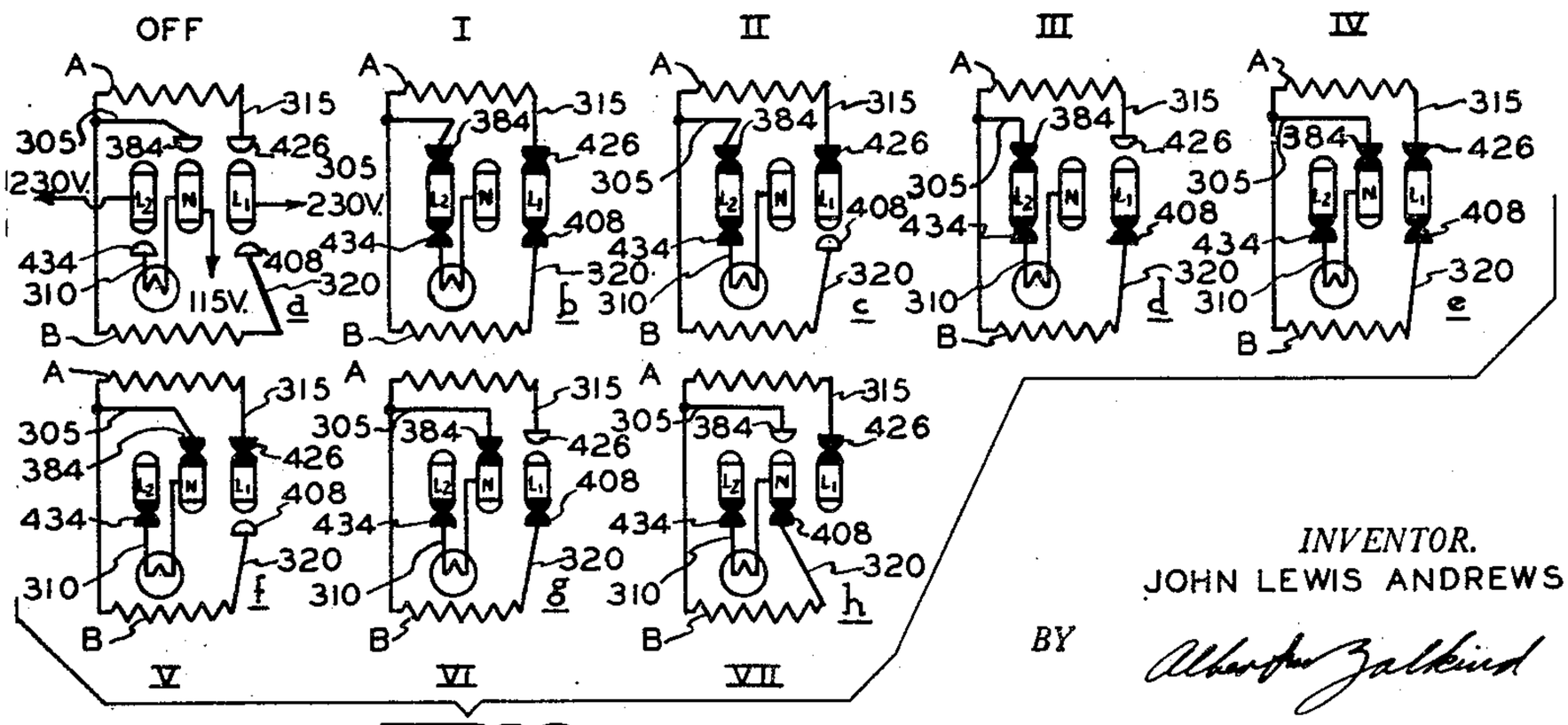

Fig. 23.

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ELECTRIC BURNER SWITCH

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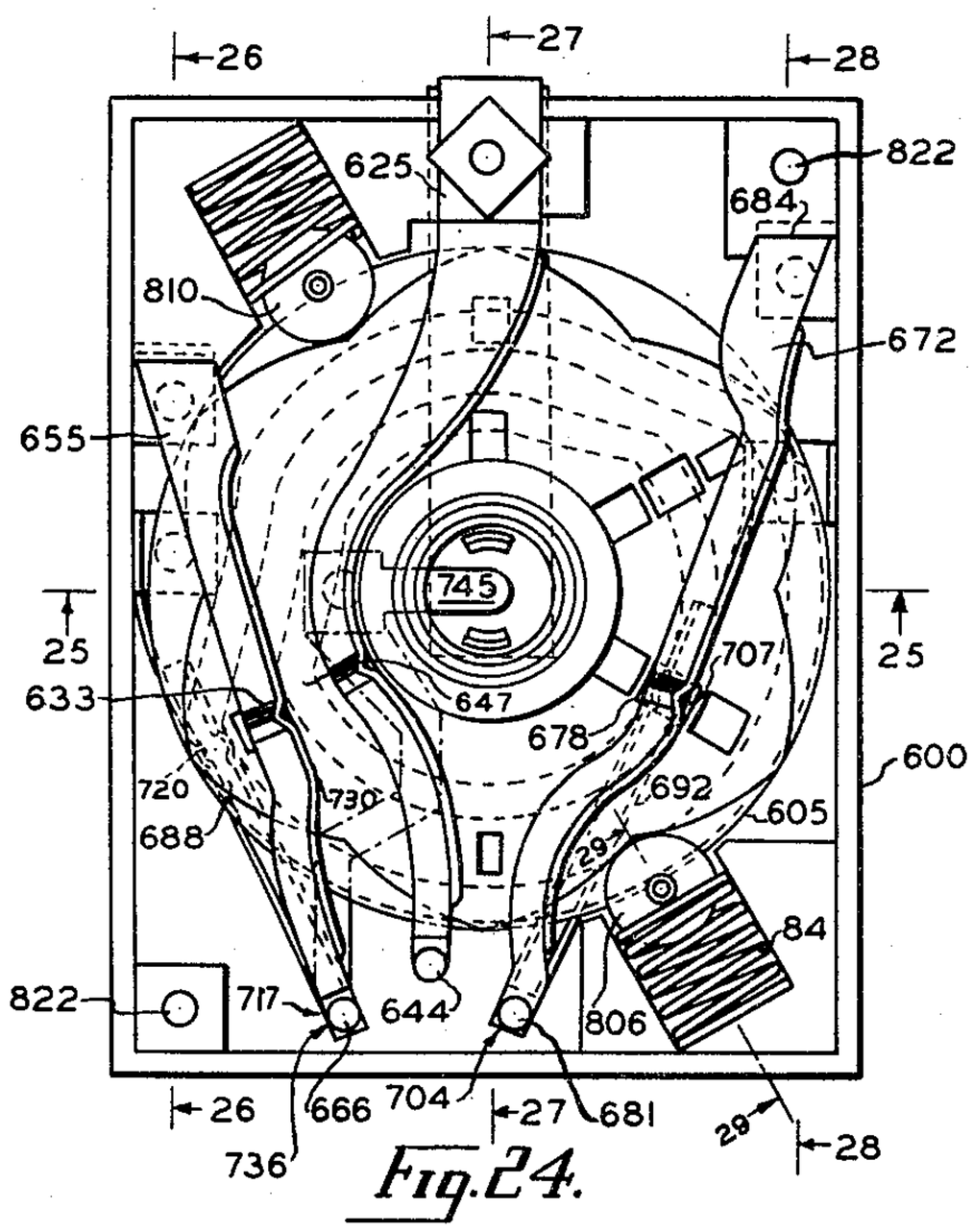
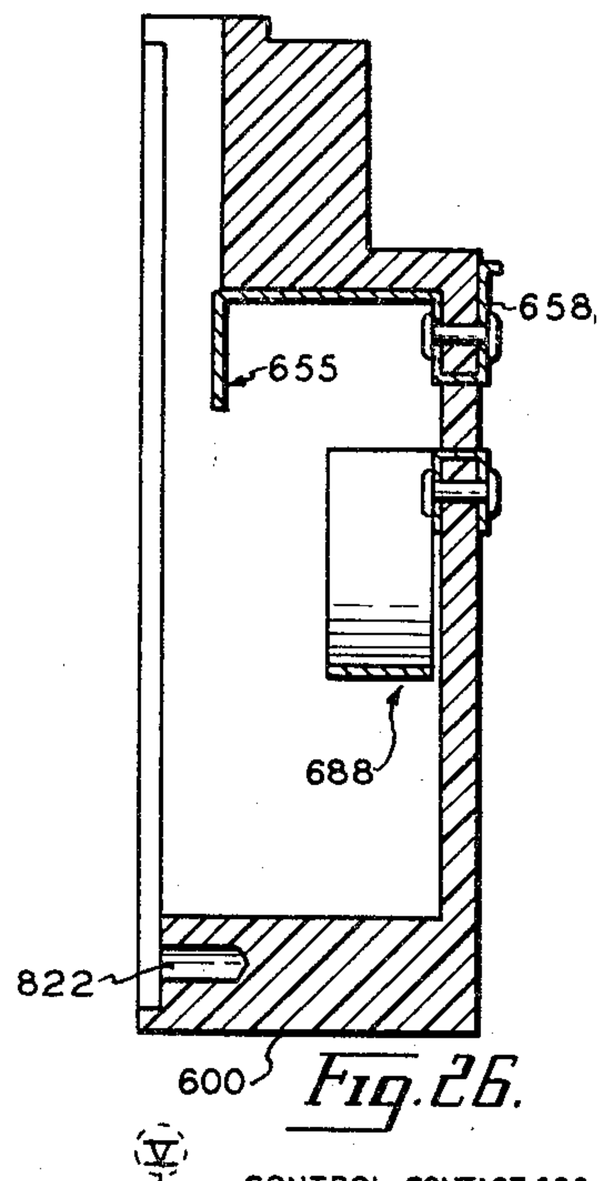


Fig. 24.



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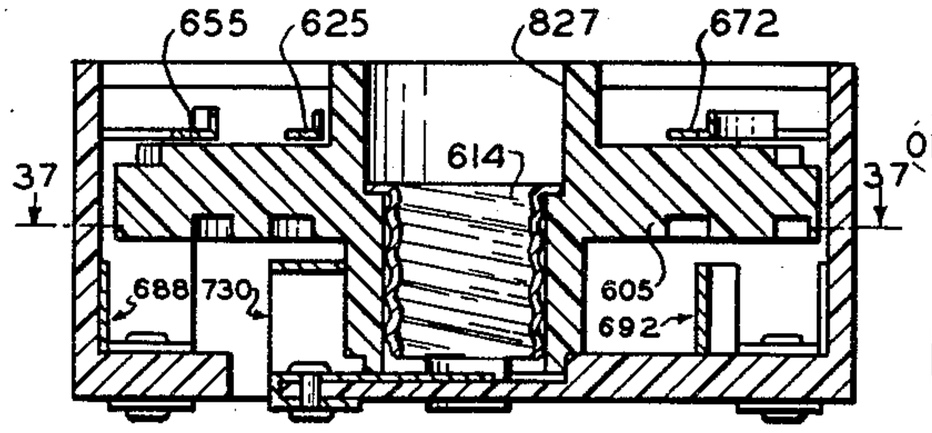

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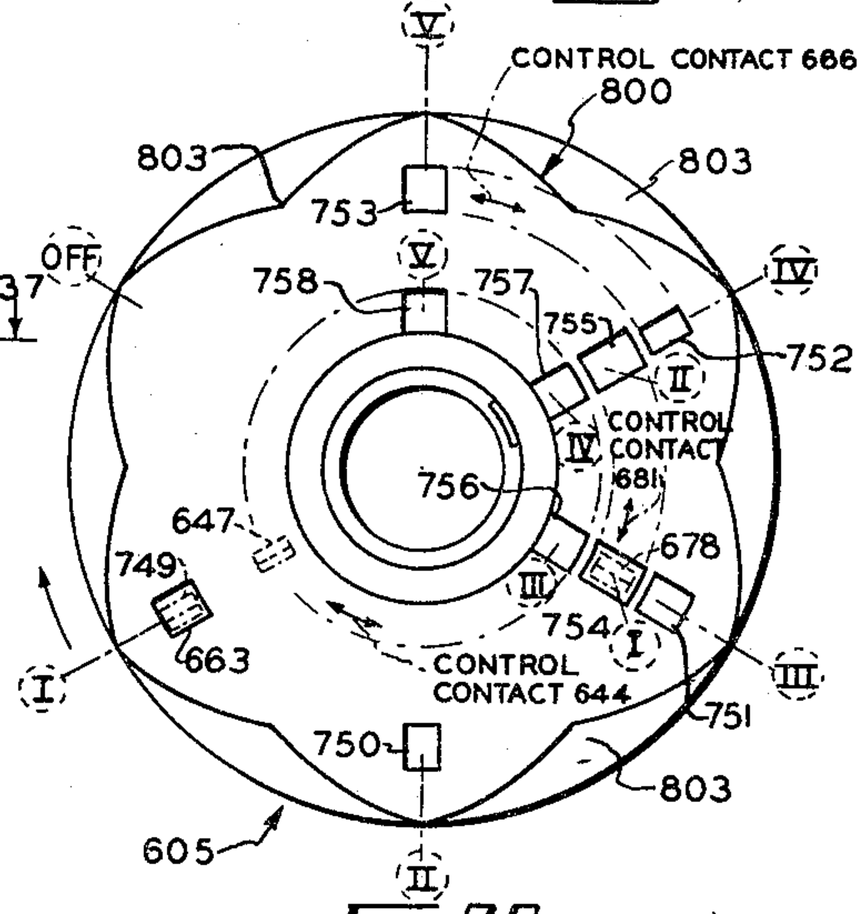

Fig. 36.

