

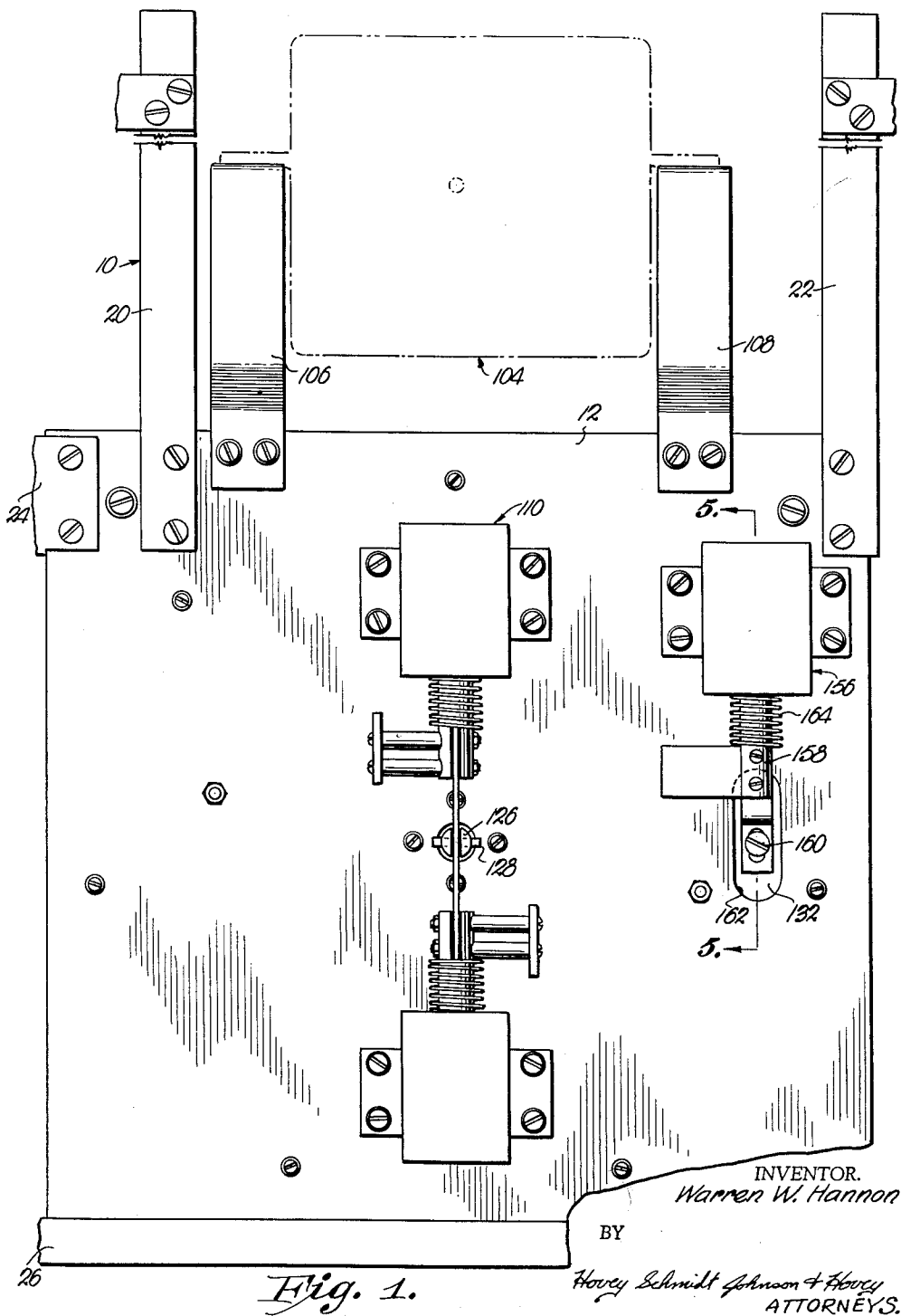
May 9, 1961

W. W. HANNON
ELECTRICAL SWITCH APPARATUS

2,983,802

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Fig. 2.

