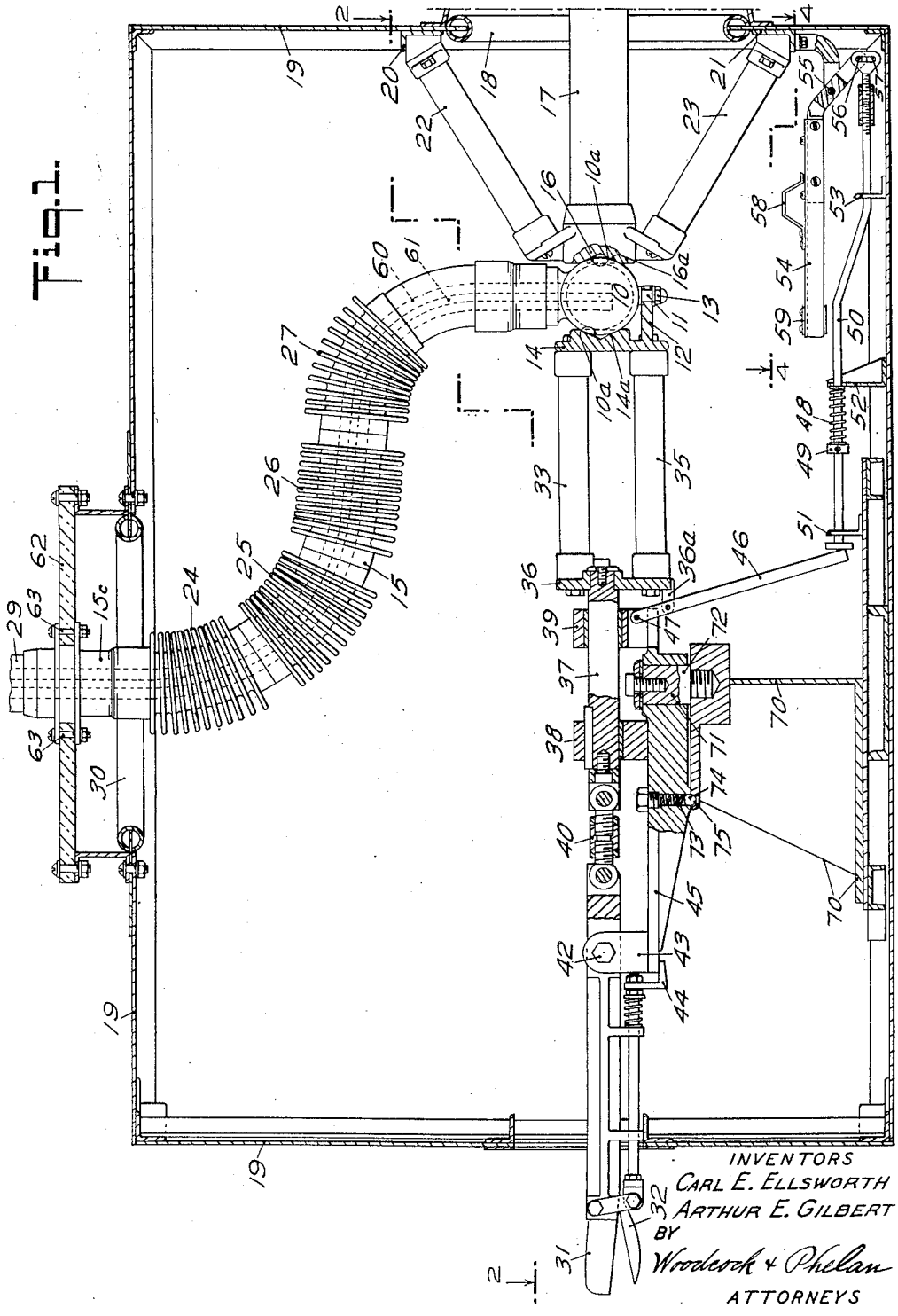
March 6, 1951 C. E. ELLSWORTH ET AL 2,543,768

TRANSFER SWITCH FOR HIGH-FREQUENCY HEATING SYSTEMS

Filed Aug. 20, 1947 4 Sheets-Sheet 1

Fig. 1.



