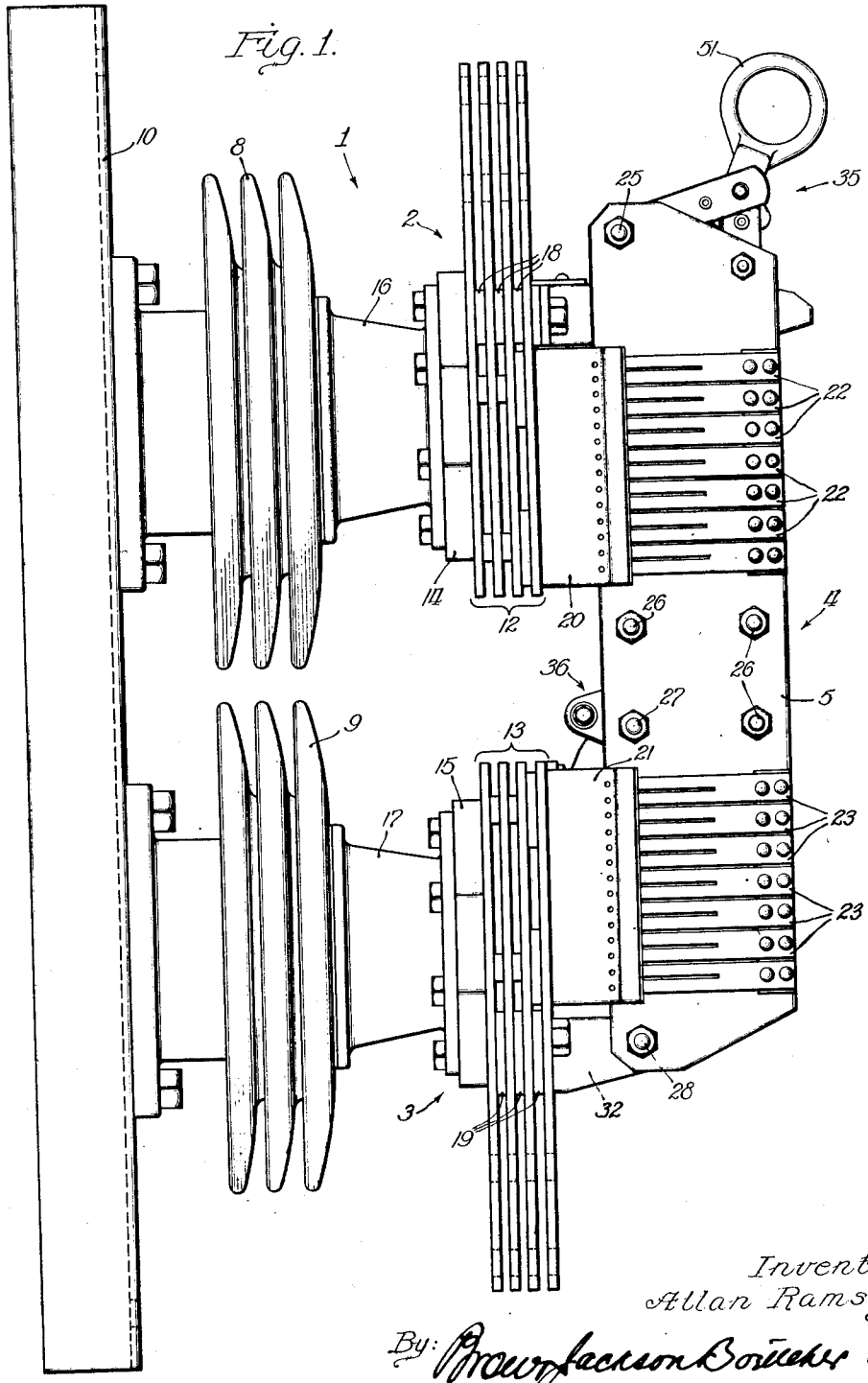
Dec. 24, 1940. A. RAMSEY 2,226,386

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Fig. 1.



Inventor:
Allan Ramsey

By: Brown Jackson Boettcher & Dennis. Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 2.