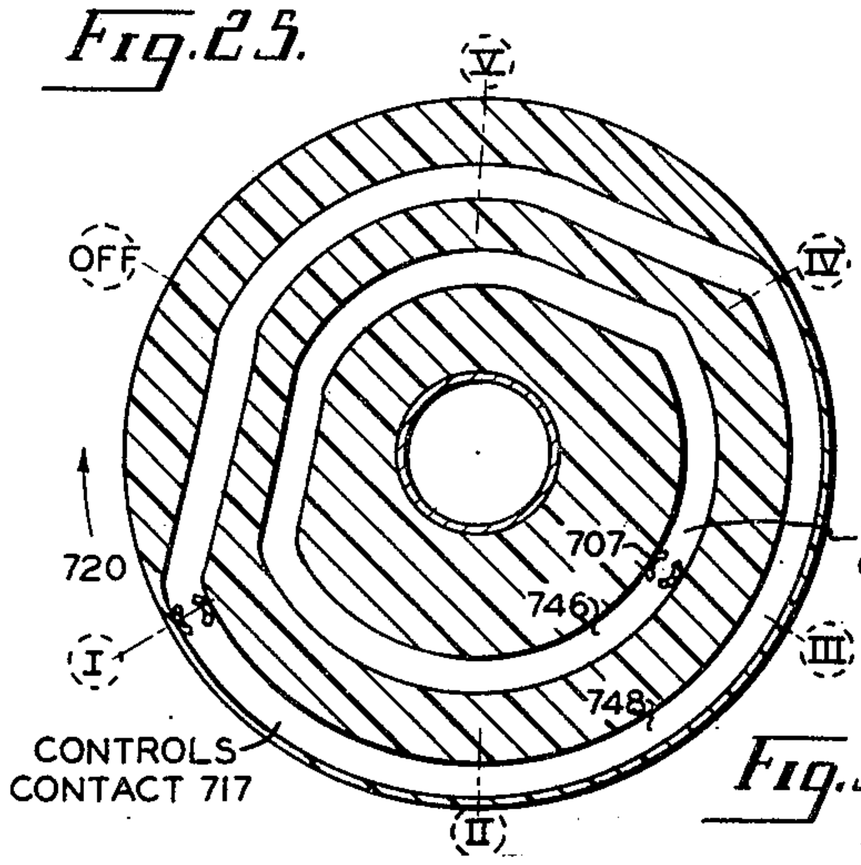

Fig. 37.

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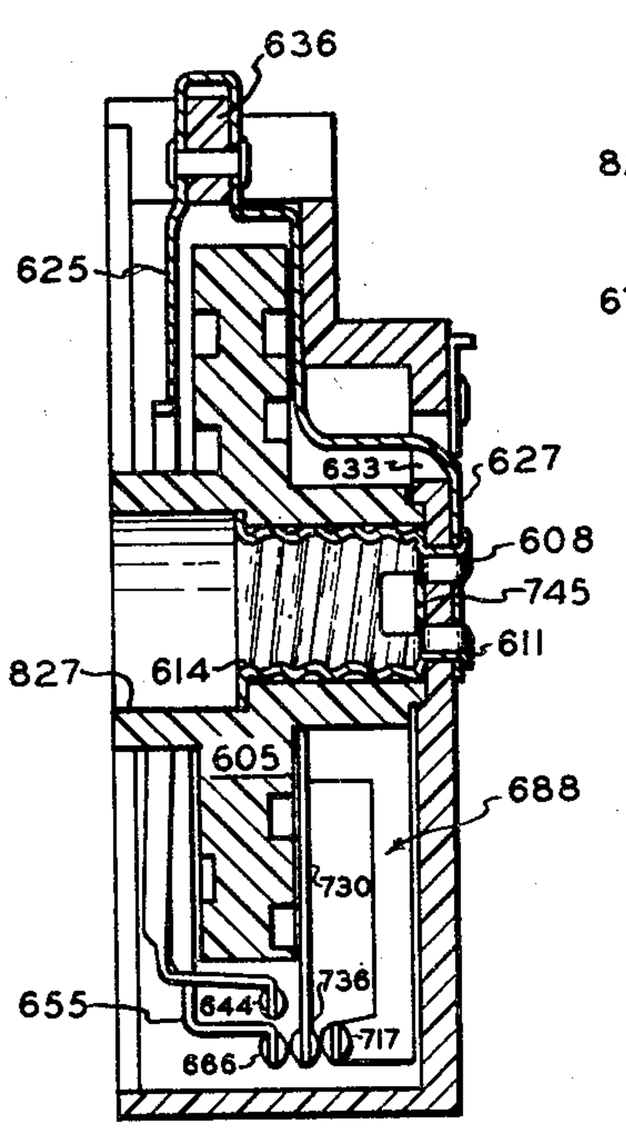
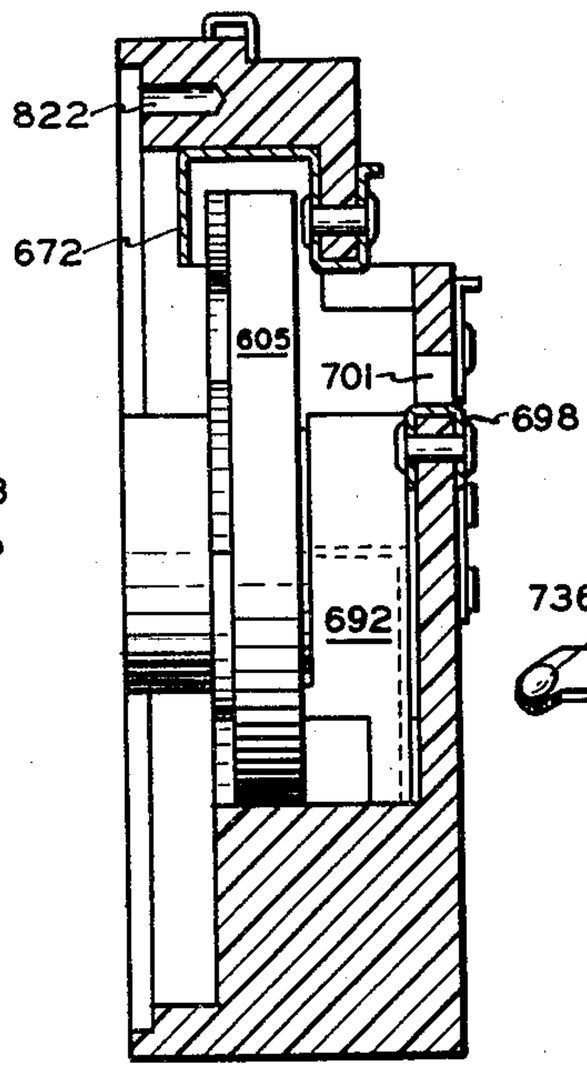


Fig. 27.



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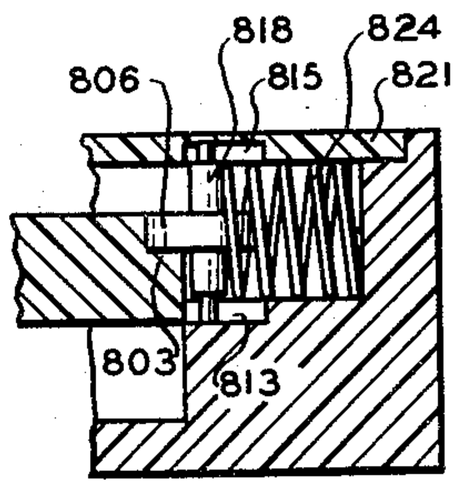

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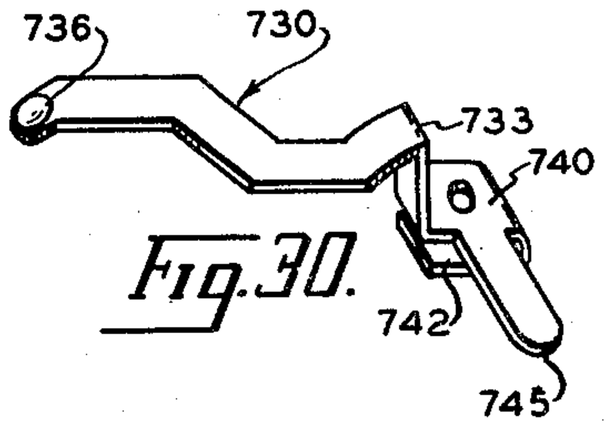

Fig. 30.

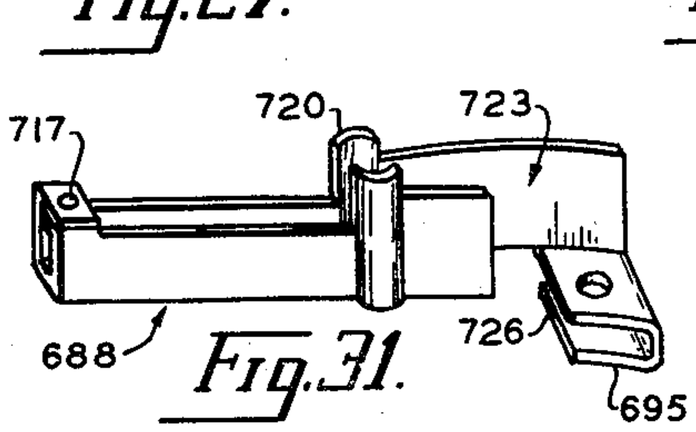

Fig. 31.

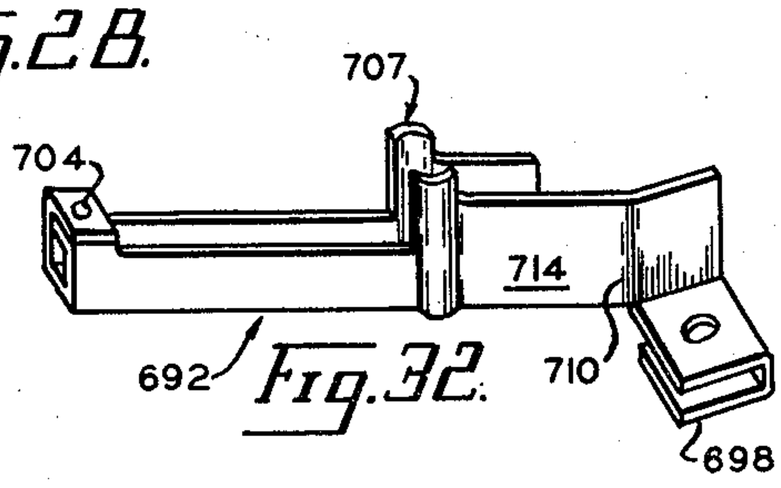

Fig. 32.