INVENTORS
CARL E. ELLSWORTH
ARTHUR E. GILBERT
BY
Woodcock & Phelan
ATTORNEYS

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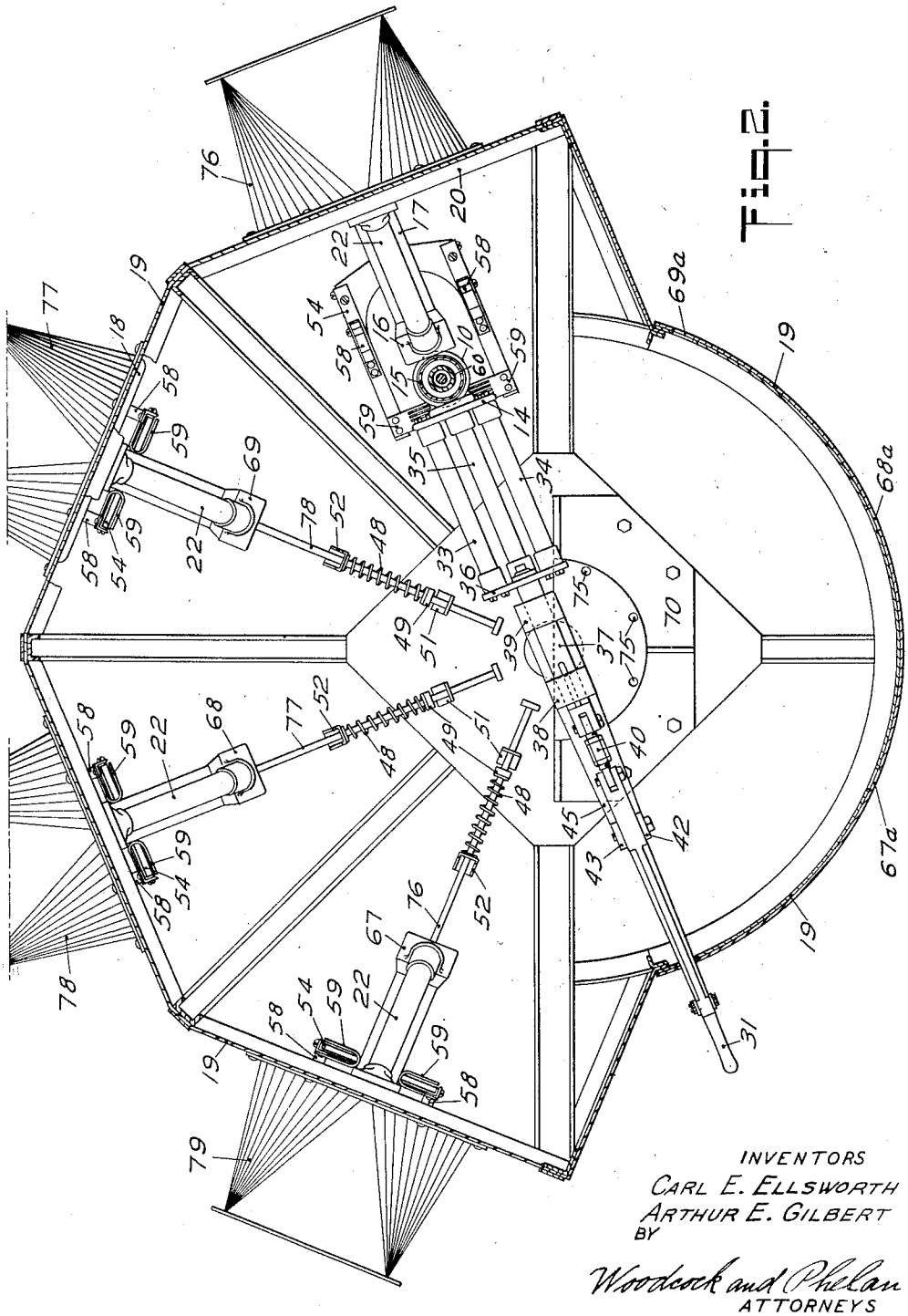
Fig. 2