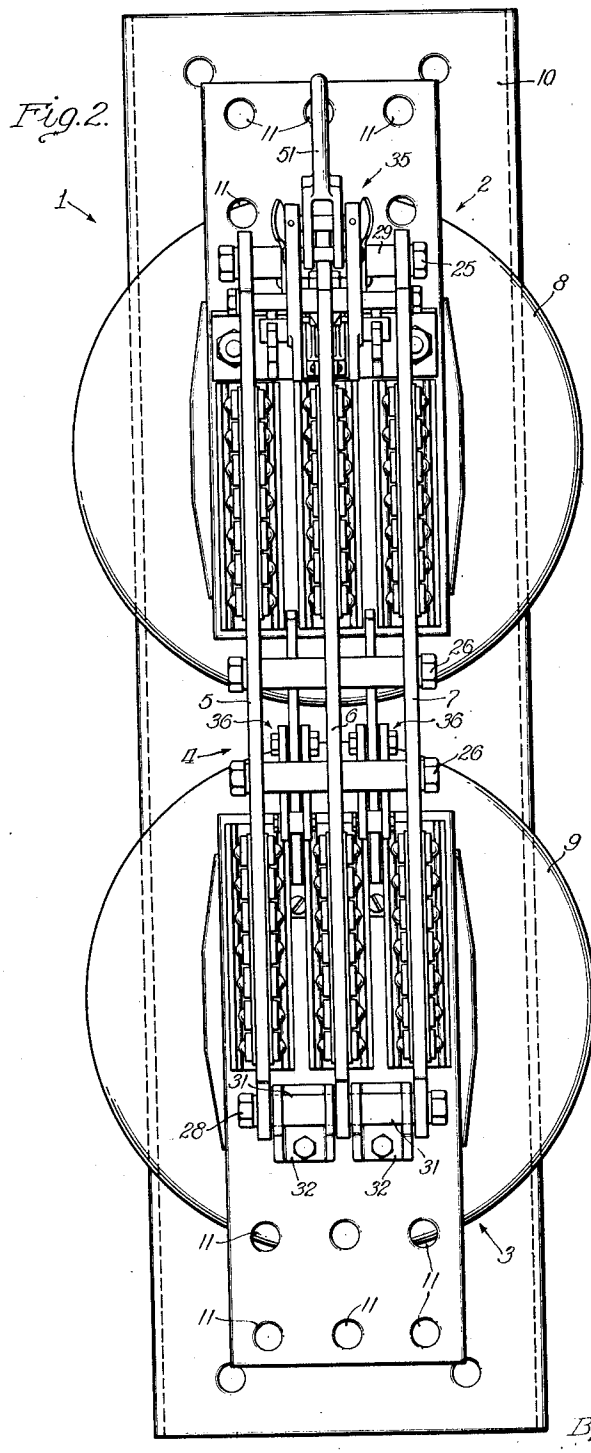
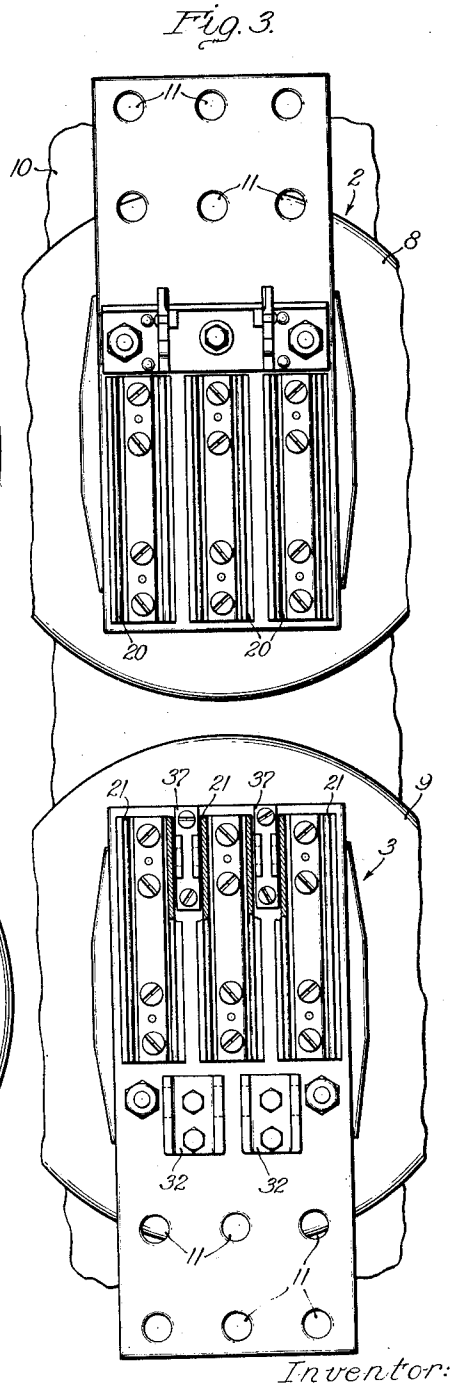


Fig. 3.



Inventor:
Allan Ramsey
By: Brown Jackson Boettcher
Denver. Atty's.