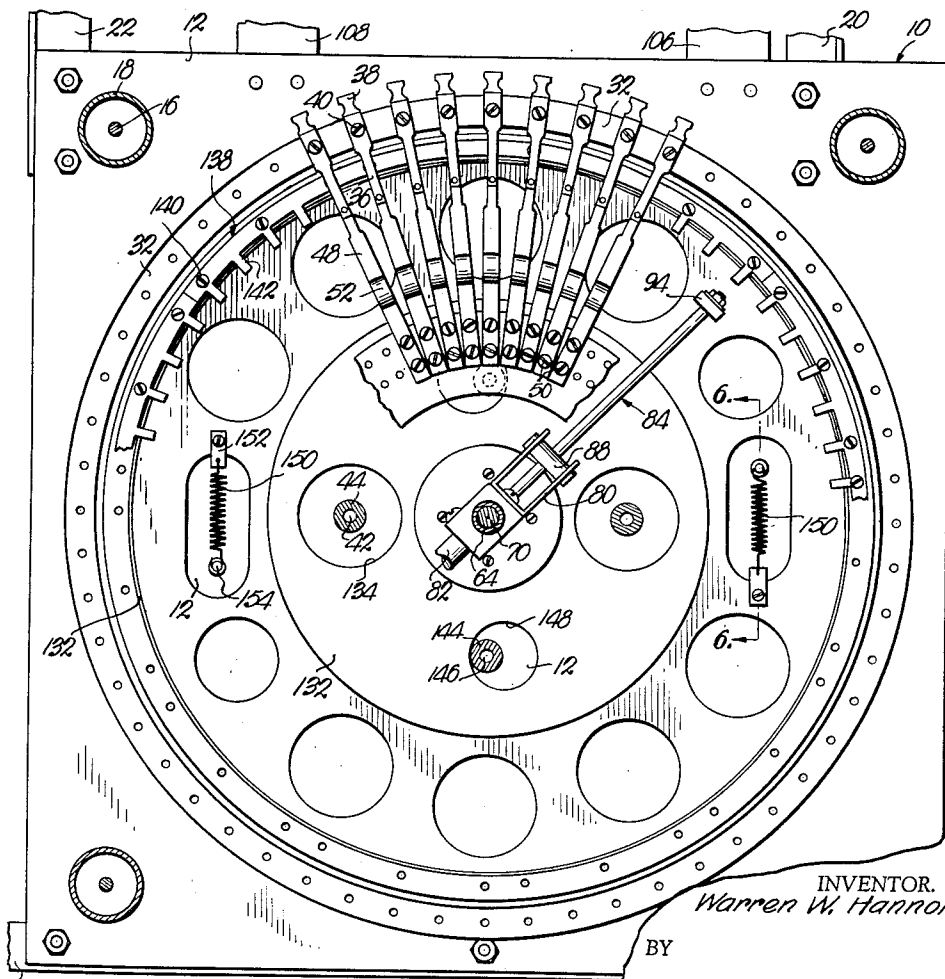
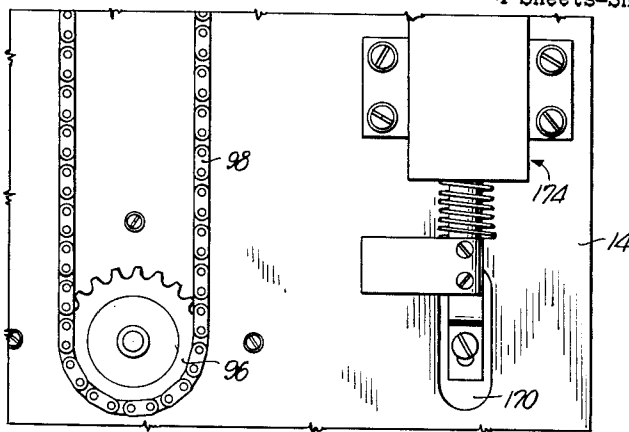


Fig. 4.

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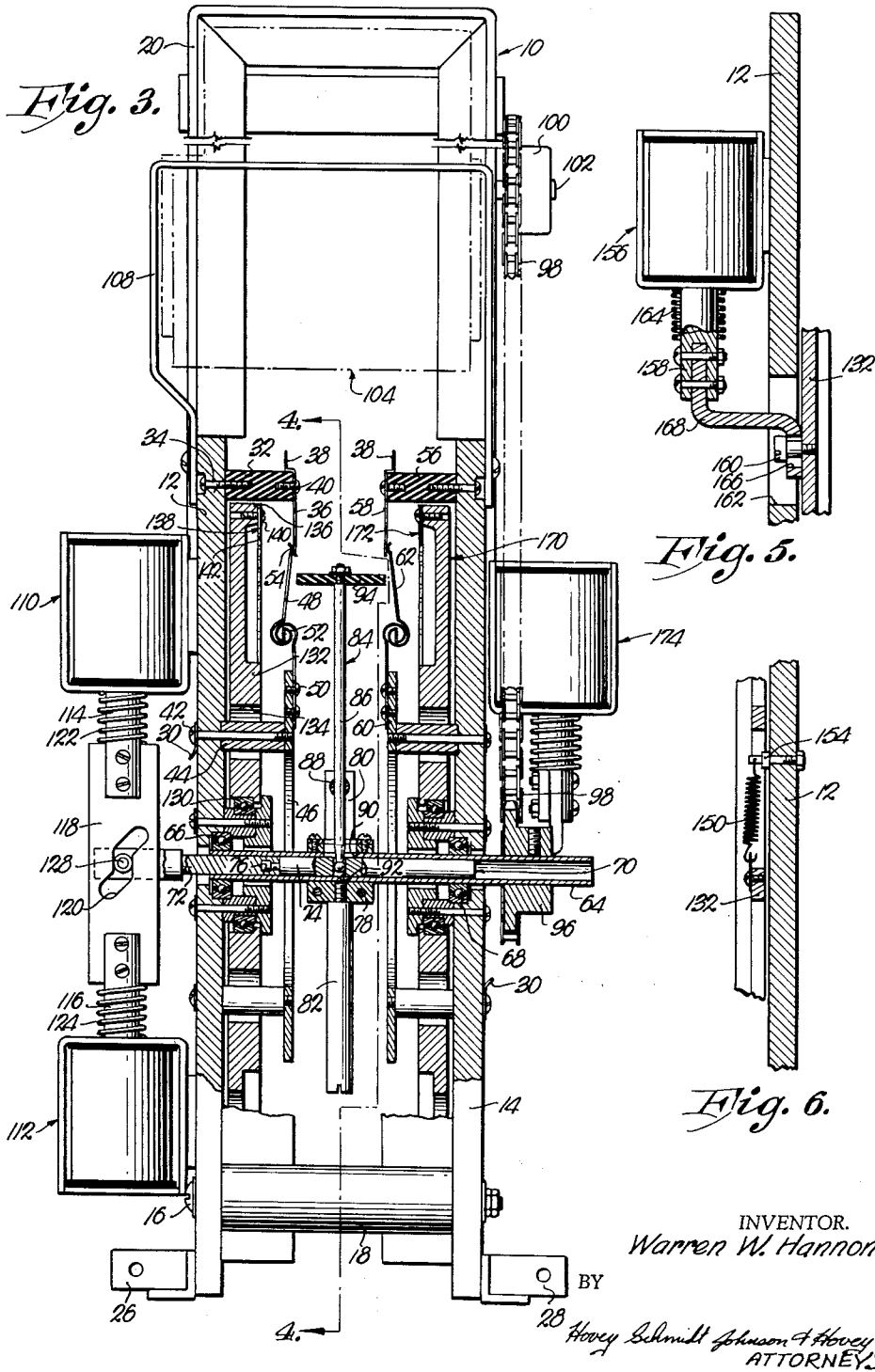
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ELECTRICAL SWITCH APPARATUS