INVENTORS
CARL E. ELLSWORTH
ARTHUR E. GILBERT
BY
Woodcock and Phelan
ATTORNEYS

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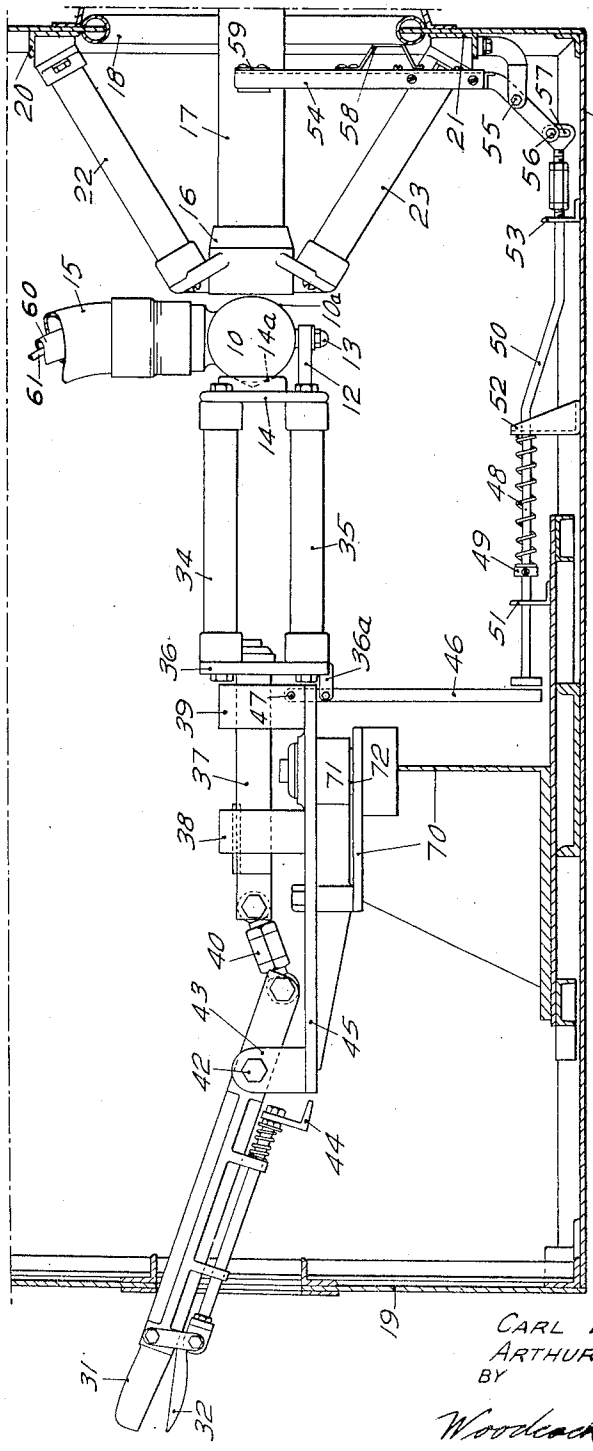

Fig. 3.

INVENTORS
CARL E. ELLSWORTH
ARTHUR E. GILBERT
BY
Woodcock and Phelan
ATTORNEYS

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TRANSFER SWITCH FOR HIGH-FREQUENCY HEATING SYSTEMS

Filed Aug. 20, 1947 4 Sheets-Sheet 4

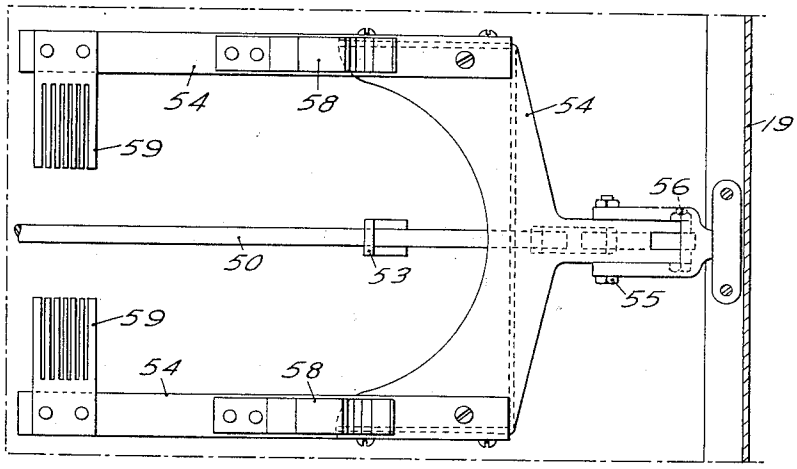

Fig. 4.