Dec. 24, 1940. A. RAMSEY 2,226,386

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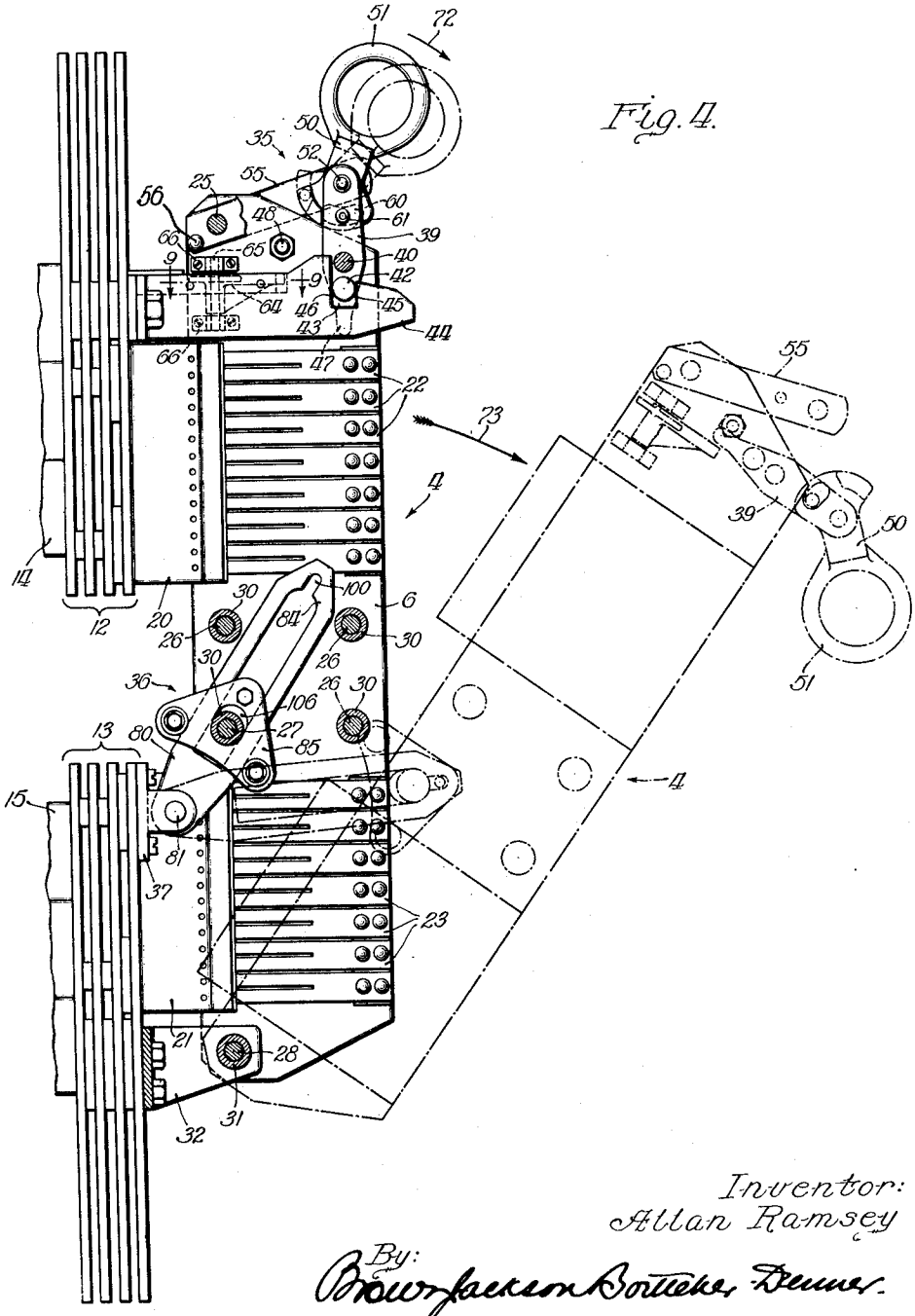


Fig. 4.

Inventor:
Allan Ramsey

By: Brown Jackson Boettcher Dennis

Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 5.

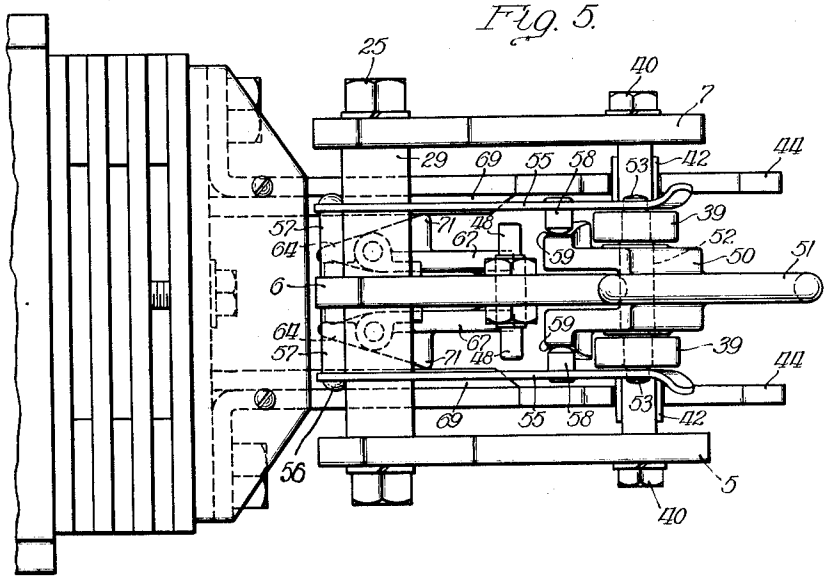
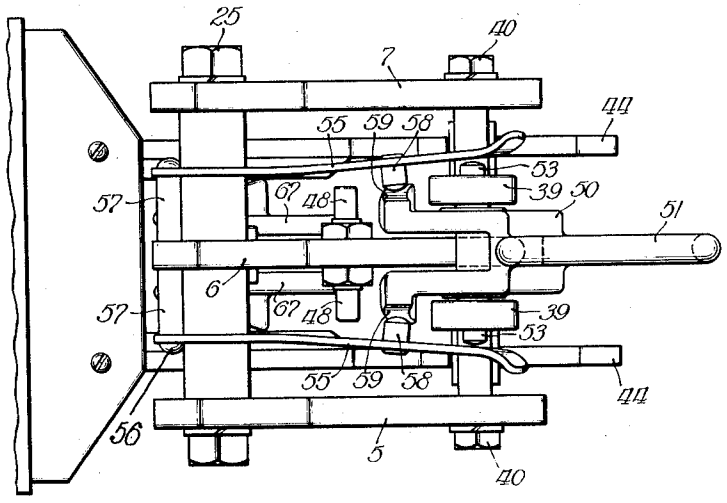


Fig. 6.