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19 Claims. (Cl. 200—104)

This invention relates generally to the art of switching electrical circuits and more particularly to improved switching apparatus of novel type adapted to accomplish important switching functions not heretofore possible with any single switching component of conventional character.

In many types of electrical equipment it is necessary to provide means for selectively disconnecting (or connecting) any one or more of a relatively large plurality of normally commoned (or isolated) electrical circuit terminations from (or to) all of the remainder thereof, for maintaining such switched condition of the terminations until it is desired to restore them to their normal condition, for controllably restoring the terminations from a switched condition to the normal condition thereof, and for repeating such operations successively with respect to different selected ones or groups of the plurality of circuit terminations being handled.

One exemplary type of equipment in which such switching functions must be performed is found in automatic circuit analyzing apparatus (such as disclosed in my U.S. Letters Patent No. 2,849,677 or my copending application Serial No. 710,466) adapted for testing other electrical systems for, among other possible circuitry faults, shorts or insufficient insulation resistance between various terminations of the often multitudinous circuits involved in the system being tested. It may be noted that my mentioned prior inventions teach and utilize, in connection with the testing of systems having substantial numbers of circuit terminations, the advantageous principle of successively checking for shorts, for example, between each circuit termination (or group thereof which are intentionally electrically commoned within the system being tested), and all of the remaining terminations simultaneously and in one operation, as compared with the tremendously more time consuming, previous method of successively checking each circuit termination against each other termination separately and in succession. Obviously, however, the utilization of the improved principle just mentioned requires means for commoning, for example, large groups of circuit terminations and for isolating therefrom during testing, other ones or normally smaller groups of terminations, with the respective identities of the commoned and the isolated terminations changing during each successive operation of the testing program. The switching problem thus presented is extremely complex when effort is made to provide the required switching functions by means of previously available switching components.

Heretofore, the best available approach to providing even the more basic switching functions possible with the apparatus of this invention was to provide a separate switch for each circuit termination to be handled, together with means for operating each of such switches independently of the others and, if any degree of coordinated operation of the switches was desired, some master control means for controlling the operation of all of the switch operating means. In practice, such an assemblage

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with conventional components would normally involve the provision of a relatively great number of relays, i.e., one for each circuit termination, in combination with stepping switch means for selectively actuating one or more of the relays to one switching condition thereof while the remaining relays were left in the other switching condition thereof. That the initial component and assembly costs, power consumption, space requirements, weight characteristics, servicing time and general complexity of such heretofore available arrangements have been relatively high, will be apparent.

It should be noted further in explaining the general background from which the present invention arose, that consideration has been given to the possibility of whether switching functions of the types in question might be practically provided by the utilization of so-called "cross-bar type" switching assemblies, but such means have been found unsatisfactory for this purpose. Such cross-bar type switching assemblies conventionally involve basically the provision of a first set of parallel, electrically conductive rods, a second set of parallel, electrically conductive rods disposed perpendicularly and normally in spaced relation to the first set, a solenoid or the like for each of the first set of rods respectively for moving the corresponding one of the latter into and out of a shifted position nearer the second set of rods, and a solenoid or the like for each of the second set of rods respectively for moving the corresponding one of the latter into and out of a shifted position nearer the first set of rods such that any of the first set of rods which are in their shifted positions will be in electrically conductive engagement with any of the second set of rods which are in their shifted positions.

Such cross-bar type switching assemblies are primarily adapted for switching any of a first group of circuit terminations into and out of connection with any of a second and distinct group of other circuit terminations, and for this purpose they are reasonably satisfactory, although even in such application it will be recognized that the provision of a separate rod and solenoid or other operating mechanism for each and every circuit termination to be handled imposes serious cost, space and other burdens as the number of circuit terminations to be handled becomes at all substantial.

Accordingly, even as to the more basic types of switching functions for which the apparatus of this invention is particularly adapted, the cross-bar type switch is, at best, little or no better than the multiple relay and stepping switch approach mentioned above, while many of the more complex switching functions of which the apparatus of the invention is capable simply cannot be performed by any known kind of cross-bar type switch.

It is, therefore, the primary object of this invention to provide a solution to above-mentioned and other problems heretofore prevailing in the switching art with respect to the effective and efficient performance of various special switching functions, particularly where relatively large numbers of circuit terminations must be handled.

It is another important object of the invention to provide a simplified and relatively inexpensive, integrated assembly presenting an electrical switching unit or component of extreme versatility and reliability in performing various types of switching functions, a number of which have been difficult or impossible to accomplish practically with previously available equipment.

It is another important object of the invention to provide improved switching apparatus which is particularly suited for handling relatively large numbers of circuit terminations to be switched with minimum requirements of space and operating power.