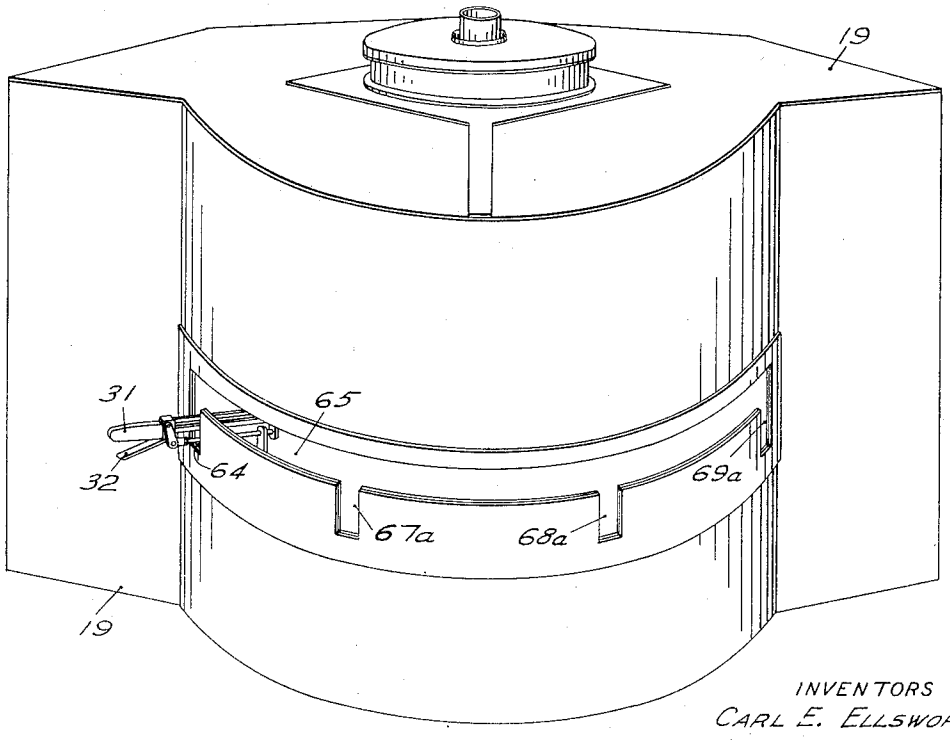

Fig. 5.

INVENTORS
CARL E. ELLSWORTH
ARTHUR E. GILBERT
BY
Woodcock and Phelan
ATTORNEYS

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UNITED STATES PATENT OFFICE

2,543,768

TRANSFER SWITCH FOR HIGH-FREQUENCY HEATING SYSTEMS

Carl E. Ellsworth, Louisville, and Arthur E. Gilbert, near Louisville, Ky., assignors to The Girdler Corporation, Louisville, Ky., a corporation of Delaware

Application August 20, 1947, Serial No. 769,698

14 Claims. (Cl. 200—8)

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This invention relates to transfer switches of the type particularly applicable for use with high-frequency heating systems and has for an object the provision of a transfer switch which is relatively compact, rugged in construction, easily operated, and which insures the completion of circuit connections with a minimum of electrical resistance.

In the application of electrical energy to dielectric materials for the generation of heat therein, relatively high voltages and frequencies are utilized. For example, the voltage may be of the order of from 1000 to 50,000 volts with a frequency of the order of from 1,000,000 cycles per second to 10,000,000 cycles per second, and above. Since the heating effect is proportional to the square of the voltage and directly to the frequency, it is desirable for any given installation to utilize high, optimum values of frequency and voltage. This means that the voltages involved, without provision of safety features, are dangerously high. The conductors are ordinarily of relatively large size and, in general, are included in concentric lines.

As explained in Zottu Patent 2,419,307, a transfer switch is essential if a high-frequency generator is utilized to supply energy to more than one load for the reason that the very size of the conductors makes difficult, if not impractical, the manual connection and disconnection of such conductors from one load to another. The transfer switch of said Zottu patent while satisfactory, leaves something to be desired in compactness, ease of operation and the development of desired contact pressures.

In carrying out the present invention in one form thereof, there is provided in circular array around a common center a plurality of stationary contacts respectively connected to various loads to be supplied with high-frequency energy. A centrally located movable contact may be fluid-cooled through internally located flow channels, the contact-engaging portion itself consisting of a spherical contact movable into and out of engagement with concave surfaces of each of the stationary contacts and presenting to each a different contact surface. Preferably, a toggle mechanism or equivalent is utilized to develop high-contact pressures and to eliminate sliding friction during movement from one circuit-controlling position to another. The high-voltage movable contact is isolated from the operating mechanism by a plurality of insulators and is connected by a flexible conductor, including a plurality of Sylphon bellows, to the incoming line from the high-frequency separator.

For further objects and advantages of the invention, reference is to be had to the following description taken in conjunction with the accompanying drawings, in which the transfer switch

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has been illustrated together with a grounding arrangement which forms the subject matter of a copending application filed by Austin Proctor, a co-worker of ours, on August 20, 1947, Serial No. 769,660.

In the drawings:

Fig. 1 is a sectional elevation of a transfer switch embodying the invention;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a fractional view similar to Fig. 1 but with the parts in an open circuit position;

Fig. 4 is a view taken on the line 4—4 of Fig. 1; and

Fig. 5 is an isometric view of the switch illustrating the manner in which the operating handle projects from the enclosing housing.