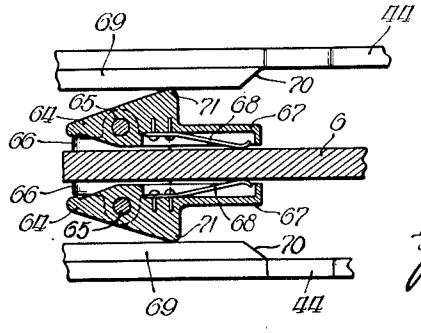


Fig. 9.

Inventor:
Allan Ramsey

By: Mason, Fenwick & Lawrence
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 7.

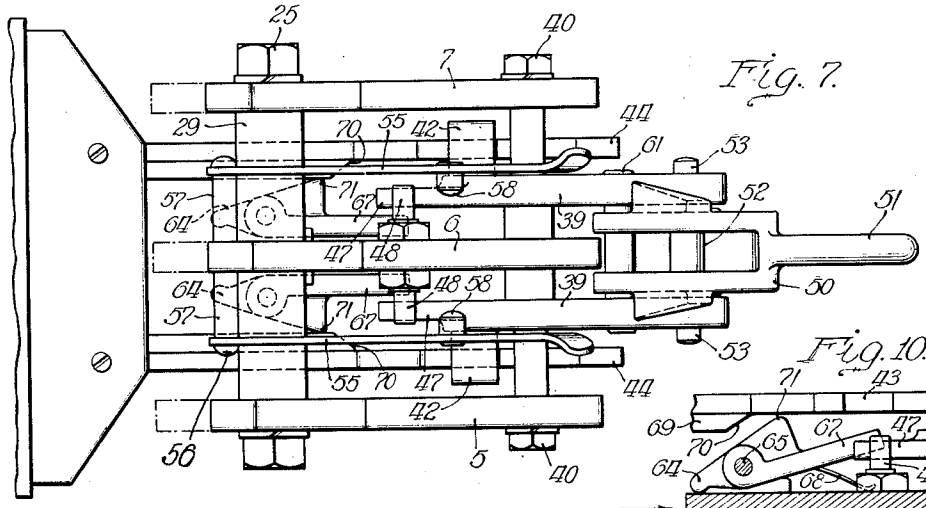


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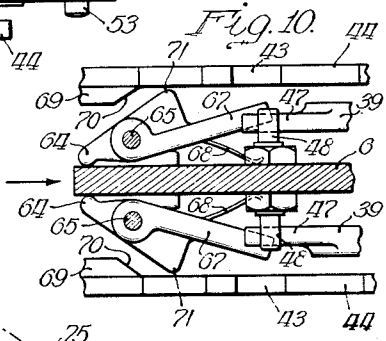
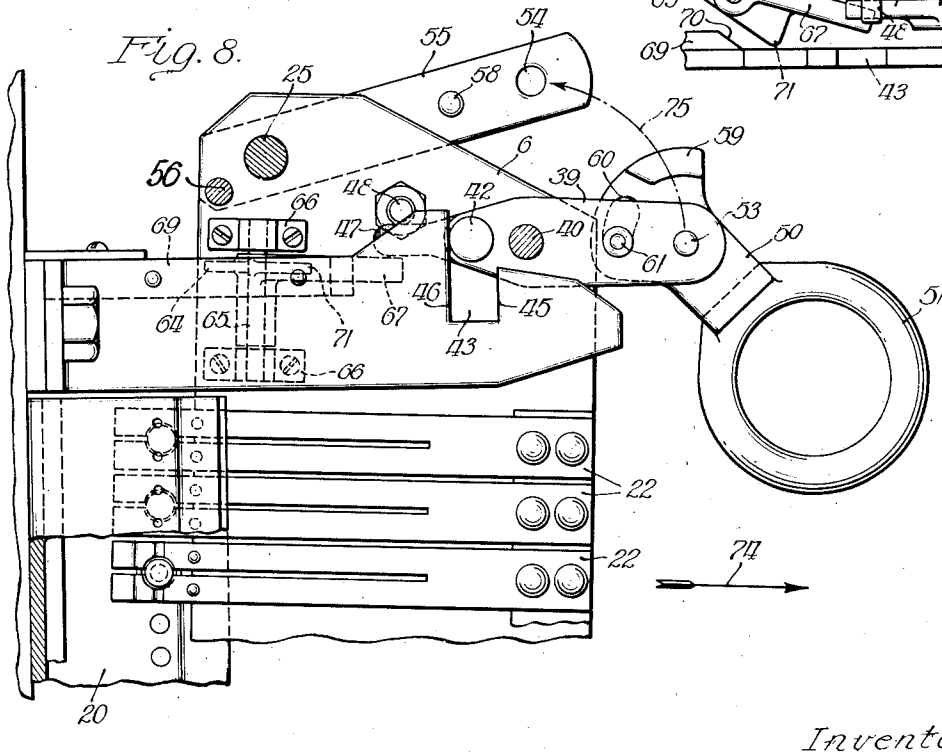


Fig. 8.