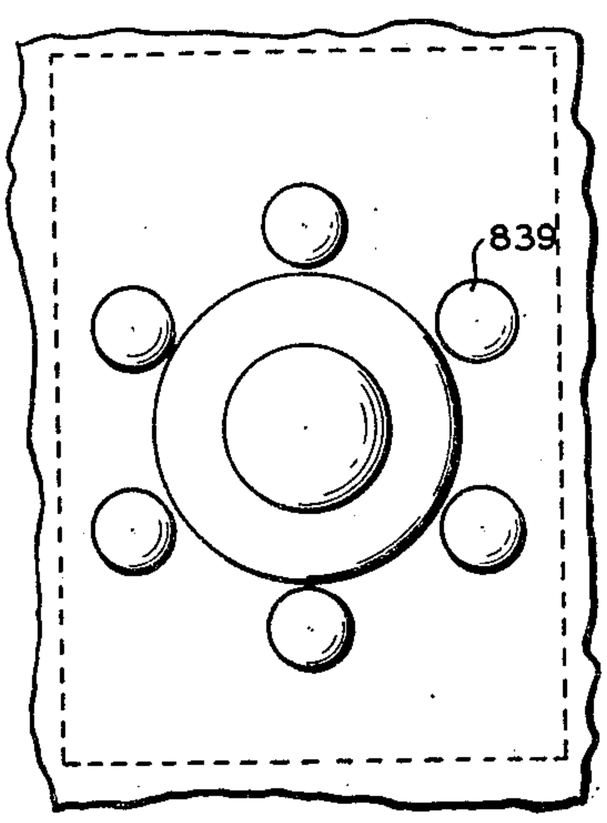

Fig. 39.

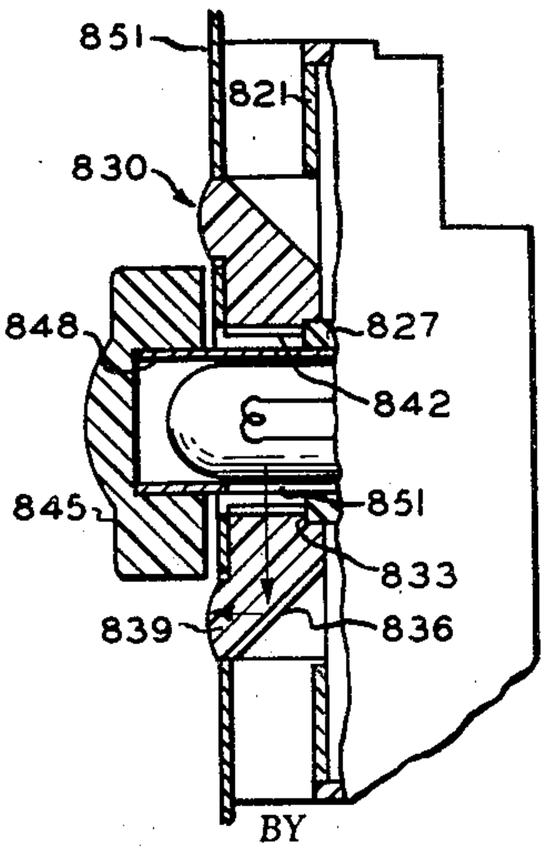

Fig. 38.

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ELECTRIC BURNER SWITCH

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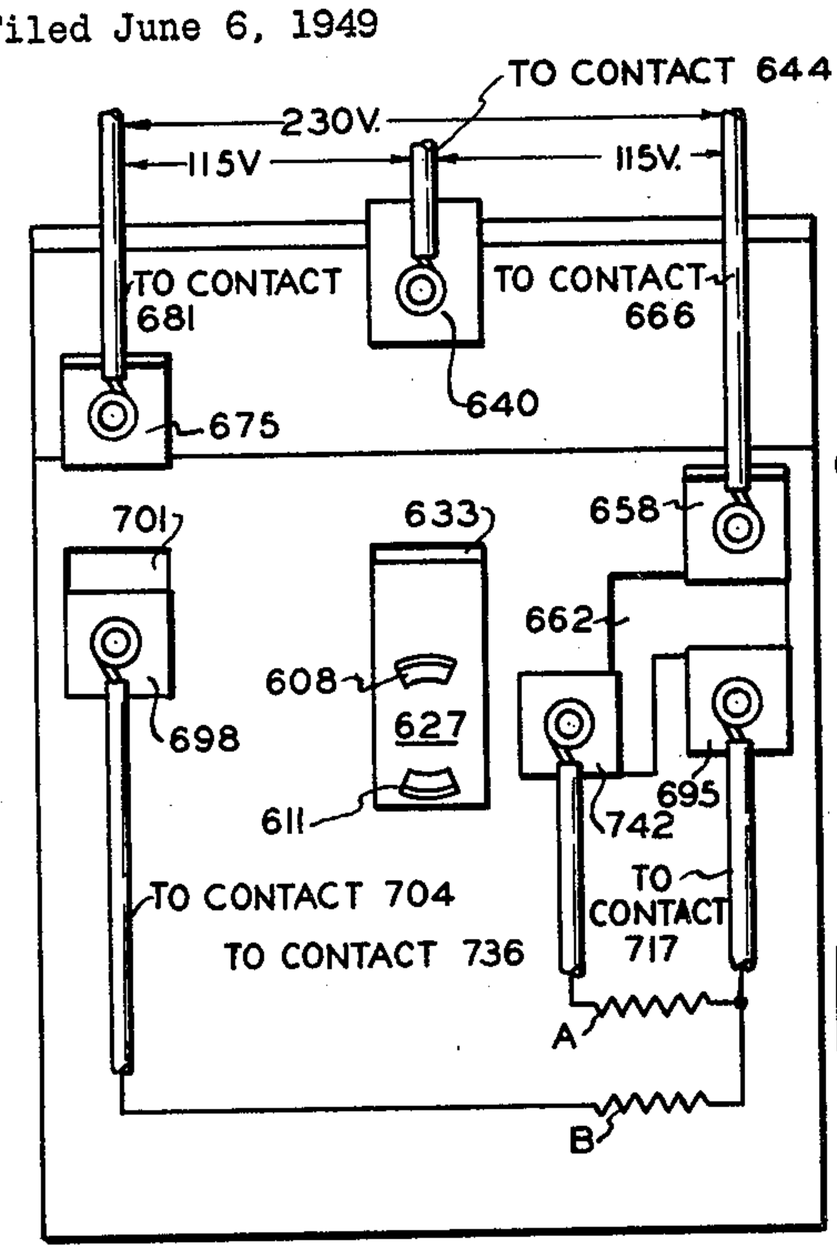

Fig. 35.

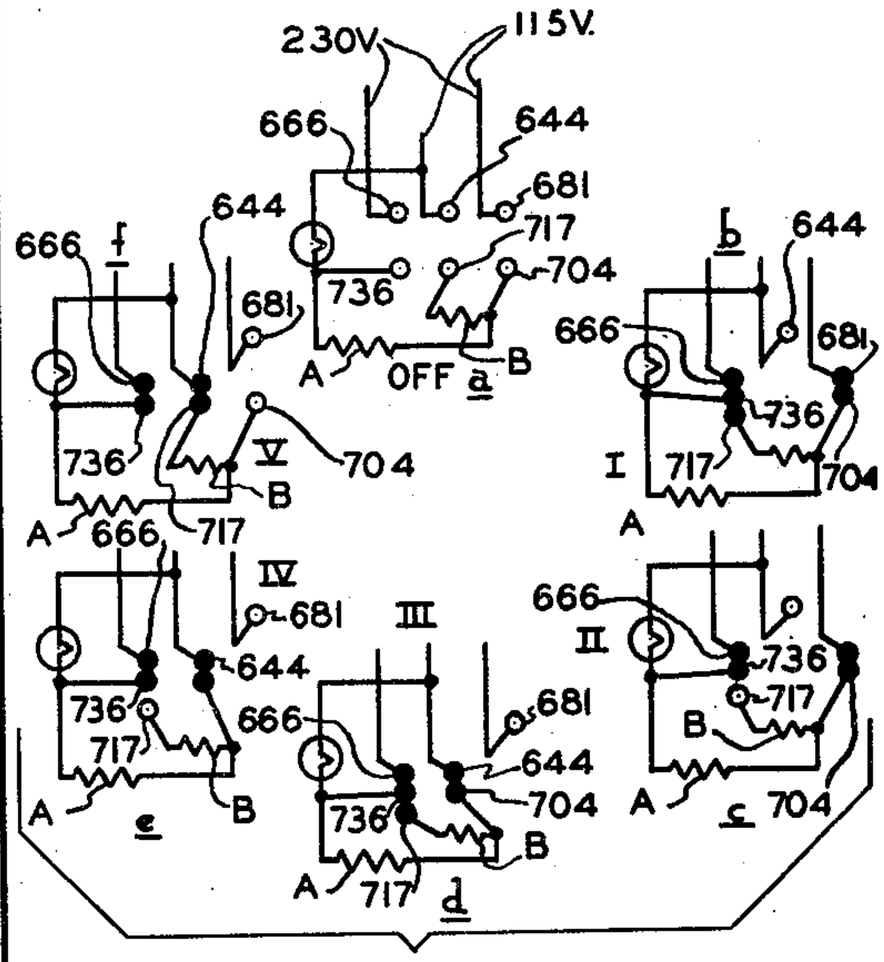

Fig. 40.

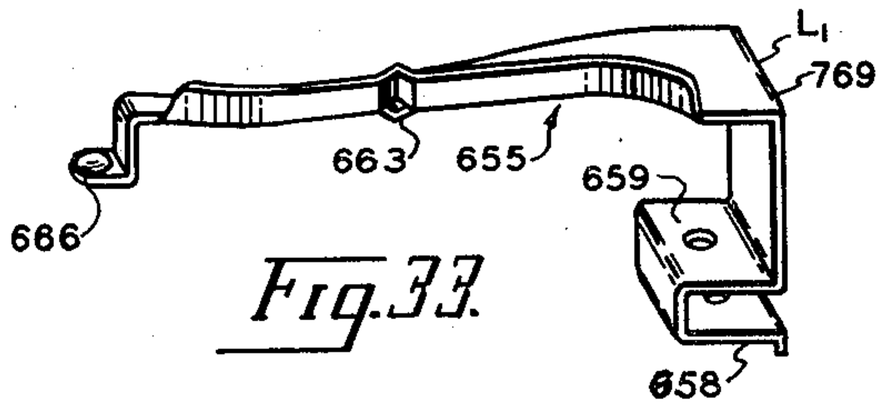

Fig. 33.

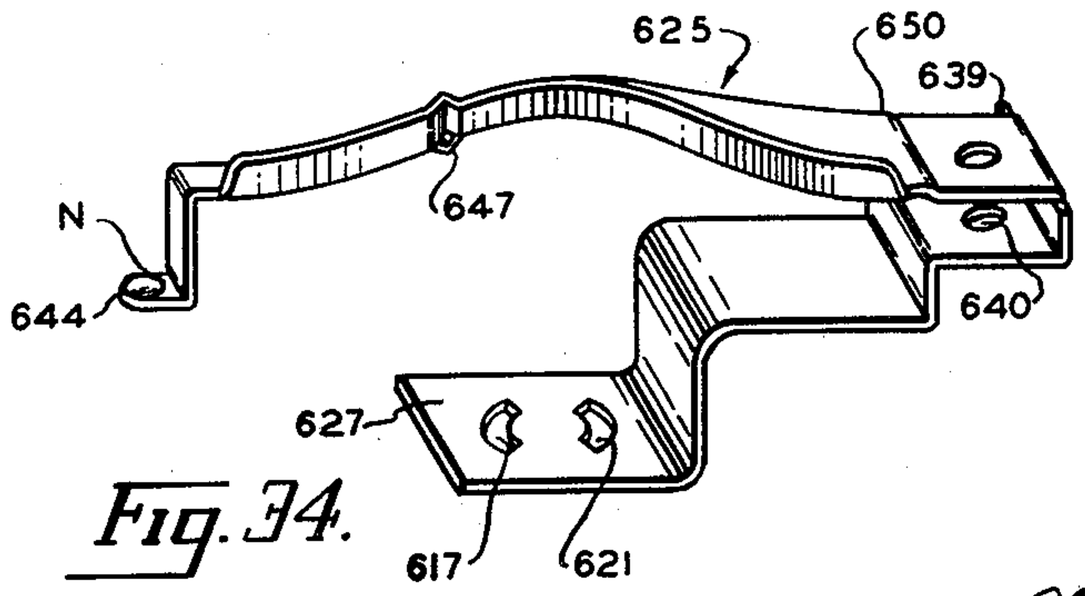

Fig. 34.