Referring to the drawings, the invention in one form has been shown as applied to a transfer switch comprising a movable contact 10 which, in its preferred form is provided with curved contact surfaces 10a. As shown, the movable contact 10 is hollow and spherical, with the lower end thereof provided with a stud 11 extending through an arm 12 and secured in place by a nut 13 located on the outer threaded end thereof. The arm 12 extends from a supporting member or bracket 14 having a conical or concave surface 14a to form a line contact with the ball-shaped movable contact 10. The stud 11 is loosely disposed within the opening in the arm 12 so that when the supporting member or bracket 14 is moved to the right against the movable contact 10, the concave surface 14a is pressed against it. In Fig. 1 the movable contact 10 is illustrated in one circuit-controlling position for transfer to energy from a flexible conductor 15 through movable contact 10 and a stationary contact 16, by way of the inner conductor 17 of a concentric line to a selected load (not shown) connected thereto. The outer conductor 18 of the concentric line is connected to the housing 19 of the switch, which housing may include angle supports 20 and 21 from which there extend insulators 22 and 23 for supporting the stationary contact 16. The stationary contact 16 is also provided with a concave or conical surface 16a which also provides line contact with the ball-shaped movable contact 10.

The flexible conductor 15 is hollow and is made flexible by forming it from a series of Sylphon bellows, only four of which, the bellows 24—27, are shown. The conductor 15 is secured at one end to a connector 15c and forms an extension from the inner conductor 29 of a concentric line, having an outer conductor 30. The conductors 29 and 30 are directly connected to the output terminals of the high-frequency generator. The conductor 29 is of course secured to connector 15c. The movable contact 10 may be operated

into and out of engagement with any selected one of the stationary contacts by means of an operating handle 31 which includes an actuator 32. To isolate the movable contact 10 from the operating handle 31, a plurality of insulators, such as insulators 33, 34 and 35, in triangular array extend between the bracket 14 and a bracket or member 36 secured to the end of an actuating rod 37. The rod 37, supported in bearings 38 and 39, is connected to one end of a link 40 of a toggle mechanism, the other link thereof being formed by an extension of the handle 31 which, it will be observed, is pivoted by a screw 42 extending through a bracket 43. With the toggle in the straightened position as shown in Figs. 1 and 2, there will be developed a very substantial force pressing the movable contact 10 into line contact with the stationary contact 16. Upon pressing the latch actuator 32, a latching arm 44 is withdrawn from beneath a part of a rotatable frame or turntable 45. The operating handle 31 may then be moved upwardly, as viewed in Figs. 1, 3 and 5, to rotate its toggle-extension downwardly to break the toggle. This movement moves the rod 37 to the left to withdraw the movable contact 10 from engagement wth the stationary contact 16. As this movement occurs, an arm 36*a* extending from the member 36 rotates an actuating rod 46 in a clockwise direction around its pivotal support 47. When this occurs, a compression spring 48, acting on a collar 49 secured to a rod 50, moves the rod to the left through its guides 51, 52 and 53 to rotate a grounding contact arm 54 about its pivotal support 55.

The lower end of the arm 54 has a pin 56 extending through it and into a slot 57 formed in an adjustable member carried by the rod 50. The grounding arm 54, Fig. 4, is provided with four sets of contacts. The pair of contacts 58, upon clockwise rotation of the arm 54, engage the grounded outer conductor 18, Fig. 3, of the concentric line, while the pair of contacts 59 resiliently form a wiping engagement with the inner conductor 17. Thus, as the movable contact 10 disengages the stationary contact 16, the inner conductor 17 of the concentric line and the housing 19 is grounded in avoidance of all hazards to the operator at the load which is being disconnected from the high-frequency generator.

It will be observed that each of the remaining stationary contacts is provided with similar grounding arms 54 together with their associated contacts and that these are in positions for grounding each of the inner conductors of the lines extending from the transfer switch. By reason of these provisions, maximum safety is attained inasmuch as the interruption of the grounding connection can occur only when there is deliberate operation of the handle 31 to connect a particular concentric line and load to the high-frequency generator, as to the supply conductor 29.