Inventor:
Allan Ramsey

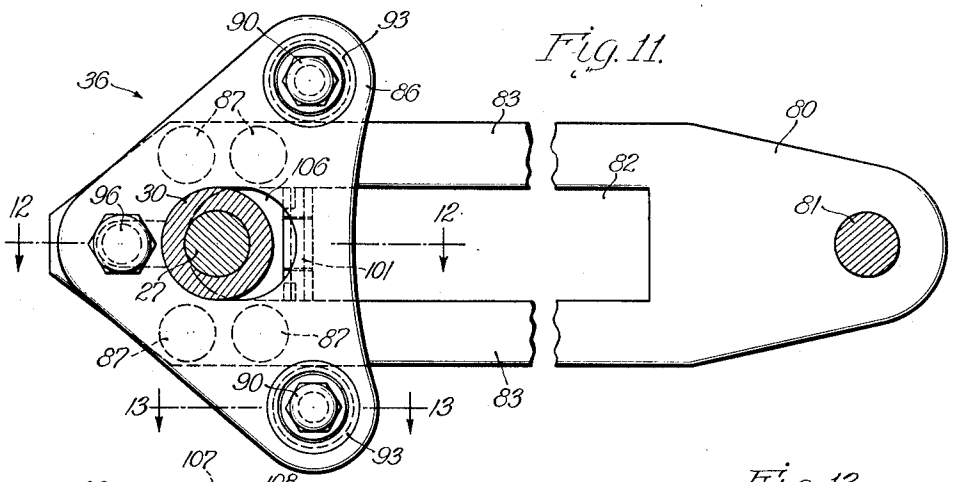
By: Brownjackson Dorsett & Dawes
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

Filed Dec. 14, 1936 21 Sheets-Sheet 6

Fig. 11.



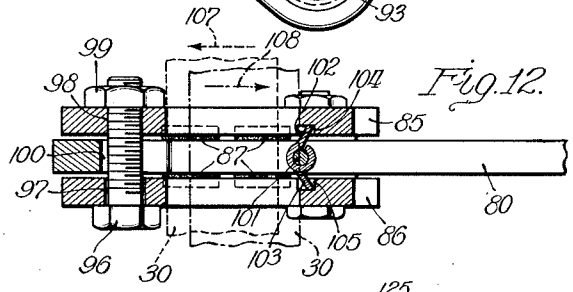


Fig. 12.

Fig. 13.

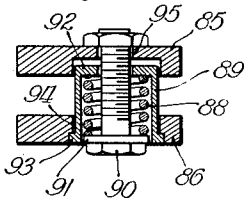


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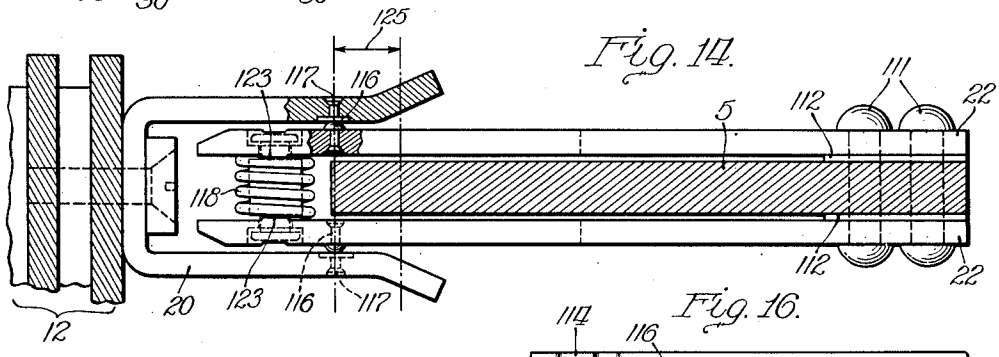


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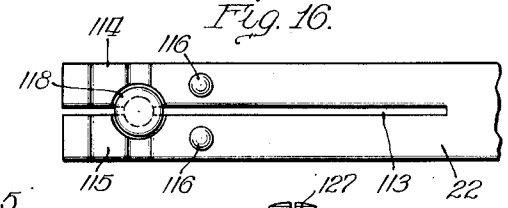


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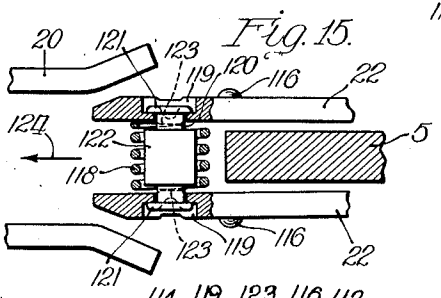


Fig. 17.

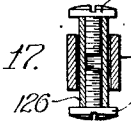
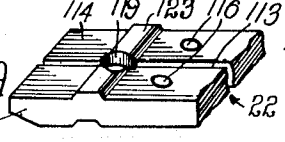


Fig 16A



Inventor:
Allan Ramsey

By: Brownjacksonbottcher, Dennis.
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

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Fig. 18.