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United States Patent Office

2,710,323

Patented June 7, 1955

2,710,323

ELECTRIC BURNER SWITCH

John Lewis Andrews, Fairfield, Ill.

Application June 6, 1949, Serial No. 97,425

24 Claims. (Cl. 200—153)

This invention relates to multiple switches and more particularly to a switch for use in conjunction with the burner of a domestic range.

It is an object of the invention to provide a switch to be used for connecting two electric coils of an electric range burner in various combinations with the line and neutral conductors of a power source so that a variety of heats may be conveniently provided.

It is another object of the invention to provide a multi-switch of simple construction and utilizing a minimum number of parts.

It is a further object of the invention to provide a switch structure which may be economically manufactured.

It is an additional object of the invention to provide a switch structure having a minimum number of moving components.

It is a still further object of the invention to provide a multi-switch of the rotary type but so constructed as to have a lamp incorporated therein for illumination of the face of the switch or for selective indication of corresponding to various heats, wherein the lamp forms a part of the burner switching system and requires no extra mechanism for control.

Another object of the invention is to provide a switch mechanism such that a minimum number of precious metal contacts are required.

A further object of the invention is to provide a switch mechanism for use in conjunction with a particular system comprising heater coils and line conductors in such a manner as to effect a simple electrical combination therebetween; whereby a novel circuit is achieved.

Additional objects of the invention are to provide a switch which is unusually rugged in construction, easily assembled or disassembled, and having no fragile or delicate parts likely to get out of order.

In addition to all of the above objects a very important object of my invention is to provide a novel switching mechanism such that any danger of spark carry-over from one contact to another is virtually eliminated.

It is a well known fact that one of the drawbacks of rotary type switches of the prior art resides in spark carry-over by the switch arm as it moves from one contact to the next succeeding contact. This is termed "blow-out" in the trade and may result in serious consequences under aggravated conditions wherein heavy currents are carried. The "blow-out" effect which may result in a short circuit through the spark path, is frequently caused when the switch arm is moved too fast, so that it literally pulls the spark with itself from a first contact to a second contact. Accordingly, it has been customary to move the switch arms of rotary switches slowly so as to give the spark a chance to damp out before the switch arm reaches the next succeeding contact. By a novel, though simple construction, I effect a lengthening of the path of movement of the switch arm between contacts by providing a broken path for the arm; that is, the end of the arm in leaving a contact moves in a predetermined direction but prior to reaching the next contact changes direction, whereby the total length of motion of the contact end of the arm is substantially increased and the time of motion in

breaking engagement is relatively slow, though speeded up in passing from one contact to the next contact, the total time for the complete composite motion being dependent on the design of the particular mechanism.

A further drawback of prior art switches is their complexity, especially where a large plurality of heats is provided for. I overcome this by a novel arrangement of switching elements in conjunction with a pair of burner resistances which have two ends permanently connected in series, all as will hereinafter be described.

In general, my switch construction comprises a housing and a cam rotatably supported therein; a plurality of switch arms are also supported in the housing which arms cross over the cam segmentally and have an end fixedly joined to the housing at respective points while being free at their opposite ends. In order to effect as compact a construction as possible, I mount my switch arms on both sides of the cam, the cam being provided with arm actuating means comprising formations for engaging respective switch arms to deflect them in predetermined paths as the cam is rotated. The free ends of the arms carry contacts for simultaneous selective engagement with, or disengagement from, certain other contacts which connect to the line and neutral conductors of the power supply. By utilizing a novel mode of connecting the burner coils and switch arms in relation to the line and neutral conductors, a minimum number of precious metal contacts are required. Further, a balanced load is achieved for certain heats.

In at least two forms of my invention, I show constructions wherein the arms and the arm actuating means on the cam are so formed and co-act in a manner such that as the cam is rotated to actuate one or more arms, depending on the specific circuit desired, the actuated arms disengage from stationary line conductor contacts in which they happen to be in engagement by moving initially in a substantially normal direction from such contacts. In other words, with reference to the axis of the rotary cam the free ends of the motivated arms first move in a direction parallel to the axis of the cam to disengage from the line conductor controls, whence continued rotation of the cam deflects the arms laterally to bring them opposite contacts with which they are to engage, and the final action of the cam drops the free end of the arms on the latter contacts. In order to achieve this co-action, I provide switch arms wherein each has two cam followers while the cam has individual formations co-acting with each of the followers. The arm actuating means on the cam for each switch arm is so devised as to provide the bi-planar motion, in angularly related paths, for respective switch arms in a sequential order as described above.

Another form of the invention provides for single plane motion of the arms and also of the line conductor contacts in such a manner as to achieve a bi-planar effect as will be later described, wherein the switch arms are movable in one plane and the line conductor contacts are movable in different planes, and the cam is devised to motivate these members in a sequential order so as to preserve the angularly related motion therebetween.

In addition to the features hereinabove set forth, my novel switch structure also incorporates certain other unique features such as an indexing means, a color filter in conjunction with the lamp, etc. and many other constructional features of an improved nature.

With the foregoing objects, features and general description in mind, a detailed description of my invention and its various modifications will now be given in conjunction with the appended drawings in which:

Figure 1 is a plan view of the casing showing one of the switch arms and the cam in operative position, the

top of the casing being left open and only certain elements being disclosed therein, for clarity.

Figure 2 is a view of the bottom of the casing showing a power conductor carried thereby and the manner in which it is secured to the bottom wall.

Figure 3 is a cross-section through 3—3 of Figure 2 showing many essential elements and in particular showing all contact engagements for one of the heats.

Figure 3*a* is a cross-section showing a turning knob for rotating the cam.

Figure 4 is a cross-section through 4—4 of Figure 3.

Figure 5 is a cross-section through 5—5 of Figure 4.

Figure 5*a* shows schematically the reversible paths of motion of the various switch arms.

Figure 6 is a perspective of the neutral bus.

Figure 7 is a perspective of the switch arm shown in Figure 1.

Figures 8 and 9 show perspectives of other switch arms as used in this modification.

Figure 10 is a cross-section through 10—10 of Figure 3.

Figures 11*a* through 11*h* show diagrammatically the various circuits set up by the switch to provide seven selective heats.

Figure 12 is a top plan view of a second form of my invention.

Figure 12*a* is a perspective of a switch arm used exclusively for lamp control.

Figure 13 is a section through 13—13 of Figure 12.

Figure 14 is a section through 14—14 of Figure 12.

Figure 15 is a view of the outer side of the cam.

Figure 16 is a view of the inner side of the cam.

Figure 17 is a sectional view showing certain details of the illuminating system.

Figure 18 is a plan view of the rotating knob.

Figure 19 is a section through 19—19 of Figure 12.

Figure 20 is a perspective of one of the switch arms.

Figure 21 is a perspective of another of the switch arms.

Figure 22 is a perspective of the neutral conductor.

Figure 23*a* through 23*h* is a series of circuit diagrams of the seven heats provided by this form of the invention.

Figure 24 is a plan view looking into the housing of a third form of my invention, comprising a five heat switch.

Figure 25 is a section through 25—25 of Figure 24.

Figure 26 is a section through 26—26 of Figure 24.

Figure 27 is a section through 27—27 of Figure 24.

Figure 28 is a section through 28—28 of Figure 24.

Figure 29 is a section through 29—29 of Figure 24.

Figures 30 through 34 are perspectives of switch elements of this modification.

Figure 35 is a rear view of the housing showing the manner in which the various switch elements are secured thereto.

Figure 36 is a front view of the cam.

Figure 37 is a section of the cam through 37—37 of Figure 25.

Figure 38 is a view in section showing the illuminating system of this form of invention.

Figure 39 is a plan view of certain elements seen in Figure 38 and Figures 40*a* through *f* show circuit diagrams for the various positions of this five heat switch.

The switch arm and cam construction for effecting bi-planar motion

With reference now to the figures of the drawing, more particularly to Figures 1, 3 and 7, and disregarding for the present certain structural details in order to focus attention on the essentials of the switch arm and cam co-action, my invention comprises a molded housing 10 in which is mounted a flexible switch arm 20 deflectable by an arm actuating formation or ridge 30 integral with a plastic disc-like molded cam 40 upon rotation of the cam about its axis O—O, Figure 3. As shown in Figure 3*a*, the cam is rotated by a translucent plastic knob 41

which keys into a collar 42 on the cam and houses an electric lamp disposed in the collar. The cam may be set in any of eight positions corresponding to an "off" and seven heat positions, being maintained in a selected position by an indexing means to be later described.

As shown on Figure 7, the arm 20 consists of an elongated member of any suitable spring-like metallic material formed with angularly related bends 43 and 46.

The arm 20 is affixed to the housing 10 by a rivet 51 (Figure 1) passing through a hole 54 (Figure 7) whereby the free end generally indicated at 57 may be deflected either laterally or vertically as seen in Figure 7, lateral deflection being by virtue of bend 43 while vertical deflection is provided by bend 46. Considering Figure 1, these deflections amount to a clock-wise or counter-clock-wise pivoting of the free end 57 about bend 43 and pivotal motion out of the plane of the paper of the free end about bend 46. As seen on Figure 3, arm 20 may deflect to the left away from L1 and also out of the plane of the paper, i. e., towards L2, as will be understood by comparing with Figure 4.

The body portion of arm 20 is slotted to provide a resilient tongue 60 which terminates in a pair of spaced guides 63 and 66, as shown on Figure 7 and as further represented on Figures 1 and 5. A shorter tongue 70 is also provided in the slotted portion of the body, which latter tongue terminates in a V-shaped formation 73. The formation 73 as well as the guides 63 and 66 act as cam followers and protrude downwardly out of the plane of body member 20 so as to engage the arm actuating ridge 30 on cam 40. Thus it will be evident by comparing Figures 1 and 5 that the follower 73 rides atop the ridge. The top surface of the ridge is provided with a plurality of V-shaped depressions or notches 76 through 82 and it will be appreciated that as cam 40 is rotated the follower 73 may successively engage the various depressions 76 through 82 whereby to effect a rise-and-fall motion of arm 20 about bend 46. It will likewise be understood that follower 63, 66 is responsive to radial eccentricity of ridge 30; thus as cam 40 is rotated arm 20 will deflect about bend 43 to a degree depending on the point of engagement of the follower with ridge 30. In this connection it should be noted that the deflections of arm 20 are within the elastic limit of the material used. The importance of tongue 60 and its uniqueness is herewith stressed; owing to friction between follower 63, 66 and ridge 30, there could occur a binding action which would prevent arm 20 from dropping of its own resilience to make contact, i. e., follower 73 would not move into any of the notches. Tongue 60 renders arm 20 independent of this binding action owing to the fact that tongue 20 can flex downwardly to make contact even though tongue 60 may remain stationary should binding occur, i. e., the two tongues may flex independently of each other.