It has already been mentioned that the movable contact 10 may be fluid-cooled for some applications of the invention. If air be introduced through a flexible tube 60 for producing a blast of cooling air against the hollow inner surface of movable contact 10, with exit thereof around the outer surface of the flexible tube 60, the resulting air pressure within the bellows 24—28 may tend to elongate them. Accordingly, it is preferred that there be provided one or more tension members to resist elongation of the flexible conductor 15. Preferably the flexible tube 60 is so constructed as itself to resist elongation. For example, it may include either as an integral part thereof or separately therein tension members such as a cable 61 which resist elongation without materially decreasing the flexibility of conductor 15 about the axis of the inner conductor 29. It is further contemplated that the tension members themselves may extend between the movable contact 10 and the connector 15c carried by the supporting plate 62 into which the flexible conductor 15 is also secured as by the screws 63. The tension-resisting elements may be utilized with or without cooling of contact 10 and whether or not a liquid be used as a cooling medium in place of circulation of air, or other cooling gas.

Thus far there has been described the operation of the switch from its position illustrated in Figs. 1 and 2 to the position illustrated in Fig. 3.

After the operation of the switch to the open-circuit position illustrated in Fig. 3, the movable contact 10 may be rotated into engagement with any selected one of the stationary contacts. For example, the handle 31 may be lifted from its position shown in Figs. 1 and 5 upwardly and out of an indexing recess 64 and thence along a circumferential slot 65, Fig. 5, formed as a part of the housing 19 until it coincides with another indexing slot, such as one of the slots 67*a*, 68*a* and 69*a*. Thereupon the handle 31 is moved downwardly to straighten the toggle and to move the contact 10 into engagement with the corresponding one of associated stationary contacts 67, 68 or 69, shown in Fig. 2. Of course, any other position may thereafter be selected for operation of the switch.

The movable-contact assembly, Fig. 1, including the turntable or frame 45, is rotatably supported on a subframe 70 by means of a bearing 71 of the frame 45 which receives a bearing member 72 extending upwardly from the subframe 70. A further indexing mechanism is provided by a spring 73 which urges a ball 74 into recesses 75 formed in the upper plate of the subframe 70 in positions corresponding with the locations of the stationary contacts.

Each of stationary contacts 16, 67, 68 and 69 is mounted on the inner conductor of a concentric line, the outer grounded conductors 76, 77, 78 and 79 of which are shown in Fig. 2.

It is, of course, to be understood that interlock contacts will be provided, so that immediately upon upward movement of the operating handle 31, or upon releasing movement of the latch actuator 32, the high-frequency generator will be deenergized. Such interlock contacts are conventional, and, therefore, have not been illustrated; see for example the interlock contacts 119 of the aforesaid Zottu Patent No. 2,419,307. Besides personnel protection, it is intended that the high-frequency generator shall always be deenergized before operation of the selector switch in order to avoid any arcing between the movable contact 10 and any selected stationary contact.

In the operation of the switch from one circuit-closing position to another, it is to be observed that the movable contact 10 will rotate relative to the bracket 14 and its supporting arm 12. This is particularly advantageous since such relative rotation will bring into registry with each stationary contact a different contact-engaging surface of the curved movable contact 10. Thus, wear on the movable contact 10 will be distributed

over a substantial part of the curved surface thereof. This advantageous result is brought about by the pivotal mounting of the movable contact 10 on the arm 12 and by reason of the fact that the flexible conductor 15 does not turn or twist about its center line. In other words, it assists in producing the relative rotary motion of the contact 10 relative to the arm 12. The flexible conductor 15 need not be formed of a plurality of Sylphon bellows since any flexible conductor may have one end attached to the connector 15c and may extend downwardly toward the circular array of stationary contacts 16, 67, 68 and 69, and thence outwardly and in spaced relation with the plane thereof, and thence downwardly to the movable contact 10. With such a flexible conductor, as 15, the movement of the free end thereof to which the contact 10 is secured describes an arc having a radius somewhat less than that of the circular array of stationary contacts. The flexible conductor 15 not only provides for the circular motion but also for the radial motion during movement of contact 10 into and out of engagement with a selected stationary contact.

While a preferred embodiment of the invention has been illustrated, it is to be understood that further modifications may be made without departing from the scope of the appended claims.

What is claimed is:

1. A transfer switch comprising a plurality of stationary contacts laterally spaced one from the other, a movable contact, a bracket for supporting said movable contact for rotation relative to said bracket, actuating mechanism for moving said bracket to move said movable contact into and out of engagement with a selected stationary contact, a flexible conductor having one end secured to said movable contact and having its opposite end anchored in spaced relation thereto, said flexible conductor being effective to produce relative rotation between said stationary contact and said bracket.

2. A transfer switch comprising a plurality of stationary contacts laterally spaced one from the other, a movable contact, a bracket for supporting said movable contact for rotation relative to said bracket, actuating mechanism for moving said bracket to move said movable contact into and out of engagement with a selected stationary contact, a hollow flexible conductor having lateral flexibility but resisting rotary movement about the axis thereof, one end of said flexible conductor being secured to said movable contact, supporting means for said conductor spaced from said movable contact and said bracket, said conductor resisting rotation thereof to bring different areas of said movable contact into engagement with each of said stationary contacts.