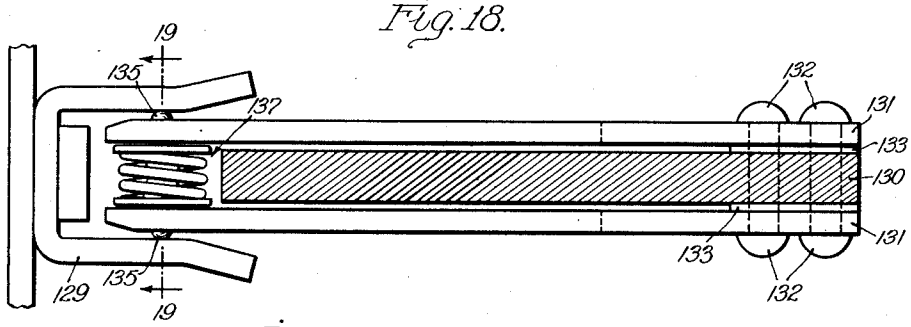


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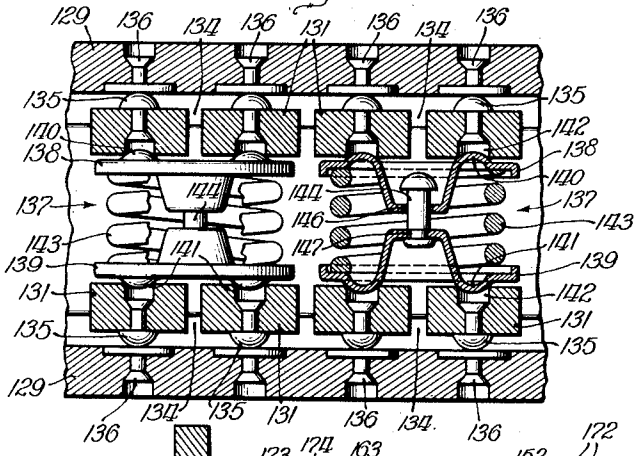
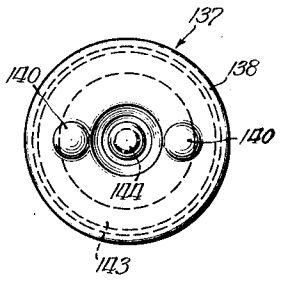


Fig. 20.



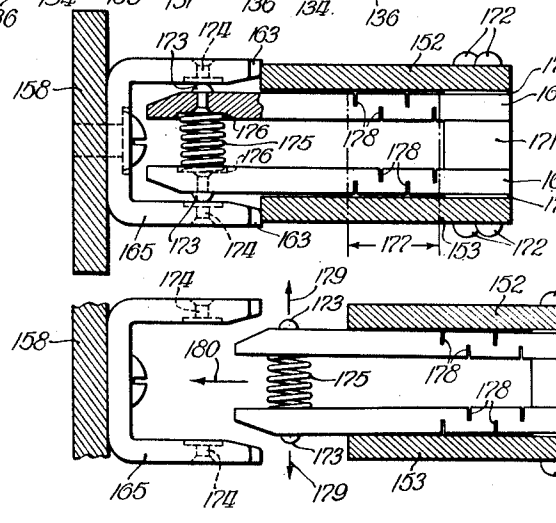


Fig. 23.

Fig. 24.

Inventor:
Allan Ramsey

By: Brumbaugh Graves Donohue & Raymond.

Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 21.

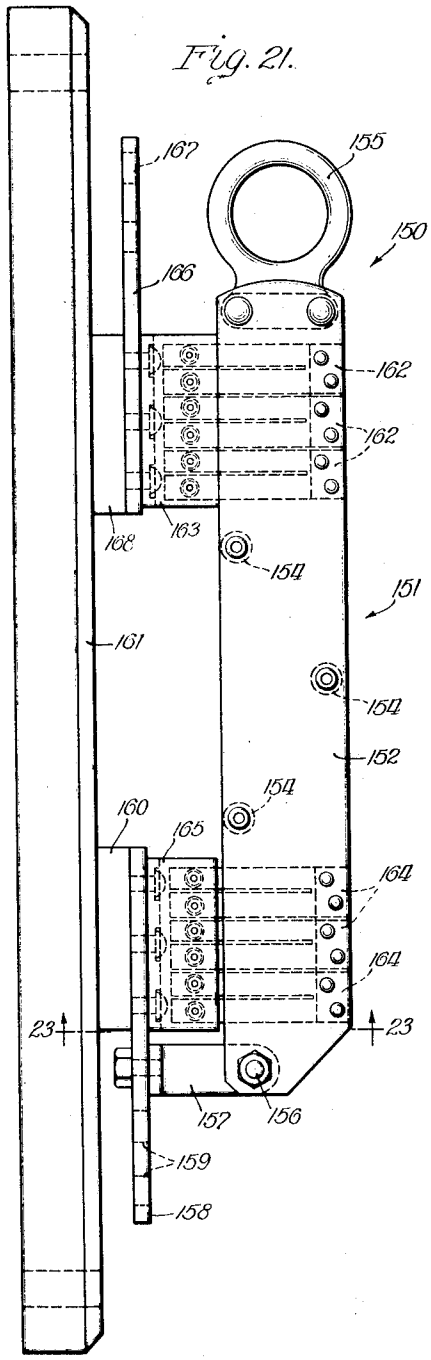
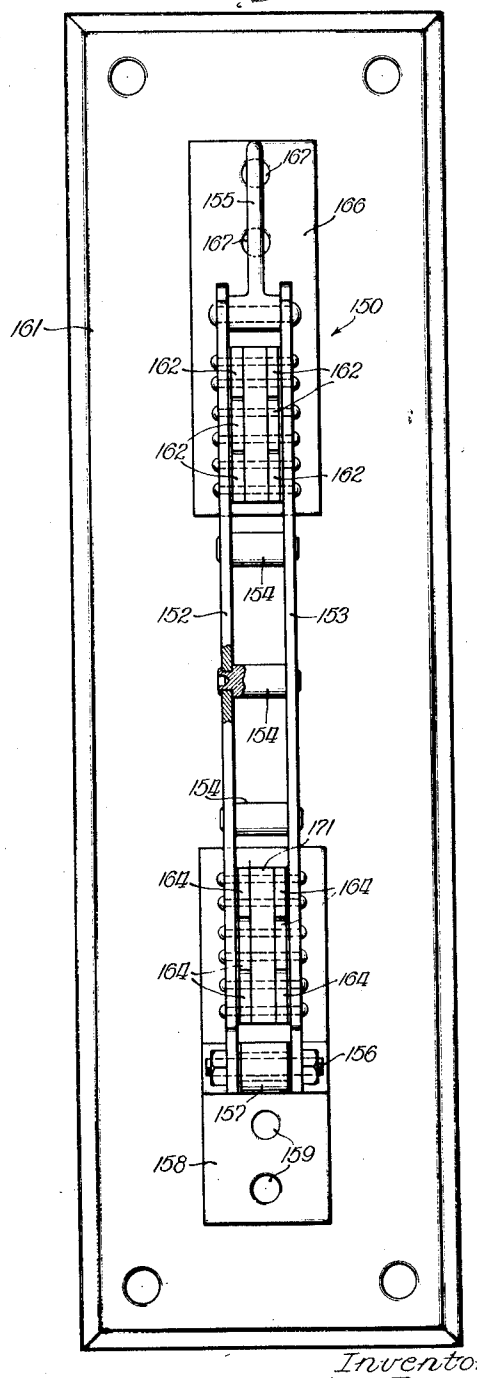