It is another important object of the invention to pro-

vide switching apparatus whose nature particularly adapts it for handling the switching of large numbers of circuit terminations which may be carrying high electrical voltages.

It is another important object of the invention to provide switching apparatus which is adapted to be simply and reliably controlled in its operation by electrical control voltages applied to a minimized number of electrically responsive motive means.

It is another important object of the invention to provide switching apparatus adapted for isolating one or more selected circuit terminations of a substantial number of such terminations from the remainder thereof and for commoning all of the latter, which is further adapted for quickly changing the identity of the isolated and the commoned terminations in successive operations of the apparatus, and which, if desired, may be further adapted for simultaneously connecting any isolated termination with other isolated terminations or external circuitry or/and for simultaneously controlling the continuity of external circuits functionally related to the isolated or the common terminations or to both.

It is another important object of the invention to provide switching apparatus in which selected ones of a plurality of contact structures may be quickly and successively moved into shifted switching positions, latched in such shifted positions then simultaneously released to their normal positions.

Still other important objects of the invention, including certain significant constructional features, will be made clear or become apparent as the detailed description hereinafter of illustrative embodiments of the invention progresses.

Finally, with regard to objects and applicability of the invention, it should be noted that the invention is conceived both to represent a basically significant advance in the switching art and to involve novel principles and structure of wide applicability not only in many and varied general types of presently known electrical equipment, but also in other now unknown types of equipment which the advent of the invention may itself suggest or render possible of practical construction. Accordingly, although reference to specific applications may be made herein for illustrative purposes, it is to be understood that the broad scope and wide applicability of the invention are in no way to be taken as limited thereby.

In the accompanying drawings:

Fig. 1 is a fragmentary, elevational view of one side of an illustrative embodiment of the invention;

Fig. 2 is a fragmentary, elevational view of a portion of the opposite side of the embodiment of Fig. 1;

Fig. 3 is an edge elevational view of the embodiment of Fig. 1, with parts being broken away and shown in section to illustrate the construction in the zone of a central, vertical plane through the apparatus;

Fig. 4 is a fragmentary, cross-sectional view taken on irregular line 4—4 of Fig. 3, with some parts being broken away and the duplication of other parts omitted for clarity of illustration of underlying structure;

Fig. 5 is a fragmentary, cross-sectional view taken on line 5—5 of Fig. 1;

Fig. 6 is a fragmentary cross-sectional view taken on line 6—6 of Fig. 4; and

Figs. 7 and 8 are enlarged, fragmentary cross-sectional views of illustrative forms of modified contact assemblies which may be utilized with the invention in lieu of that shown in Figs. 3 and 4.

Referring first to Figs. 1 through 6 inclusive, the currently preferred, basic embodiment of improved switching apparatus chosen for illustration of the invention, is generally designated by the numeral 10.

Apparatus 10 is provided with a frame including spaced, parallel, side plates 12 and 14 held in fixed relation to each other as by bolts and spacers at 16 and 18 respectively. If desired, bracket means as at 20, 22,

24, 26 and 28 may be provided for mounting the apparatus 10 in a housing or the like (not shown) and for supporting other components that may be used in conjunction with the apparatus 10 in a particular piece of electrical equipment of which the apparatus 10 forms a part. In the embodiment under consideration, plates 12 and 14, bolts 16 and spacers 18 are preferably all formed of metal to render the frame of apparatus 10 electrically conductive for use as a common ground, lugs as at 30 being provided for making electrical connection thereto. If it be desired to increase the resistance leakage characteristics of the path between pole pieces 48 and contacts 36, plates 12 and 14, and perhaps other parts normally formed of metal, may be made from electrically insulative material and commoning electrical connections to pole pieces 48 otherwise conventionally provided.

The plate 12 is provided on the face thereof adjacent plate 14 with an annular contact supporting member 32 formed of electrically insulating material and secured to plate 12 as by screws 34. A plurality of electrically conductive, elongated, metal, stationary switch contacts 36 are equally spaced around the entire circumference of member 32 and extend radially inwardly from the latter, and also outwardly from member 32 to provide lugs 38 thereon for the electrical connection of circuit terminations therewith. Contacts 36 may be secured to member 32 as by screws 40. It will be understood that, in an application of apparatus 10 where the latter is to be permanently employed for switching a given set of circuit terminations, the wire leads corresponding to the latter may be soldered directly to lugs 38; while, in an application of apparatus 10 where the latter is to be used for switching any given set of circuit terminations only temporarily (as in circuit fault system testing equipment such as referred to hereinbefore), intermediate leads permanently soldered to lugs 38 may be used and be provided with socket or other type coupling means to which different sets of circuit terminations may be rapidly connected and disconnected.

Also mounted on the plate 12 in spaced relation to the latter, as by bolts 42 and spacers 44, is an annular pole piece carrying member 46. A plurality of elongated, resilient, electrically conductive, metal pole pieces 48, of which there is one for each of the contacts 36, are mounted on the member 46 in equally spaced disposition therearound, as by screws 50. Each pole piece 48 preferably includes a coiled and counter-coiled, intermediate portion 52 to render the same more flexible without impairing its overall resiliency. Each pole piece 48 extends radially outwardly from the member 46 and terminates in a contact engaging portion 54 normally engaging the corresponding contact 36. Each of the pole pieces 48 and the corresponding contact 36, therefore, present a single pole switching assembly which is closed when the pole piece 48 is in its normal position but may be opened upon movement of the pole piece 48 against its own resiliency to shift the portion 54 thereof away from corresponding contact 36. It will be observed that in the embodiment illustrated in Figs. 1 through 6 inclusive, the member 46, bolts 42 and spacers 44 are preferably formed of conductive, metallic material in order to provide a commoning connection between all of the pole pieces 48 and the common ground provided by plates 12 and 14 and the other parts of the main frame hereinbefore identified.