3. A transfer switch comprising a plurality of stationary contacts laterally spaced one from the other, a hollow spherical movable contact, a bracket for supporting said movable contact for rotation relative to said bracket, actuating mechanism for moving said bracket to move said movable contact into and out of engagement with a selected stationary contact, a hollow flexible conductor of construction providing lateral flexibility but resisting rotary movement about the axis thereof, one end of said flexible conductor being secured to said movable contact and resisting rotation thereof to bring different areas of said movable contact into engagement with each of said stationary contacts, and a flexible fluid conduit extending lengthwise of said flexible conductor for flow of a coolant into and out of said hollow contact in heat exchange therewith.

4. A transfer switch comprising a sperical movable contact, a plurality of stationary contacts spaced one from the other in circular array around said movable contact, means including an operating mechanism rotatably supporting said movable contact for movement into alignment with any selected one of said stationary contacts, said operating mechanism including means connected to said movable contact for moving it generally radially toward and away from a selected stationary contact and for developing high contact pressures when said movable contact engages a stationary contact and for relieving that pressure as said movable contact disengages a stationary contact, said operating mechanism including a pivotal support for movement of said mechanism and said movable contact from one stationary-contact position to another, and a flexible conductor connected to and movable with said movable contact but which resists rotation about its own axis to produce relative rotation between said movable contact and said operating mechanism as the latter is moved from one stationary contact position to another to present different areas of said movable contact to each of said stationary contacts.

5. The combination set forth in claim 4 in which each of said stationary contacts is provided with a conical surface for engagement by said movable contact and said operating mechanism is provided with a pressure-applying member having a conical surface for engaging said movable contact.

6. A transfer switch comprising a plurality of stationary contacts spaced one from the other in a common plane and in circular array about a common axis, a supply conductor spaced outwardly from said common plane of said stationary contacts with the adjacent end thereof substantially concentric with said common axis, a flexible conductor connected at one end to said adjacent end of said supply conductor and extending both axially toward and radially outward from said common axis to a point adjacent to, but within the radius of, said circular array of said stationary contacts, a movable contact, having a spherical contact surface, connected to the free end of said flexible conductor, operating mechanism, means supporting said mechanism for rotation about said common axis, said operating mechanism including insulating means interposed between said axis and said movable contact for electrically insulating the latter from the remainder of said mechanism but serving as a mechanical connection between said movable contact and said remainder of said mechanism, the disposition and flexibility of said flexible conductor providing for movement thereof with said movable contact about said circular array of stationary contacts.

7. A transfer switch comprising a plurality of stationary contacts spaced one from the other in circular array about a common axis, a movable contact, each of said stationary contacts and said movable contact having curved contact-engaging surfaces for nesting relation one with the other, a pivoted supporting member having spaced guides, an actuating member carried by said guides and slidable with respect thereto in directions normal to said axis, means including said actuating member for supporting said movable contact and for moving it into and out of abutting engagement with a selected stationary

contact, an operating handle pivotally connected to said supporting member and to said actuating member for rotating said supporting member and said movable contact from one to another of said stationary contacts, a flexible conductor directly connected at one end to said movable contact, and means supporting said flexible conductor in spaced insulated relation with said pivoted support and from said actuating member for movement of said end with said movable contact from one to another of said stationary contacts.

8. A transfer switch comprising a plurality of stationary contacts spaced one from the other in circular array about a common axis, a movable contact, each of said stationary contacts and said movable contact having concave and convex contact-engaging surfaces for nesting relation one with the other, a pivoted supporting member having spaced guides, an actuating member carried by said spaced guides and slidable with respect thereto in directions normal to said axis, means including said actuating member for supporting said movable contact and for moving it into and out of abutting engagement with a selected stationary contact, an operating handle pivotally connected intermediate its ends to said supporting member, a link the respective ends of which are pivotally connected to one end of said operating handle and to one end of said slidable actuating member to form a toggle for rotating said supporting member and said movable contact from one to another of said stationary contacts, a flexible conductor directly connected at one end to said movable contact, means supporting said flexible conductor including its other end in spaced insulated relation with said pivoted support and from said actuating member for movement of said end with said movable contact from one to another of said stationary contacts, an indexing member having a slot to receive said handle when said movable contact is in alignment with a selected stationary contact, said movement of said handle into said slot straightening said toggle to move said movable contact into nesting relation with said selected stationary contact and to apply substantial contact pressure thereto, said handle upon being lifted from said slot breaking said toggle and withdrawing said slidable member and said movable contact from engagement with a stationary contact preparatory to rotation of said movable contact into alignment with another selected stationary contact.