Fig. 22.



Inventor:
Allan Ramsey

By: Brown Jackson Boettcher Dennis.
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 25.

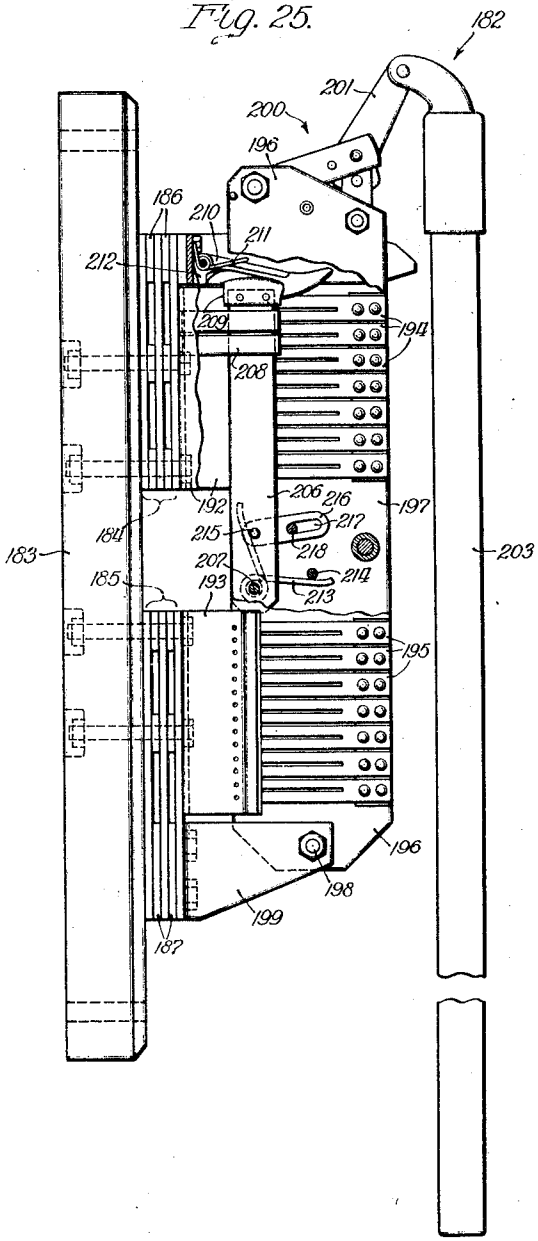
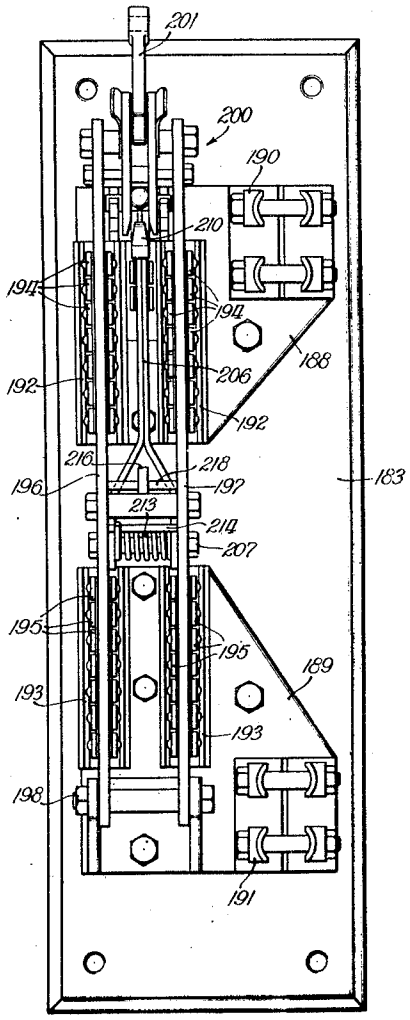


Fig. 26.



Inventor:
Allan Ramsey

By: Brown Jackson Boettcher Dunner.