The plate 14 is provided on the face thereof adjacent the plate 12 with an annular contact supporting member 56 carrying contacts 58 and with a pole piece carrying member 60 having a number of pole pieces 62 mounted thereon, the construction of such parts 56, 58, 60 and 62 and their relationships to each other and the plate 14 being the same as hereinbefore described with regard to the parts 32, 36, 46 and 48 respectively and the plate

A tubular shaft 64 is rotatably mounted on the main frame of apparatus 10 for rotation upon the axis of annular members 32, 46, 56 and 60 by means of a bearing 66 on the plate 12 and a bearing 68 on the plate 14. Slidably and rotatably received within and extending from the end of shaft 64 adjacent the plate 12, is a rod assembly generally designated 70 having a pair of relatively rotatable sections 72 and 74 which may be interconnected as at 76 for reciprocation together without impairing their relative rotatability. A hub 78 is rigidly mounted upon the shaft 64 and carries bracket means 80 for swingably mounting a switch actuating element hereinafter to be described, as well as a counterweight 82 for such element which extends oppositely than the bracket means 80 and the element from the hub 78.

A switch actuating element generally designated 84 includes an elongated rod 86 extending inwardly from a point between the sets of pole pieces 48 and 62 past a point where same is pivotally mounted as at 88 upon the bracket means 80, through an elongated, longitudinal slot 90 provided in shaft 64 and into a groove 92 formed in the rod section 74. Mounted at the outer extremity of the element 84 is a pole piece engaging member 94, which is preferably, although not necessarily, formed of electrically insulating material in the particular embodiment of Figs. 1-6 inclusive.

It will first be understood that the element 84 is mounted for rotation with the shaft 64 about the axis of rotation of the latter by virtue of the action of the pivot 88 and the slot 90 in confining shiftability of the element 84 to a plane including the axis of rotation of the shaft 64. It will be further understood, however, that the element 84 is mounted for swinging movement in either direction in such plane when the rod 70 is reciprocated relative to the shaft 64 and regardless of the particular rotational position of the latter. The mentioned rotatability of the element 84 with the shaft 64 provides for positioning the element 84 between and in juxtaposition with any corresponding pair of pole pieces 48 and 62 around the circumference of members 46 and 60 respectively, while the swingability of the element 84 in either direction provides for the shifting of either the pole piece 48 or the pole piece 62 of any corresponding pair thereof upon engagement therewith by the member 94 when the element 84 is swung upon its pivotal mounting 88 by reciprocation of the rod 70 relative to the shaft 64 in the appropriate direction.

It will be understood by those skilled in the art that the rotational positioning of the shaft 64, and, therefore, the element 84, may be accomplished in various ways depending upon the application to be made of the apparatus 10. For purposes of illustration, however, the embodiment shown may use a sprocket 96 secured to the shaft 64, together with a chain 98 coupled to a driving sprocket 100 on the drive shaft 102 of any suitable form of rotative motive means as generally indicated at 104 and which may be mounted upon the frame of apparatus 10 by means of brackets as at 106 and 108. Since the function of rotating shaft 64 is to precisely locate the rotated position of the switch actuating element 84 between and in juxtaposition with various corresponding pairs of pole pieces 48 and 62 at various times, it will be understood that the motive means 104 may preferably be of a type providing for stepped advancement of the rotative motion of shaft 102 thereof. In the embodiment illustrated, a satisfactory form of motive means 104 is provided by using a telephone type stepping switch for the latter, in which construction the advancing means forming a part of the stepping switch 104 provides the necessary motive power to the shaft 102 of such stepping switch and the contacts of the latter may be used for control functions in connection with the other parts of the equipment of which the apparatus 10 forms a part. It is to be understood, however, that the motive means 104 should be capable of imparting rotative movement

to the shaft 64 in such manner that the switch actuating element 84 may be advanced between the pole pieces 48 and the pole pieces 62 and stopped in operative position between any corresponding pair of the latter.

The means provided for reciprocating the rod assembly 70 relative to the shaft 64 may include a pair of solenoids generally designated 110 and 112 having opposed armatures 114 and 116 respectively which are interconnected by a cam plate 118 having a slot 120 therein generally inclined to the axis of the plate 118 extending between the armatures 114 and 116. It may be noted that the armatures 114 and 116 are respectively provided with springs 122 and 124 for normally maintaining the plate 118 in a centralized location when neither of the solenoids 110 and 112 are electrically energized. The section 72 of rod assembly 70 is provided on the part thereof extending out of the shaft 64 beyond the plate 112, with a bifurcated end portion 126 embracing the cam plate 118 and with a pin 128 extending across such bifurcated portion 126 and through the slot 120 of cam plate 118.