9. A transfer switch comprising a plurality of stationary contacts spaced one from the other in circular array about a common center, a movable contact having a curved contact surface, operating mechanism for moving said movable contact into and one of engagement with a selected stationary contact and when out of engagement with a selected contact for moving it from one stationary contact to another, means supporting said operating mechanism for rotation about an axis extending through said center and normal to the plane of said circular array of stationary contacts, means for connecting said movable contact to a source of supply comprising supporting means spaced outwardly from said plane of said stationary contacts and substantially in alignment with said axis, said means including a flexible conductor extending downwardly toward said plane and outwardly in spaced relation with it and into conductive relation with said movable contact, said operating mechanism including means for rotatably supporting said movable contact generally in said plane of said stationary contacts, and means including said conductor for holding said movable contact in fixed relation with respect to said flexible conductor for presentation of different surface areas thereof to each of said stationary contacts when operated into selected engagement therewith.

10. A transfer switch for high voltage, high-frequency electrical energy comprising a plurality of stationary contacts spaced from each other in circular array around a common center, a supply connector for a supply line spaced outwardly from the plane of said stationary contacts and substantially concentric with an axis extending normal to said plane and from said common center, a flexible conductor connected at one end to said connector and extending toward said plane, thence outwardly thereof and in spaced relation therewith, and thence downwardly to a point near said plane, the free end thereof being radially within said circular array of stationary contacts, a movable contact of spherical shape connected with said free end and disposed in said plane, means including a bracket supporting said movable contact for rotation with respect thereto, said bracket and each of said stationary contacts having conically shaped surfaces for line contact-engagement with said movable contact, insulating means supporting and extending from said bracket towards said center, a turntable rotatable about said axis, and operating mechanism carried by said turntable and connected to said insulating means for actuation of said movable contact into and out of engagement with a selected one of said stationary contacts and rotatable with said turntable for rotation of said movable contact from one selected stationary contact to another selected stationary contact, said conductor restraining said movable contact for relative rotation with respect to said bracket to bring a different contact surface thereof opposite each of said stationary contacts.

11. A transfer switch for high-voltage high-frequency electrical energy comprising a centrally disposed input conductor forming the inner conductor of a high-frequency electrical concentric line, a movable contact, a frame mounted for rotation about an axis substantially concentric with that of said inner conductor, actuating means carried by said frame, said actuating means having an insulated bracket rotatably supporting said movable contact in electrical isolation from said frame, said actuating means also having an operating lever extending diametrically outwardly from said actuating means for rotating said frame, said actuating means and said movable contact from one circuit-engaging position to another, said actuating means including a toggle mechanism for developing high-contact pressures between said movable contact and an associated stationary contact, and a flexible conductor connected at one end to said inner conductor and at its other end to said movable contact, said flexible conductor including a plurality of Sylphon bellows to impart flexibility thereto for all directions of movement resulting from movement of said movable-contact structure from one stationary contact to another and into and out of engagement therewith.

12. The combination set forth in claim 11 in which said movable contact is hollow, and in which said flexible conductor includes fluid-transmitting means for flow of a stream of cooling fluid into heat exchange relation with said

movable contact, and thence outwardly therefrom for minimizing rise in temperature thereof.

13. A transfer switch comprising a movable contact and at least one stationary contact, means including an operating mechanism rotatably supporting said movable contact for movement into alignment with said stationary contact, said movable contact being hollow, a hollow fluid-conducting flexible conductor connected to said movable contact for flow of current thereto, and a fluid-conducting conduit disposed within said hollow conductor for flow of cooling fluid directly into heat exchange relation with said movable contact for cooling the same and outwardly therefrom in the space between said flexible conductor and said conduit disposed therein.

14. A switch comprising a movable contact of spherical shape, a plurality of stationary contacts in circular array around said movable contact, each of said stationary contacts having a conical circuit making surface, an actuating member rotatably supporting said spherical contact and having a conical surface for engaging said spherical contact, means for moving said actuating member to bring its conical surface into diametral alignment with said spherical contact and the conical surface of a selected stationary contact, and means attached to said spherical contact for producing relative movement with respect to said actuating member for a different diametral alignment through said spherical contact for each circuit making position thereof.

CARL E. ELLSWORTH.
ARTHUR E. GILBERT.

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