From the above description it will be clear that rotation of cam 40 effects a motion of the free end 57 of arm 20 such that initially it moves in one direction and thereafter moves at right angles to the first direction. For example, assuming that follower 73 is engaged, say, in notch 81, it will be apparent from Figure 1 that upon counterclockwise rotation of cam 40 arm 20 will first rise as follower 73 comes out of the notch and no further motion of the arm will be experienced until the bend 84 of the ridge 30 engages follower 63, 66; at this time the arm will be deflected toward the right since the radius from the center of the cam to the ridge 30 begins to decrease after passing the cam portion 84. Continued rotation of the cam results ultimately in follower 73 being received in notch 79 at which time the free end 57 of the arm drops downwardly into the plane of the paper by virtue of the resiliency of the arm material. Thus, the motion of the free end 57 is initially upwardly, then to the right, and then downwardly. This bi-planar motion of the free end 57 of the arm provides a broken path of traverse for a precious metal con-

tact **87** carried at the free end for purposes of engagement with one or the other of a pair of fixed line conductor contacts **L1**, **L2** as indicated on Figures 1, 3 and 4. Contacts **L1** and **L2** are engageable from above, or on their upper surfaces, by contact **87** and are engageable on their lower surfaces by other switch arm contacts as will hereinafter be described. Further, contacts **L1** and **L2** are supported by conductor buses **88** and **89** fixedly secured to the housing as by rivets **88'** and **89'**, respectively, and the buses are connected to a 230 volt line as indicated in Figures 2 and 4.

Liberal arcuateness of bend **43** is provided so that contact **87** will have a sufficient component of translational movement with respect to bend **43** to align with **L2** at the end of its traverse, since **L1** and **L2** for manufacturing convenience do not lie on a true circle with respect to the motion of the arm. The bi-planar reversible path of motion of contact **87** may be seen diagrammatically on Figure 11, it being noted that contact **87** may engage only **L1** or **L2**.

Two additional switch arms, as shown in Figures 8 and 9, are provided in this form of the invention; their general construction and co-action with cam **40** being similar to that just described for the switch arm **20**. Figure 8 shows a switch arm **90** which will be understood to be formed of any suitable spring stock and being provided with bends **93** and **96** corresponding to bends **43** and **46** of arm **20**.

In the case of arm **90**, however, the flanges **99** and **103** which correspond to flanges **63** and **66** of arm **20**, are formed upwardly so as to engage a ridge **107** on the lower face of cam **40**, as shown in Figure 4. In a similar manner the **V** formation **110** faces upwardly to form a cam follower for engaging the transverse exposed surface of ridge **107**. Arm **90** is in other respects similar to arm **20** being fixedly secured in the housing **10** by a rivet **112** as shown. The follower guides **99** and **103** are formed at the end of a tongue **113** while follower **110** is formed at the end of an opposing tongue **116**. Further, the free end **120** of arm **90** is provided with a precious metal contact **123** (Figure 8) which is engageable with the lower surface of either contact **L1** or a neutral power contact **N**, Figures 3 and 4, it being noted that contacts **L1**, **N** and **L2** are fixed in the same plane and are engageable from above or below that plane.

Contact **N** is supported by a bus **125** carried on the bottom wall of the casing in a manner to be hereinafter described, and is connected to the neutral conductor of the power line.

Referring now to Figure 4, the downwardly exposed surface of ridge **107** will be understood to be provided with a series of notches indicated as **127** through **132** and beign shown in dotted lines on Figure 4 since they are in the downwardly disposed face of ridge **107**.

The co-action between arm **90** and ridge **107** is substantially the same as heretofore described for arm **20** and ridge **30**. Thus upon rotation of cam **40**, arm **90** will be actuated in one direction initially and substantially at right angles to the original direction subsequently. By reference to Figure 5*a* it will be seen that contact **123** is motivated in a reversible path between the conductor contacts **L1** and **N**; such motion being initially away from a conductor contact in a direction substantially normal thereto and thence transversely to the next contact and finally normally again upon engagement therewith, all as heretofore described in connection with arm **20**.

The remaining arm of the switch **140**, is as shown in Figure 9 and will be seen to be a structure somewhat similar to arm **90** as shown in Figure 8 except for the fact that the vertical bend **146** is disposed on the opposite side as compared with bend **93** of arm **90**. Thus, as shown in Figure 9, arm **140** is comprised of a vertical bend **146** and a horizontal bend **149** to provide bi-planar motion of the free end **152**. Follower guides **154**, **157** and **160** are identical in construction with that heretofore described in connection with **99**, **103** and **110** of arm **90**. Similarly, a precious metal contact **163** is provided at the free end of the arm. Thus when arm **140** is mounted in the housing as shown in Figure 4, being fixedly secured thereto by a rivet **167**, the follower guides **154** and **157** straddle an actuating formation comprised of the integral ridge **170** while follower **160** rides the exposed surface of the ridge. Ridge **170** is disposed outwardly of and surrounds ridge **107**. This relationship will be clearly understood by comparison of Figures 3, 4 and 5.

A plurality of five notches **173** through **177** is indicated as shown by dotted lines on Figure 4, is provided for engagement with follower **160** as the cam is rotated. It will be understood that the motion of the arm **140** in response to rotary movement of the cam will be of a bi-planar nature as heretofore described for the other two arms of this form of the invention and by reference to Figure 5*a* the reversible and broken path movement of the contact **163** intermediate contacts **L2** and **N** will be clear.

From the foregoing it is apparent that arm **20** co-acts only with contacts **L1** and **L2**; arm **90** co-acts only with **L1** and **N**; and arm **140** co-acts only with **L2** and **N**.

In summation of the basic principles of operation of my switch, as thus far described:

A housing **10** carries therein a rotary cam **40** having a plurality of actuating means or ridges on both faces thereof. These ridges are radially eccentric and are provided with notches at predetermined points on the exposed surfaces thereof. Each ridge engages a respective switch arm, the arms being made of resilient spring material and so formed as to be deflectable in two planes substantially at right angles to each other. Each arm has cam followers for engaging its respective cams so as to respond to the radial eccentricity of the cam as well as to the notches on the surfaces of respective ridges. The switch arms have free ends provided with contacts which are adjacent three fixed power line conductor contacts **L1**, **L2** and **N** in the housing. The radial eccentricity of each ridge is capable of deflecting, in one plane, its respective switch arm for alignment with either of two predetermined fixed line contacts. The notches in each ridge determine the initial and final motions in another plane of the free ends of the respective arms, either in breaking away from a fixed contact or making engagement with a fixed contact. The relative eccentricities and the relative positions of the notches of the respective ridges predetermine the particular engagement of certain of the switch arms with the line or neutral contacts for a selected rotated position of the cam.

It will now be clear from all of the foregoing that I have provided a fundamental mode of operation for a switch arm such that in making or breaking contact an elongated and bi-planar path is provided, whereby any danger of spark carry-over or "blow-out" is eliminated.

The arm positioning stations for the seven heats provided by this form of my invention are indicated in Roman numerals on the several cam ridges shown in Figures 1 and 4; as is the off position indicated by "Off." It will be noted that certain heats require no notches in certain ridges. A table of the eight stations for the cam ridges is as follows:

Station	Ridge 30 Notches	Ridge 107 Notches	Ridge 170 Notches	Heat Number
1	76	127	173	I
2	77	128	174	II
3	78	129	None	III
4	79	130	175	IV
5	80	131	176	V
6	81	132	None	VI
7	82	None	177	VII
8	None	None	None	Off

By comparing Figure 3 with the diagram of Figure 11*f*, it will be seen that the engagement of contact in Figure 3 corresponds to heat V. It will be apparent that as the cam rotates successive stations comprising eccentricities and/or notches actuate respective arms whereby any circuit condition shown in Figure 11 may be obtained.

While I believe that persons skilled in the art will understand the mode of laying out the cam ridges to suit any desired conditions, for purposes of complete disclosure herein it may be stated that the basic principles involve initially an analysis of the circuits to be effected, e. g., as shown in Figure 11 to ascertain the successive motions of the switch arms required to effect a change from one circuit to the next circuit, in the order of the power ratios or degrees of heat corresponding thereto. For example, starting with a circuit for highest heat (I) and drawing an electrical diagram for each of a series of successive steps in circuit change to ascertain switch arm motions, down to lowest heat (VII) precisely as shown in Figure 11, will enable a switch designer to draw three cam layouts, each having eight (8) stations (to include an "Off" position) at equally spaced corresponding points about a 360° transverse. Thus the problem involves conventional multi-cam design once the principles underlying my invention are understood.

The cam support, lamp base and indexing means

Referring now to Figures 3, 4 and 5 it will be seen that collar **42** of cam **40** is concentrically received in a central bore **182** of a housing cover **183**. As shown in Figure 1 diagonal corners of the housing **10** are provided with shelves to receive screw holes **186** and it will be understood that the cover **183** is retained on the housing by virtue of screws (not shown) passing through the cover and fastening into holes **186**. Cam **40** is maintained in proper position in the housing by the concentric shoulder **190** on cover **183**, as seen in Figure 3, and also by a metal lamp base **193** which rotatably engages the base **194** of collar **42** in such a manner as to permit rotation of the cam. The lamp base is securely fixed to the housing by virtue of a pair of prongs **196** and **198** which pass through correspondingly disposed slots in the bottom of the housing (Figure 3) and also through arcuate slots **200**, **201** (Figure 6) in the neutral bus **125**. Prongs **196** and **198** are clinched over as shown in Figures 2 and 3 and thus securely hold the neutral bus on the bottom of the housing as well as making an integral unit of the housing, the lamp base, and cam **40** though rotation of cam **40** is permitted. Comparison of Figures 2 and 3 will make the relationship clear. The cam is further braced against any sidewise motion by having a necked-down portion **204** socketed in a shallow counterbore **206** in the bottom wall of the casing.

The lamp base **193** accommodates between its prongs **196** and **198**, a tongue **210** which forms an extension of the bottom portion of the switch arm **20**, as clearly shown on Figure 7. The tongue **210** runs in a shallow groove **211** in the bottom wall of the housing which passes between the prongs **196** and **198**; thus tongue **210** is centrally disposed therebetween to form a terminal for engaging the center contact of a lamp screwed into base **193**. It will also be noted at this time that base **193** is in electrical contact with the neutral bus **125**. The lamp is energized by virtue of the voltage existing between switch arm **20** and the neutral bus **125**, being 115 volts when arm **20** is in such a position that contact **87** engages either of the contacts **L1** or **L2**.

An indexing means is provided for the cam **40** comprising a star-shaped formation **212**, as shown in Figure 10, being molded directly on the cam just above the necked down portion **204** (Figure 3). The star-shaped area has eight troughs corresponding to seven heats and an "Off" position and is wide enough axially to accommodate the thickness of a pair of discs **213** and **216** which are integrally carried on respective pins **219** and **222**, the lower ends of the pins being of reduced diameter and rotatably and slidably engaged in slots **225** and **227** provided in the neutral bus **125**. The upper end of each pin is slidably engaged in a slot **230** provided in cylindrical spring housings **235** and **238**, respectively, molded at the bottom of housing **10**. Housings **235** and **238** are molded so as to open outwardly at the bottom of the casing, being closed however, by neutral bus **125** which acts as an end retainer for a spring **241** within housing **235**, Figure 3. The outer end of housing **238** is closed in the molding thereof in order to serve as a retainer for a spring **244**. Springs **241** and **244** bear against pins **219** and **222**, respectively. Accordingly, the discs **213** and **216** are biased against the star formation (Figure 10) and as the cam is rotated they are forced into the troughs between the points of the star so as to act as resilient detents in holding the cam in any selected position. Moreover, inasmuch as the discs are mounted on pins which are rotatable in their respective slots, they cause no drag on the cam during its rotation, but rotate therewith.

The electrical circuit

Referring now to Figure 11, and more particularly to circuit diagram *a*, the mode of connection of the heater coils A and B with switch arms **20**, **90** and **140** is illustrated. Coils A and B are connecetd in series at the burner. It will be understood that contacts **L1** and **L2** and N are connected through their respective buses to the outside wires and the neutral of a 230 volt line so that the voltage existing between N and either **L1** or **L2** is 115 volts. For the position shown in Figure 11*a*, contacts **87**, **123** and **163** are out of engagement with the contacts L1, L2 and N, and are poised as shown with relation to each other by the configuration of the cam; and thus no current flows to either coil A or B. It will also be noted that no voltage exists across the lamp.