It will be apparent to those skilled in the art that, by virtue of the action of the slot 120 upon the end 128, the rod assembly 70 may be reciprocated in either direction relative to the shaft 64 when one or the other of the solenoids 110 and 112 is energized. As above noted, the rotative coupling 76 provides for relative rotation between the rod sections 72 and 74, while permitting the latter to rotate with the shaft 64. When the solenoid 110 is energized to pull plate 118 upwardly as illustrated in Fig. 3, the rod assembly 70 is reciprocated toward the left of such figure and the switch actuating element 84 is swung on its pivot 88 in a direction such that the pole piece engaging member 94 will engage pole piece 62 to move the latter out of contacting engagement with contact 58 and therebeyond; conversely, when the solenoid 112 is energized, the rod assembly 70 is reciprocated toward the right in Fig. 3 and the switch actuating element 84 is swung in a direction to engage the pole piece 48 and move the same out of its normally contacting relation with contact 36 and therebeyond. It will be understood that suitable energizing control leads will be provided to solenoids 110 and 112 for selectively energizing the latter as desired, just as it will be further understood that the overall equipment in which apparatus 10 is incorporated, will include suitable electrical energizing and control leads to be associated with the motive means 104 and the other control solenoids hereinafter to be described.

Rotatably mounted upon bearing means 130 carried by the plate 12, is an annular latching ring assembly 132 having cutouts as at 134 to clear the spacers 44 and bolts 42. Such latching ring assembly 132 is rotatable upon an axis concentric with the shaft 64 and is provided at its outer circumferential portion with a flange 136 extending toward the plate 114. Such flange 136 carries latching means generally designated 138, secured to the flange 136 as by screws 140, which means 138 includes a plurality of equally spaced, radially inwardly extending latching elements 142 of which there is one provided for each of the pole pieces 48. The latching elements 142 are preferably resilient in character and extend inwardly from the flange 136 such a predetermined distance that, when the latching ring 132 is in its normal position and any given pole piece 48 is swung by the switch actuating element 84 away from the corresponding contact 36, the end portion 54 of such pole piece 48 will pass under the corresponding latching element 142 and be retained by the latter so as to be maintained out of engagement with the corresponding contact 36 until the same is released. As will be most clear from Fig. 4, the latching elements 142 are sufficiently spaced that upon suitable rotation of the latching ring 132 through a small angle, any of the pole pieces 48 which have been latched under or behind correspond-

ing latching elements 142 may be released whenever the latching ring 132 is suitably rotated away from its mentioned normal position. Referring to Fig. 4, it will be seen that a protuberance 144 mounted on the plate 12 as by a bolt 146, cooperates with an opening 148 in the latching ring assembly 132 to provide a stop against rotation of the latter in one direction under the influence of a spring 150 oppositely secured to the latching ring 132 as at 152 and to the plate 12 as at 154. The spring 150 serves to normally maintain the latching ring assembly 132 in its normal position with protuberance 144 engaging one edge of opening 148, in which normal position of the latching ring assembly 132, there is a latching element 142 disposed in proper juxtaposition to each of the pole pieces 48 for latching the latter when the same is swung away from its corresponding contact 36 by the switch actuating element 84.

Solenoid means generally designated 156, which are shown in Fig. 1 but omitted from Fig. 3 in order to more clearly illustrate the structure already described as associated with the solenoid 110, are mounted on the plate 112 and provided with a reciprocable armature 158 having a pivotal connection 160 to the latching ring assembly 132, such means interconnecting the armature 158 and the latching ring assembly 132 extending through a slot 162 in the plate 12. A spring 164 is preferably provided on the armature 158. It will be understood that when the solenoid 156 is energized by application of electrical power thereto through suitable control leads, the armature 158 will be reciprocated to rotate the latching ring assembly 132 away from its normal position to an angularly displaced position in which the latching elements 142 have been moved away from any latched pole pieces 48 to free the latter for return to their normal positions in engagement with the corresponding contacts 36.

Since the solenoid 156 and its associated structure was omitted from Fig. 3, another view thereof is provided in Fig. 5, from which it will be apparent that the pivotal connecting means 160 operates in conjunction with an enlarged slot 166 adapted to allow for any lateral displacement between an extension 168 of the armature 158 and the latching ring assembly 132 during rotation of the latter.

As will be apparent from Fig. 3, similar latching and associated control structures are provided for the pole pieces 162 associated with plate 14 and include a latching ring assembly 170, latching means 172 and solenoid means 174, which are essentially identical in construction and correspond respectively to the latching ring assembly 132, the latching means 172 and the solenoid means 156 described above.

In operation, the embodiment of Figs. 1-6, inclusive, may be used to perform essentially as follows:

Since all of the pole pieces 48 and 62 are normally commoned by their conductive mounting upon the main frame plates 12 and 14 (or by a connection between lugs 30), and since each of the pole pieces 48 and 62 is normally in contacting engagement with its corresponding contact 36 or 58, it will be understood that when neither of the solenoids 110 and 112 are actuated, all of the circuit terminations connected with lugs 38 of contacts 36 and 58 will be commoned and that electrical connection thereto may be made, if desired, by means of the lugs 30. The motive means 104 may then be electrically actuated to rotate the shaft 64 to dispose the switch actuating element between a particular pair of pole pieces 48 and 62. With the switch actuating element 84 so positioned, one or the other of the solenoids 110 and 112 may then be energized to swing the element 84 to operate one or the other of the pole pieces 48 and 62 away from its corresponding contact 36 or 58 and into latched condition behind the corresponding latching element 142 of the corresponding latching means 138 or 172. At this point, the

external circuit termination connected with the lug 38 of the particular contact 36 or 58 whose pole piece 48 or 62 has been operated, will be electrically isolated from the remainder of the circuit terminations connected to both sets of lugs 38, while the remaining terminations will remain commoned.