Figure 11*b* shows the circuit set up when cam **40** is rotated so as to provide contact between **123** and **L1**, **163** and L2 and **87** and L2. It will then be understood that coils A and B are in parallel across 230 volts and the lamp is across 115 volts. This circuit corresponds to the first or highest heat for the particular burner controlled. In like manner, rotation of the cam provides various positions of the three contacts **87**, **123** and **163** as indicated in Figures 11*c* through *h*. These several diagrams provide for six more heats of varying degree whence the total number of heats effectively provided by this switch will be seen to be seven. Mathematically there are ten possible circuit combinations for the three fixed and three movable contacts utilized in conjunction with a pair of coils wired as shown. Of the ten possible circuits, seven are used.

It will be readily understood that six other heats may be effected when the following connections are made by rotation of cam **40** as follows:

2nd heat: Coil B across 230 volts, coil A being shunted by L1 out of the circuit, Figure 11*c*;
3rd heat: Coil A across 230 volts, coil B being open at L2, Figure 11*d*;
4th heat: Coils A and B in parallel across 115 volts, Figure 11*e*;
5th heat: Coil B across 115 volts, coil A shunted across L1, Figure 11*f*;
6th heat: Coil A across 115 volts, coil B open at **L2**, Figure 11*g*;
7th heat: Coils A and B in series across 115 volts, Figure 11*h*.

From the foregoing it will be apparent that a versatile selective system is effected by the combination of my switch mechanism and a pair of burner coils having a permanent series connection; it should also be apparent that in effecting the seven heats described only four moving parts are utilized, i. e., the cam and three switch arms.

It will further be apparent that only six precious metal

contacts are utilized. Such construction is in considerable contrast with conventional types of switches as found in the prior art wherein ordinarily the number of arms and contacts are doubled for effecting the number of heats provided in my arrangement.

It will still further be apparent that I provide for illumination without the necessity of an additional switch contact or other switch mechanism for controlling on and off conditions of the lamp. This feature effects an important economy as will be appreciated by those skilled in the art.

Further consideration of my switching arrangement indicates that development and changes are possible; thus adding two extra contacts, that is a pair of contacts, and coupling them electrically and mechanically with the structure hereinabove described, would yield additional circuit combinations. In other words, the broad principles set forth are applicable for the design of switches for any desired number of heats and in certain instances balanced circuits will result for various heats, depending on the particular circuit configuration and combinations used. For example, the first heat with the present arrangement effects a balanced load on the line. Were a heat desired wherein coils A and B are in series across 230 volts (not provided in the present embodiment) a balanced load would also result.

The broad electrical principle of my invention will now be appreciated, namely, a combination of burner coils permanently connected in series and connected to various movable switch arms in such manner that a lamp may be energized by one of such switch arms, which, except for the off position, is engaged with one or the other of a pair of line contacts. Thus, by referring to Figure 11, it will be noted that arm **20** is always at a 230 volt potential, except for the off position. In other words, one end of the coil A is always at a 230 volt potential. When coil A, however, is not used in any particular circuit, it is shunted across contact L1, thereby placing the other end at 230 volt potential and like polarity at any instant. Accordingly, no current can go through coil A although the lamp remains energized.

The form of the invention shown in Figures 12 to 23 comprises four switch arms designated as **305**, **310**, **315** and **320**. The switch arms are fastened to the housing **300** by being bolted or riveted to shelves **325**, **330**, **335** and **340**, respectively, which are formed in the end wall of housing **300** as shown in Figure 19. In this manner the four switch arms are maintained at their proper respective levels for co-action with a molded plastic cam **345** to be hereinafter described. The connections to the burner coils A and B are shown in Figure 12.

The switch arms and cam co-action

With reference now to Figure 20, a perspective of switch arm **305** is disclosed wherein it is seen to be comprised of two arm elements **350** and **353** formed from a sheet of spring stock. These elements straddle cam **345** as shown in Figure 12. Element **350** (Figure 20) is joined by a bend **356**, while element **353** is joined by a bend **360**, to a section **364** which in turn is joined by a bend **368** to a flange **371**. Flange **371** is connected by a bend **374** to a flange **377**. Flange **377** is integral with a flange **380** for fastening to shelf **325**.

The free end of arm element **350**, which carries a precious metal contact **384**, is thus deflectable by virtue of bend **356** in an upward or downward direction as viewed on Figure 20. Further, by virtue of bends **364** and **374**, the free end of the element **350** is deflectable in a horizontal plane. Thus by referring to Figure 12, it will be understood that arm element **350** may move to the left and also into the plane of the paper as may be seen by noting Figure 14 which shows element **350** to be in its outermost position. Referring back to Figure 20, it will be seen that the arm **350** comprises a flange **387** in which a V-shaped crimp **390** has been formed thus permitting the formation of another V-shaped crimp **394** in the arm portion proper, which crimp extends downwardly out of the plane of the arm and serves as a cam follower in co-action with cam **345** having certain notches, later described, on a ridge **395** to provide rise-and-fall motion of element **350** as follower **394** rides out of or into the notches, respectively.

The lower arm element **353** of switch arm **305** terminates in a pair of arcuately shaped flanges **396** and **398** which together form another cam follower for co-action with an eccentric groove **400** in cam **345** at its under side, as seen on Figures 12 and 13.

Cam groove **400** is laid out so that contact **384** can engage only contacts L2 or N which are connected to power.

The details of arm **320** (Figure 12) are not separately shown but will be understood to be similar to those for the arm **305** except for being reversed in position. For example, arm element **401** (Figure 12) corresponds to arm element **353** except that it is positioned on top of the cam while arm element **404** corresponds to element **350** except that it is positioned to engage on the under-surface of the cam; elements **401** and **404** straddle cam **345**, element **401** having follower flanges **402**, **403** for engaging a groove **405** in the top surface of the cam, while element **404** has a V-shaped follower **406** protruding downwardly to engage certain notches, later described, in a ridge **407** on the bottom surface (Figure 16).

The arm element **404** carries at its free end a contact **408** and groove **405** is laid out so that contact **408** engages contacts L1 or N only, being connected to the power.

Thus contact **384** and **408** are engageable from above and below, respectively, with the power contacts as will be clear from Figure 14.

Contacts L1 and L2 are connected across 230 volts while N is connected to neutral for 115 volts. These three contacts are held in fixed position in the same plane by buses to be hereinafter described.

By referring to Figures 12 and 14, it will be seen that contact **408** is in engagement with the neutral contact, contact **384** being raised thereabove (Figure 14). This condition corresponds, by way of illustration, to the seventh heat as may be seen by referring to the circuit diagram for the seventh heat in Figure 23*h*.

Referring now to Figure 21, the arm **315** is shown in perspective and is seen to comprise a body member **410**, a bracing side flange **413** and V-shaped crimps **416** and **419** in the body and the flange members, respectively. The crimped formations are substantially the same as heretofore described in connection with Figure 20, crimp **419** being necessitated in order to obtain crimp **416**, in a manner which will be understood by a person skilled in the art. Arm **315** terminates in a flange **423** for fastening to the housing and the free end of the arm carries a contact **426**. This arm is positioned above the cam **345** so that the crimp **416** acts as a cam follower engageable with certain notches provided in a ridge **428** on the upper surface of the cam as indicated in Figures 12, 13 and 14. It will be noted at this point, however, that arm **315** is capable of deflection only in an upward or downward direction as viewed on Figure 21, or out of the plane of the paper as viewed on Figure 12, being stopped from motion into the plane of the paper by engagement with fixed contact L1. In other words, contact **426** is capable of engaging with or disengaging from the upper surface of contact L1 but is not capable of deflecting into alignment with any other contact such as N or L2.

Switch arm **310** is generally similar to the construction just described for arm **315** except that it is formed reversely for mounting below the cam. Thus a V-shaped follower **430** (Figures 12 and 12*a*) is formed so as to protrude upwardly out of the plane of the arm for engagement with certain notches on a ridge **431** (Figure 14) on the under surface of the cam. The free end of arm **310** carries an embossed contact **434** and it will

be noted that this arm is capable of deflection only into the plane of the paper as viewed on Figure 12 so that it can engage with or disengage for the lower surface of contact L2 but cannot move out of alignment therefrom for engagement with contact N or L1. A tongue 435 is formed at the base of arm 310 and extends between the prongs 436 on the lamp base to form a center terminal thereof (Figure 14).

Thus contacts 426 and 434 are restricted to single plane motion for co-action with, and only with, contacts L1 and L2, respectively.

Power line contacts

The contacts L1, L2 and N are comprised of precious metal and are all fixed in a common plane, as heretofore mentioned, L1 and L2 being carried at the ends of buses 437 and 440, respectively, which are suitably fastened to the housing as indicated in Figure 12 which also shows the specific power connections. The neutral contact N is carried by a bus 445 (shown in perspective in Figure 22) comprising a body portion 447, an upright section 450 and a horizontally extending flange 453 which is bent reentrantly on itself and extends rearwardly sufficiently to maintain contact N on an extremity 456 in proper position with respect to the line contacts and cam elements 350 and 404.

The cam construction

Figures 15 and 16 show the outside and inside faces of the cam 345 respectively, to a somewhat reduced scale, illustrating the relationship of the eccentric grooves and the notched ridges. All formations are designated by legends to indicate, with reference to the plan view of Figure 2, the particular functions of the grooves and ridges. For example, the under side of the cam (Figure 16) has ridge 407 formed thereon. The ridge has a plurality of notches 488 through 492 formed therein which accommodate follower 406 to provide engagement of contact 408 with either N or L1 depending on the degree of rotation of the groove 405 (Figure 15) which controls the horizontal position of contact 408 by virtue of engagement with follower 402, 403.

In a similar manner contact 384 may be brought into engagement with contact N or L2 when the V-shaped cam follower 394 on arm element 350 drops into one of the series of notches 505 through 510 on the ridge 395; depending on the rotated position of groove 400 which engages follower 396, 398 to determine aligning of contact 384 with either N or L2. On the upper surface of the cam, as shown in Figure 15, is the ridge 428 having a plurality of spaced notches 518–522 for engaging the follower 416 of switch arm 315. Thus contact 426 on arm 315 is deflected into or out of the plane of paper as viewed on Figure 12 to engage or disengage contact L1, as heretofore described.

By referring to the wiring diagram of Figure 23, it will be seen that the arm 310 is used solely for switching the lamp on and off at each heat period, thus seven notches 539 are provided in ridge 431 (Figure 16) corresponding to the seven heats of this particular switch and each time the other switch arms are engaged with certain contacts for setting up a particular circuit comprising the coils A and B, contact 434 of the arm 310 will engage the lower portion of contact L2 to thus energize the lamp across L2 and neutral contact N.

As seen on Figures 15 and 16, Roman numerals are used to designate locations on the ridges corresponding to respective heats, there being notches required at some points but not at others as will be understood by referring to Figure 23; e. g., on ridge 395 there is no notch for the off position or heat VII. On ridge 428 there is no notch for the off position or heats III and VI; while on ridge 407 there are no notches for the off position or heats II and V.

In order to clarify Figure 12 as to which contacts are above and which are below the fixed contacts L1, L2 and N, Figure 23*a* represents diagrammatically the actual physical configuration insofar as relative vertical spacing of the various contacts is concerned.

General assembly and indexing of the cam

By referring to Figure 14, the mode of fastening the neutral bus 445 by means of prongs 436 to the body 300 will be apparent, as will also be the indexing of the cam, which indexing mechanism is substantially the same as has been heretofore described, spring biased discs 535, 538 being utilized to resiliently engage a star formation molded on the cam substantially as shown in Figure 10.

Thus the cam, lamp base, neutral bus assembly and indexing means is substantially the same as heretofore described in connection with the form shown in Figures 1–11; the cam being relatively supported for engagement with and actuation of the switch arms and being settable in any of eight angular positions corresponding to an off position and seven selective heats.

The control knob and illuminating system

By referring to Figures 13, 14, 17 and 18, the knob control and illumination system of my switch, will be apparent. A metallic nipple 550 (Figure 13), having a slot 553 (Figure 17) at its lower end, keys on to a projection 557 formed internally in the collar 560 of the cam 345. A translucent plastic knob 563 is force fitted at the upper end of the collar and counterbored so as to accommodate a color filter 567 of any suitable material which may be fastened to the cover plate 570 in any suitable manner or which may be force fitted on the exterior of nipple 550. An aperture 573 (Figure 17) in nipple 550 is aligned with the lamp filament. Thus, for any position of the knob 563 light rays from the lamp pass through the aperture and by reflection from the internal surfaces of the knob as shown in Figure 17 provided diffused illumination therefor.

The electrical circuits

Figure 23*a* through *h* illustrates diagrammatically the off-position and the positions of the various contacts for effecting the seven heats. Note that contacts 426 and 434 make or break with L1 or L2, respectively, and do not engage any other contacts in the system. Contact 434, which energizes the lamp, is in engagement with L2 for all heats as heretofore mentioned and as provided for by the seven notches 539 (Figure 16). Note further that contact 408 makes or breaks with contacts N or L1, only, while contact 384 makes or breaks with contacts N or L2, only, all as heretofore specified.

An advantage of this particular switch construction resides in the use of the extra arm 310, which if desired, could be utilized to provide extra heats for the switch. While switch arm 310 has been dissembled as provided with an embossed contact 434, it will be understood that in the event extra heats are intended, a precious metal contact may be provided. However, for purposes of switching the relatively low wattage lamp on and off an embossed contact is sufficient.

It will be apparent that the modification described provides for bi-planar motion for two contacts only, i. e., 384 and 408, but it should be noted that these are the two controls which are required to move between the power contacts L1 and N or L2 and N, whence the advantage from a standpoint of preventing arcing over between the latter controls is preserved. Contact 426 on the other hand is engageable only with contact L1 and accordingly single direction motion is adequate although not as desirable as bi-planar motion would be for the purpose of attenuating any arc which might be caused upon disengagement.

The form of the invention disclosed in Figures 24–40

comprises a molded casing 600 wherein is rotatively mounted a cam 605, in a manner heretofore described, by means of clinched prongs 608 and 611 (Figure 27) of a lamp base 614. The prongs pass through holes 617 and 621 of a switch arm 625 (Figure 34) and thus secure the base section 627 of the arm to the bottom wall 630 (Figure 35) of the casing. The arm 625 is comprised of suitable spring stock and is formed as shown in Figures 27 and 34 so as to pass upwardly through a slot 633 in the bottom wall and around a shelf 636, being provided with perforated flanges 639, 640 through which it is riveted to the shelf. The free end of the arm carries a precious metal contact element 644 while intermediate of the arm a cam follower 647 is provided in a manner heretofore described in the other modifications. By virtue of the bend 650 (Figure 34) it will be appreciated that the contact 644 may be deflected into or out of the plane of the paper as viewed on Figure 24, or to the left or right as viewed on Figure 27, the arm being thus limited to motion in a single plane.

In a similar manner a switch arm 655 is fashioned (Figure 33) having a pair of perforated flanges 658, 659 by virtue of which it is secured by riveting to the bottom wall of the casing (Figure 35); a Z-shaped slot 662 being provided therein to facilitate the assembly as will be understood by comparing Figures 28 and 35.

Arm 655 is provided with a cam follower 663 and a precious metal contact 666 at the free end thereof and by virtue of bend 769 will be understood to be deflectable into or out of the plane of the paper as viewed on Figure 24, or to the left or right as viewed on Figure 27; thus being also limited to motion in a single plane.

A third arm 672 (not shown separately) extends across cam 605 (Figure 24) in a manner similar to arms 625 and 655, which arm is likewise secured by flanges, the outer of which, 675, is visible in Figure 35. Arm 672 is also provided with a cam follower 678 and a precious metal contact 681 and by virtue of bend 684 is deflectable in a single plane similarly to the other two arms.

Below the cam are disposed a pair of arms 688 and 692 as shown in perspective in Figures 31 and 32, respectively. These arms are likewise formed of spring stock and comprise perforated flanges for attachment to the bottom wall of the casing as indicated in Figure 35 by reference characters 695 and 698 signifying the lower flange in each instance. Arm 692 may be seen in side view on Figure 28 whereas arm 688 is visible on Figure 27. It is understood that the housing is suitably slotted as at 701 (Figure 35) for assembly of these arms therewith. Arm 692 is provided with a precious metal contact 704 and the side walls of the arm are formed to effect a cam follower 707 (Figure 32) by means of projections of arcuate shape as shown. A bend 710 is provided to properly position the arm and it is deflectable to the left, as viewed on Figure 24, by virtue of a wall 714 of suitable length to provide sufficient flexure. In a similar construction, arm 688 has a contact 717, a cam follower 720, a bend 723, and a suitably deflectable wall 726.

The final arm 730 in this modification is as shown in Figure 30 and comprises a member suitably shaped to fit below the cam as shown in Figures 24 and 27, being of generally planar aspect from a bend 733 to a contact 736 and assembled in the casing by virtue of slot 662 (Figure 35), being riveted therein by virtue of perforated flanges 740 and 742. A tongue 745 on arm 730 is provided extended between lamp prongs 608 and 611 to form the central terminal of the lamp base.

It will be noted that arm 730 has no cam follower; it is not controlled directly by the cam but by arm 655 which has only a rise-and-fall motion and is at all times aligned at its contact 666 with contact 736 as shown in Figures 24 and 27. Except for the off position as shown in Figure 40*a*, contacts 666 and 736 are always engaged;

and by suitable choice of spring stock arm 655 dominates arm 730. It will be seen from Figure 27 that cam 605 acts as a stop for arm 730 in the upward direction and by virtue of the dominating characteristic of arm 655 contact 736 may, under certain conditions, be forced downwardly to engage contact 717 of arm 688. This condition is, of course, brought about by the action of the cam on arm 655, as will be later explained, and is required for the first and third heats as will be noted on Figure 40.

Thus, with reference to the plan view of Figure 24, the arms above the cam, i. e., 625, 655, 684 move in a horizontal plane, while the arms below the cam move in a vertical plane.

Referring now to Figures 36 and 37 showing the upper and lower surface of cam 605, respectively, Figure 36 discloses a plurality of notches for controlling contacts 644, 666 and 681 while Figure 37 shows the underside of the cam as a section through 37—37 of Figure 25 revealing two grooves for controlling contacts 704 and 717. The engagement relationship of these several contacts with respect to each other is shown in Figure 40 as heretofore mentioned, and should be referred to in the discussion which follows.

The relative positions of the several cam followers is indicated on Figures 36 and 37 and it will be noted that the configuration is as found in Figure 24, which corresponds to heat I as shown in Figure 40*b*. Thus folllowers 707 and 720 engage in a pair of respective grooves 746 and 748 for providing transverse motion of contacts 704 and 717 respectively. Groove 748 actuates follower 720 for alignment of contact 717 with either contact 644 or 736. Engagement with 736, is, however, controlled by arm 655 as heretofore explained. Groove 746 actuates follower 707 to align contact 704 with contact 736 or contact 681.

Follower 663 is shown engaged in a notch 749 (heat I) and is engageable as the cam rotates in notches 750 through 753 successively. Likewise follower 678 is shown engaged in a notch 754 and is engageable in a notch 755. Follower 647 is not engaged in a notch for heat I but as the cam rotates it is engageable in notches 756, 757 and 758, successively. By referring to Figure 40*b* and *d* it will be seen that there is engagement between contacts 666, 736 and 717. Thus a condition is brought about whereby dominant arm 655 (Figure 27) forces arm 730 downwardly to effect this triple engagement. This is achieved by making notches 749 and 751 relatively deep to cause cam follower 663 to drop sufficiently to permit arm 655 to force arm 730 downward away from the supporting undersurface of the cam. For heats I and III the triple engagement is thus effected by suitable depth of notches 749 and 751. On the other hand for heats II and IV, it is not desired to have engagement between contacts 717 and 736 and accordingly, notches 750 and 752 which control contact 666 for these heats are made shallow so as to prevent arm 655 from forcing arm 730 downwardly.

The depth of all other notches may be deep or shallow, but preferably deep, although this is not critical since relative depths for desired circuit conditions is required only of notches 749, 750, 751 and 752.

It should be particularly noted that notches which are radially aligned on Figure 36 are not necessarily for the same heat. Thus for heat I notches 749, 754 only are utilized; for heat II notches 750, 755 are utilized; for heat III notches 751, 756 are utilized; for heat IV notches 752, 757 are utilized; for heat V notches 753, 758 are utilized. For the off position all cam followers ride the surface of the cam, except, of course for those below the cam.

From all the above it will be seen that contact 736 is always engaged with contact 666 except for the off position, and by referring to Figure 40 the lamp is seen to be energized for all five heats. The mode of connec-

tion for the heater coils A and B is shown in Figure 35 and also the power connections.

From the above description it will be evident that this modification provides relative bi-planar motion of the switch arms, even though each arm is movable only in a single plane. However, the upper arms are always actuated by their respective notches prior to actuation of the lower arms by their respective grooves, by proper layout of the cam, so that engagement or disengagement initially occurs in a direction normal to the plane of the paper as viewed on Figure 24, followed by transverse motion of the lower arms with continued rotation of the cam.

Indexing of the cam is accomplished by molding a six pointed star thereon, thus forming recesses **803** for receiving discs **806** and **810**. See Figures 24, 29 and 36. The disc arrangement is substantially as heretofore described in connection with the other modifications except that the supporting grooves **813** and **815** (Figure 29) for the ends of pin **818** are formed in the housing and cover **821**, respectively. Bolt holes **822** (Figures 24 and 26) are provided for securing the cover to the housing. A spring **824** is utilized for biasing disc **806**. All the structure just described will be understood to be duplicated for disc **810**, although it is not shown. Thus indexing for an off and five heat positions is accomplished.

A mode of illumination for the front of the switch is shown in Figures 38 and 39, on a reduced scale. A collar **827** is formed integral with the cam, in which is located a lamp that will be understood to be secured in lamp base **614** as shown in Figure 27. Supported on the collar **827** is a molded toroid **830**, of any suitable transparent material having a shoulder **833** formed therein to rest on the collar. Toroid **830** is formed with six flat integral reflector surfaces **836** directly below six bulbously formed lenses **839**. The arrangement is hexagonal as shown in Figure 39 to correspond to an off and five heat positions in a circular layout. Secured concentrically within the central opening of the toroid is a colored filter sleeve **842**. A knob **345** is secured to a metallic sleeve **848** which keys within collar **827** in a manner hereinbefore described for rotating the cam. An aperture **851** is cut into the sleeve **848** through which light rays from the lamp pass to the reflector surfaces **836** successively as the knob **845** is rotated. Thus each lens **839** in turn receives reflected light as the knob rotates, the light being concentrated by the lens action in each case and made highly visible for any particular heat depending on the knob setting. The structure may be mounted contiguous with a range front **851** suitably apertured as shown so that the lenses protrude therethrough.

Having thus described my invention, I am aware that many modifications may be made thereof; for example, the double surface contacts may be modified so as to be replaced by a pair of separated contacts; further the switch arms for bi-planar motion may be pivotably mounted whereby deflection in one plane occurs by reason of bending of the arm material. Various cam and arm designs are possible for accomplishing my teaching and the basic principles of the other features of my invention are also subject to utilization in various embodiments.

Accordingly, I do not seek to be limited to the specific construction described hereinabove, except as set forth in the appended claims.

I claim:

1. A multi-switch comprising a housing, a plurality of angularly deflectable switch arms in said housing, each of said arms having an end secured to said housing and having an oppositely disposed free end, a rotary cam supported for manual rotation within said housing and having arm actuating means corresponding to respective switch arms and engaged individually therewith for simultaneous actuation of the free ends thereof in predetermined paths, a plurality of contact elements in said housing selectively engageable with said free ends of said arms in response to rotary motion of said cam, whereby selective engagement variations between said arms and contact elements may be effected in accordance with selected angular positions of said cam, wherein at least one of said switch arms is comprised of a metallic resilient sheet material member formed so as to be capable of flexure in two angularly related planes, said member comprising cam follower portions adapted to engage said arm actuating means on said cam, said actuating means comprising a formation for flexing said arm in one of said planes and also comprising a formation for flexing said arm in the other of said planes.