Since the operated pole piece 48 or 62 will remain latched in its actuated condition until released, the motive means 104 may then be operated to dispose the switch actuating element 84 between any other corresponding pair of pole pieces 48 and 62 and one or the other of the solenoids 110 or 112 energized to operate the desired one of such pair of pole pieces 48 and 62. Such operation may be continued until the pole pieces 48 and 62 of each of the circuit terminations desired to be isolated from the remainder of the latter have been operated and latched in their actuated conditions. It will be understood that such steps of each operational phase of the apparatus 10 are accomplished quite rapidly by virtue of the nature of the apparatus 10 and the various power means utilized, and further, that by virtue of the electrical character of all of the latter, each such operational phase of the apparatus 10 may be automatically controlled by electrical control circuitry suitable to the particular application in which the apparatus 10 is employed.

After a given operational phase of the apparatus 10 is completed, the solenoids 156 and 174 may be energized to rotationally shift the latching ring assemblies 132 and 170, whereupon all of the previously latched pole pieces 48 and 62 are released and returned to their normal positions in electrically contacting engagement with their corresponding contacts 36 and 58. Upon deenergization of the solenoids 156 and 174, the latching ring assemblies 132 and 170 return to their normal positions under the influence of springs 150, whereat they are readied for latching any pole pieces 48 and 62 which may be actuated during the next operational phase of the apparatus 10.

It will be apparent to those skilled in the art that even the basic form of the apparatus 10 described above and shown in Figs. 1-6 inclusive for illustrative purposes, is capable of performing quickly, simply and efficiently a great variety of switching functions, many of which have heretofore been considered to be both complex and difficult to accomplish with previously available means.

An idea of the scope of variations contemplated by the invention as being of possible utility in connection with special applications of the apparatus 10, may be had from reference to the exemplary modifications shown in Figs. 7 and 8. In these figures, parts numbered similarly to those described above, will be understood to be identical to the latter, except as may be expressly noted.

Referring now specifically to Fig. 7, the annular mounting member 32' on plate 12, as well as its counterpart 56' on plate 14, is formed in a number of layers of insulating material in order to carry thereon in electrically isolated condition, not only a main contact 36' (or 58'), but also a first auxiliary contact 17 normally in engagement with the contact 36' and, if desired, a second auxiliary contact 27 normally out of engagement with the corresponding contact 36' but adapted to be conductively engaged by the latter whenever the corresponding pole piece 48 (or 62), is shifted to its actuated, latched position. It may be noted in this respect, that the contacts 36' and 58' of this modification are preferably of resilient character having a normal tendency to move into engagement with the corresponding contacts 27, but adapted to be swung away from the latter and into engagement with the contact 17 under the biasing force of the corresponding pole piece 48 and 62 when the latter are in their normal positions.

The construction of Fig. 7 thus provides, in addition to the switching functions available between each pole piece 48 (or 62) and its corresponding contact 36' (or 58'), a further switching function involving each con-

tact 36' (or 58') and its associated auxiliary, normally closed contact 17 and auxiliary, normally open contact 27. Since each of the contacts 17 and 27 may be either commoned, if desired, or separately connected by suitable leads with particular circuit terminations or external control circuitry forming a part of the overall equipment, it will be apparent that the modification of Fig. 7 greatly expands the already considerable functional versatility of the basic embodiment hereinbefore described.

Similarly, reference to Fig. 8 will demonstrate how there may be associated with each pole piece 48 (and 62) a multipole switching assembly generally designated 19, in order to further increase the switching functions which may be performed. For illustrative purposes, in Fig. 8 there is shown upon each insulating mounting member 32" a double pole, double throw switching assembly 19 including a first resilient pole contact 29 having associated therewith a normally closed contact 39 and a normally open contact 49, and a second resilient pole contact 59 ganged with the pole contact 29 by insulative spacer means 69 and having associated therewith a normally closed contact 79 and a normally open contact 89. Fig. 8 also illustrates as a constructional feature, the provision of an electrically insulative buffer 99 upon the contact of assembly 19 that would otherwise normally be engaged by the corresponding main pole piece 48 (or 62), which may be desirable when all of the circuit terminations to be coupled with the assembly 19 must be isolated from ground or the frame of the apparatus 10. An alternate way of accomplishing such last-mentioned result is also illustrated in Fig. 8 as involving the substitution of insulating material in the mounting members 46" (and 60").

It is believed apparent from the structural variations disclosed above, merely for illustration, that the advantageous, basic principles and structural relationships of the invention have broad applicability and that a number of changes in certain details of construction could be made from those disclosed herein as illustrative without departing from the true spirit and intention of the invention. Accordingly, it is to be understood that the invention shall be construed as limited only by the fair scope of the claims granted.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In electrical switching apparatus, a frame; a plurality of switch assemblies on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact; a switch actuating element; means mounting said element on the frame for shifting movement along a path for disposing said element successively in juxtaposition to different of said pole pieces and for shifting movement into and out of operative engagement with any juxtaposed pole piece for shifting the latter relative to its corresponding contact; means for shifting said element along said path; means for shifting said element into and out of said operative engagement with the juxtaposed pole piece; and means for latching in its shifted position a pole piece shifted by the engagement of said element therewith.

2. Apparatus as set forth in claim 1, wherein said latching means is shiftable to release a previously shifted pole piece latched thereby, and there is provided means for shifting said latching means.

3. Apparatus as set forth in claim 2, wherein said latching means is common to a plurality of said pole pieces, whereby said plurality of pole pieces may be latched in their shifted positions by separate operations of said element shifting means and then simultaneously released from said shifted positions by a single operation of said latching means shifting means.

4. Apparatus as set forth in claim 3, wherein said contacts are mounted on said latching means for shifting with the latter.

5. Apparatus as set forth in claim 4, wherein each of

said assemblies includes a second contact disposed to be engaged by the corresponding pole piece whenever the latter is released from its latched position.

6. In electrical switching apparatus, a frame; a plurality of switch assemblies on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact; a switch actuating element; means mounting said element on the frame for shifting movement along a path for disposing said element successively in juxtaposition to different of said pole pieces and for shifting movement into and out of operative engagement with any juxtaposed pole piece for shifting the latter relative to its corresponding contact; means for shifting said element along said path; and means for shifting said element into and out of said operative engagement with the juxtaposed pole piece, said contacts being stationarily mounted on said frame.

7. In electrical switching apparatus, a frame; a plurality of switch assemblies on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact; a switch actuating element; means mounting said element on the frame for shifting movement along a path for disposing said element successively in juxtaposition to different of said pole pieces and for shifting movement into and out of operative engagement with any juxtaposed pole piece for shifting the latter relative to its corresponding contact; means for shifting said element along said path; and means for shifting said element into and out of said operative engagement with the juxtaposed pole piece, each of said assemblies including an auxiliary contact, said first-mentioned contact being biased to shift into and out of engagement with said auxiliary contact as said pole piece is moved into and out of engagement with said first-mentioned contact.

8. In electrical switching apparatus, a frame; a plurality of switch assemblies on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact; a switch actuating element; means mounting said element on the frame for shifting movement along a path for disposing said element successively in juxtaposition to different of said pole pieces and for shifting movement into and out of operative engagement with any juxtaposed pole piece for shifting the latter relative to its corresponding contact; means for shifting said element along said path; means for shifting said element into and out of said operative engagement with the juxtaposed pole piece; means for latching in their shifted positions any of a plurality of pole pieces shifted by the engagement of said element therewith; and means electrically commoning said contacts corresponding with each of said plurality of pole pieces.

9. In electrical switching apparatus, a frame; a plurality of switch assemblies on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact; a switch actuating element; means mounting said element on the frame for shifting movement along a path for disposing said element successively in juxtaposition to different of said pole pieces and for shifting movement into and out of operative engagement with any juxtaposed pole piece for shifting the latter relative to its corresponding contact; means for shifting said element along said path; means for shifting said element into and out of said operative engagement with the juxtaposed pole piece; a plurality of switch mechanisms on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact, the pole pieces of said mechanisms being in spaced juxtaposition to the pole pieces of corresponding assemblies, said path being between the pole pieces of said mechanisms and the pole pieces of said assemblies; and means for shifting said element into

and out of operative engagement with the pole piece of a mechanism juxtaposed therewith for shifting the latter relative to its corresponding contact.

10. In electrical switching apparatus, a frame; a plurality of switch assemblies on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact; a switch actuating element; means mounting said element on the frame for shifting movement along a path for disposing said element successively in juxtaposition to different of said pole pieces and for shifting movement into and out of operative engagement with any juxtaposed pole piece for shifting the latter relative to its corresponding contact; means for shifting said element along said path; and means for shifting said element into and out of said operative engagement with the juxtaposed pole piece, said assemblies being arranged on the frame with their pole pieces normally disposed within an annular, substantially planar zone, said path being annular, and said element being rotatably mounted on the frame for traversing said path.

11. Apparatus as set forth in claim 10, wherein is provided a plurality of switch mechanisms on said frame each having a contact and a pole piece adapted for shifting movement into and out of engagement with the corresponding contact, the pole pieces of said mechanisms being normally disposed within an annular, substantially planar zone in spaced juxtaposition to said zone of disposition of the pole pieces of said assemblies, said path being between said zones, there being means provided for shifting said element into and out of operative engagement with the pole piece of a mechanism juxtaposed therewith for shifting the latter relative to its corresponding contact.

12. In electrical switching apparatus; a main frame; shaft means rotatably mounted on said main frame; means for rotating said shaft means to selected rotational positions thereof; a plurality of resilient switch pole pieces mounted on said main frame and arranged in a generally annular series concentric with the axis of rotation of said shaft means; switch actuating means mounted on said shaft means for rotation with the latter, said actuating means including a shiftable element normally dis-

posed in spaced juxtaposition to a pole piece whose identity is determined by the position of rotation of said shaft means; operating means operably coupled with said element for shifting the latter, along a path at an angle to its plane of revolution about said axis, into and out of engagement with a juxtaposed pole piece for moving the latter between a pair of positions thereof; switch contact means; and means mounting said contact means on said main frame in disposition for engagement of said contact means by said pole pieces when the latter are in one of said positions thereof.

13. Apparatus as set forth in claim 12, wherein said contact means are disposed for engagement by said pole pieces only when the latter are in their normal position.

14. Apparatus as set forth in claim 12, wherein said contact means are disposed for engagement by said pole pieces only when the latter are in their shifted positions.

15. Apparatus as set forth in claim 12, wherein said contact means include both contact parts disposed for engagement by said pole pieces only when the latter are in their normal position, and contact structures disposed for engagement by said pole pieces only when the latter are in their shifted position.

16. Apparatus as set forth in claim 12, wherein is provided an auxiliary frame; and latching means on said auxiliary frame for latching said pole pieces in their shifted position.

17. Apparatus as set forth in claim 16, wherein said auxiliary frame is shiftable mounted on said main frame to render said latching means releasable, and there is provided means for shifting said auxiliary frame relative to said main frame.

18. Apparatus as set forth in claim 16, wherein said latching means includes electrically conductive means serving as at least a part of said contact means.

19. Apparatus as set forth in claim 12, wherein said operating means includes an electromagnetic device having an armature operably coupled to said element.

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