2. A multi-switch comprising a housing, a plurality of angularly deflectable switch arms in said housing, each of said arms having an end secured to said housing and having an oppositely disposed free end, a rotary cam supported for manual rotation within said housing and having arm actuating means corresponding to respective switch arms and engaged individually therewith for simultaneous actuation of the free ends thereof in predetermined paths, a plurality of contact elements in said housing selectively engageable with said free ends of said arms in response to rotary motion of said cam, whereby selective engagement variations between said arms and contact elements may be effected in accordance with selected angular positions of said cam, wherein at least one of said switch arms is constructed and arranged so as to be capable of motion in two angularly related planes and said arm actuating means comprises formations for effecting motion in said planes in sequential order.

3. In a multi-switch mechanism, a rotary cam of substantially disc shape having switch arm actuating means disposed on at least one face thereof, and an angularly deflectable switch arm disposed so as to extend segmentally across said cam and having follower means engaging said arm actuating means whereby said arm is deflected in one direction upon rotation of said cam, wherein said cam is provided with additional arm actuating means and wherein said switch arm is provided with additional follower means engaging said additional actuating means; said arm being deflected in another direction by said additional actuating means subsequent to said first deflection during rotation of said cam.

4. In a multi-switch mechanism, a rotary cam having switch arm actuating means thereon, and a switch arm formed of metallic resilient sheet material and having angularly related bend lines so as to be capable of flexure correspondingly in two angularly related planes, and having cam follower portions adapted to engage said arm actuating means on said cam, said arm actuating means comprising a formation for flexing said arm in one of said planes and also comprising a formation for effecting deflection of said arm in the other of said planes, said follower portions being engageable with respective formations, and said formations being related so as to effect sequential motions of said arm first in one plane and then in the other plane, by rotation of said cam.

5. A switch arm comprising an elongated body member formed of resilient metallic material, said member having a bend near one end and means for securing said arm adjacent said bend to a housing whereby said arm may be flexed relative to said housing and at said bend in a plane normal to the general line of said bend, and an additional bend in said member along a line generally normal to said first bend line whereby said member may be flexed relative to said housing along the remainder of its length in a plane generally normal to said first plane, said arm having a free end for engaging either of a pair of contacts and being deflectable from one to the other of said contacts, and means for deflecting said arm from one to the other of said contacts whereby said arm is flexed at both of said bend lines to effect a bi-planar path of said free end in passing from one contact and approaching the other.

6. A switch arm comprising an elongated body member formed of resilient metallic material, said member having a bend near one end and means for securing said arm adjacent to said bend to a housing whereby said arm may be flexed relative to said housing and at said bend in a plane normal to the general line of said bend, and an additional bend in said member along a line generally normal to said first bend line whereby said member may be flexed relative to said housing along the remainder of its length in a plane generally normal to said first plane, wherein a portion of said body member is formed with a slot extending generally in the direction of elongation thereof, a tongue in said slot extending from one end thereof and having a free end formed with cam follower flanges extending parallel to said first mentioned bend line, the other end of said slot being formed with a cam follower extending transversely of said arm and disposed in a line of direction co-planar with said additional bend line.

7. A multi-switch comprising a housing, a plurality of angularly deflectable switch arms in said housing, each of said arms having an end secured to said housing and having an oppositely disposed free end, a rotary cam supported for manual rotation within said housing and having arm actuating means corresponding to respective switch arms and engaged individually therewith for simultaneous actuation of the free ends thereof in predetermined paths, a plurality of contact elements in said housing selectively engageable with said free ends of said arms in response to rotary motion of said cam, whereby selective engagement variations between said arms and contact elements may be effected in accordance with selected angular positions of said cam, wherein at least one of said switch arms is deflectable in two angularly related planes and comprises two cam follower means; and said cam comprises an actuating means for each of said follower means, one of said follower means and its respective actuating means being constructed and arranged to actuate the switch arm in one direction and the other follower means and corresponding actuating means being devised to actuate the switch arm in another direction, wherein said directions lie in said angularly related planes so as to provide a broken path of motion of said switch arm in passing from one contact element to another.

8. In a multi-switch mechanism, a rotary disc-like cam having switch arm actuating formations on both sides thereof, at least one elongated switch arm disposed segmentally of said cam on each side thereof, wherein each arm is arranged to be joined to a casing at one end and to be free at the other end for removable engagement with a contact element, including cam follower means on each of said switch arms engaging individual and respective actuating formations on said cam for moving said free ends relative to respective contact elements, wherein one side of said cam has a pair of formations for actuating a respective switch arm, and wherein said arm is supported for angular deflection in two angularly related planes, said arm having respective follower means engaging said actuating formations and said formations being shaped and related so as to provide angular motion of the free end of said arm sequentially in said two angularly related planes as said cam is rotated.

9. In a multi-switch mechanism, a rotary disc-like cam having switch arm actuating formations on both sides thereof, at least one elongated switch arm disposed segmentally of said cam on each side thereof, wherein each arm is arranged to be joined to a casing at one end and to be free at the other end for removable engagement with a contact element, including cam follower means on each of said switch arms engaging individual and respective actuating formations on said cam for moving said free ends relative to respective contact elements, wherein at least one of said arms has portions straddling said cam, including a follower on each of said portions for engaging an actuating formation on each side of said cam, one of said latter formations being devised to deflect said arm in one of said angularly related planes and the other of said formations being devised to deflect said arm in the other of said planes and said formations being related as to provide such deflections in sequential order as said cam is rotated.

10. A multi-switch comprising a casing having a bottom wall, a rotary disc-like cam in said casing having a plurality of switch arm actuating formations, a plurality of switch arms in said casing having follower portions engaging respective actuating formations, said cam having an open collar disposed axially thereof, a lamp socket secured to said bottom wall and extending into said collar for supporting a lamp in said collar, one terminal of said lamp being exposed within said casing, and wherein one of said switch arms comprises a conductive member formed so as to engage said terminal at all times.

11. In a multi-switch, a deflectable switch arm, a rotary cam comprising a disk-like member having an eccentric formation disposed for engagement with a follower on said switch arm to actuate said follower in one plane, and an additional formation on said cam having an eccentricity for actuating said arm in another plane angularly related to said first plane and disposed for engagement with another follower on said arm, said eccentric formations being related so as to provide said biplanar actuation in substantially sequential order.

12. A multi-switch mechanism comprising a housing, a rotary cam of substantially disc-like shape in said housing, a plurality of elongated deflectable switch arms disposed segmentally across said cam and distributed on both sides thereof, one end of each arm being joined to the housing and the other end being free, and a plurality of contact elements in said housing arranged substantially in the same plane and being engageable on one side by certain of said free ends of said switch arms, and on the other side by at least one other free end of an arm, and actuating means carried by said cam and engageable with individual arms for deflecting said arms to or from said contact elements, said actuating means of said cam comprising an arcuate eccentric formation about the axis thereof for deflecting one of said arms in a plane substantially normal to the cam axis, and having an eccentric formation for deflecting another of said arms in a plane substantially parallel to the cam axis.

13. In a multi-switch mechanism, a rotary disc-like cam having switch arm actuating formations on both sides thereof, at least one elongated switch arm disposed segmentally of said cam on each side thereof, wherein each arm is arranged to be joined to a casing at one end and to be free at the other end for relative motion with respect to the free end of the other arm, including cam follower means on each of said switch arms engaging individual and respective actuating formations on respective sides of said cam for moving said free ends into or out of engagement with each other, the formations on one side of said cam moving the respective arm in one plane and the formations on the other side of said cam moving the respective arm in another plane.

14. A multi-switch comprising a cam, a plurality of switch arms actuatable simultaneously by said cam, contacts carried by said switch arms, certain of said contacts being engaged and disengaged with each other in selective pairs to effect selective circuit combinations in response to selected positions of said cam, said cam having formations for actuating at least one of said switch arms in one plane and another of said switch arms in another plane angularly related to said first plane when said switch arms are moving to disengage their respective contacts, whereby the relative motion of said contacts is elongated to attenuate the spark therebetween.

15. A multi-switch as set forth in claim 14 wherein said planes are substantially normal to each other.

16. A multi-switch as set forth in claim 14, wherein said cam comprises a rotary member having angularly

spaced means for engaging one of said arms to provide motion in a plane parallel to the axis of the cam, and having a ridge means for providing motion to the other of said switch arms in a plane normal to the axis of said cam.

17. A multi-switch as set forth in claim 16, wherein said one switch arm is disposed adjacent one side of said cam, and the other of said switch arms is disposed adjacent the other side of said cam, said angularly spaced means being on said one side of said cam and said ridge means being on the other side of said cam, whereby the switch arm adjacent said first side is moved in a plane parallel to the axis of said cam and the switch arm adjacent said other side is moved in the plane normal to said axis.

18. A multi-switch comprising a plurality of switch arms having contacts and being disposed on opposite sides of a cam and being individually actuatable by said cam so as to effect selective engagement and disengagement of their respective contacts with each other for effecting selective circuit combinations, including an additional switch arm on one side of said cam and actuatable by said cam and having a contact, another switch arm having a contact engageable with said first contact, said arms being flexibly mounted, wherein said first arm dominates said second arm to maintain contact engagement in certain positions of said cam, said second arm being independent of actuation by said cam except through said contact engagement, and a third switch arm actuatable by said cam and disposed on the other side thereof and having a contact engageable with the contact of said second switch arm in certain positions of said cam.

19. A multi-switch comprising a rotary cam, a plurality of switch arms disposed segmentally across said cam adjacent one face thereof, each of said switch arms having a cam follower protuberance extending toward said cam and engageable with repective notches provided in the surface of said cam, a plurality of switch arms disposed segmentally adjacent the opposite face of said cam, each of said arms having a cam follower, arm actuating means carried by said cam radially disposed relative to the axis of rotation of said cam and at varying radial distances from said axis and engaged by said followers, said switch arms having contacts engageable and disengageable with each other upon rotation of said cam to selected positions, wherein the motion of said first plurality of switch arms is substantially parallel to the axis of said cam and the motion of said second plurality of switch arms is transverse to the axis.

20. A multi-switch having a plurality of selectively engageable pairs of contact means comprising a plurality of switch arms having relative biplanar motion, a rotary cam for actuating said arms individually and simultaneously in respective planes, said switch arms when so actuated being operative to engage and disengage respective contacts wherein the path of such engagement or disengagement for at least one contact pair is in angularly related planes.

21. A multi-switch mechanism comprising a housing, a rotary cam in said housing, a plurality of elongated deflectable switch arms actuatable by said cam, one end of each arm being joined to the housing and the other end being free, and actuating formations carried by said cam and engageable with individual arms for deflecting said arms to or from current carrying positions, said actuating formations of said cam comprising an arcuate eccentric formation about the axis thereof for deflecting one of said arms in a plane substantially normal to the cam axis and also comprising an eccentric formation for deflecting another of said arms in a plane substantially parallel to the cam axis, each arm having a respective contact and said contacts being engageable with and disengageable from each other by rotation of said cam, a relative motion of disengagement being in angularly related planes.

22. A multi-switch comprising engageable contact elements and means for simultaneously making and breaking a plurality of engagements therebetween to effect selective circuit conditions, said contact elements comprising switch arms, actuating means for providing simultaneous relative motion of said switch arms so that they move in individual paths which effect angularity with respect to the immediate opening motion of at least one pair of engaged contact elements relative to each other so as to attenuate and diminish spark carry-over, the relative motion of said contact elements thus being in two angularly related paths having an abrupt change in linear direction therebetween, said actuating means having means for effecting said relative motion within a time period such as to break the path of any initial spark which may occur at the instant of opening.

23. A multi-switch as set forth in claim 22, wherein said actuating means comprises a cam having a plurality of eccentric formations engageable with respective switch arms, said switch arms being resilient deflectable members having follower portions engaging respective formations.

24. A multi-switch comprising a plurality of switch arms, a contact on each switch arm, said contacts being engageable and disengageable by motion of said arms, and means for selectively and simultaneously actuating said arms to effect individual motions thereof so as to provide relative motion of disengaging contacts in individual angularly related planes.

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