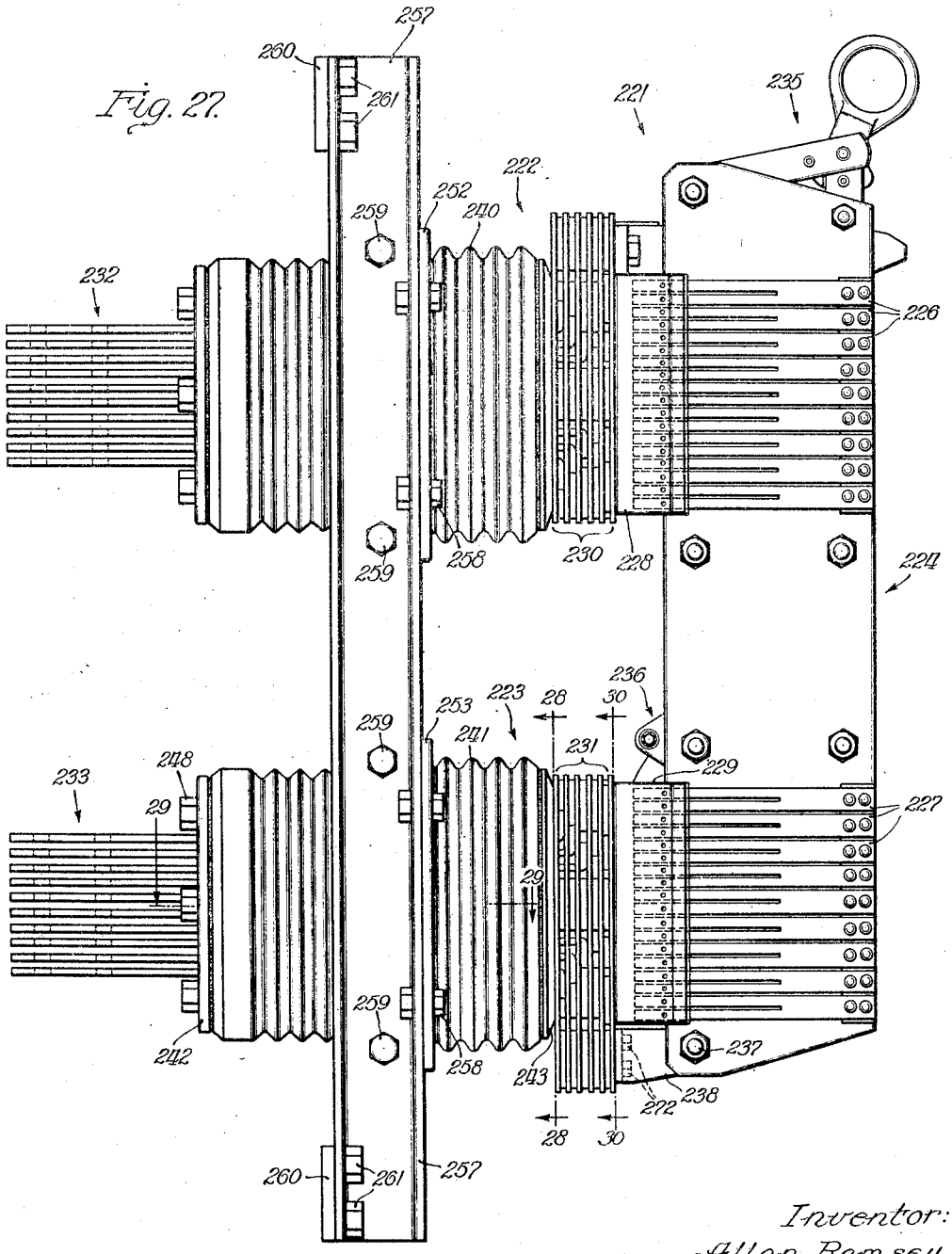
Attys

Dec. 24, 1940. A. RAMSEY 2,226,386

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Fig. 27.



Inventor:
Allan Ramsey

By: Brown Jackson Boettcher Dennis.

Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

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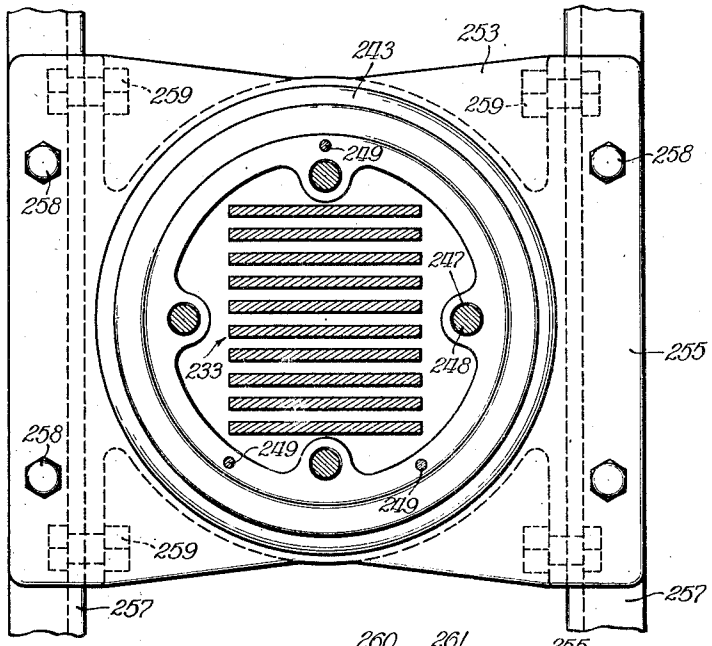


Fig. 28.

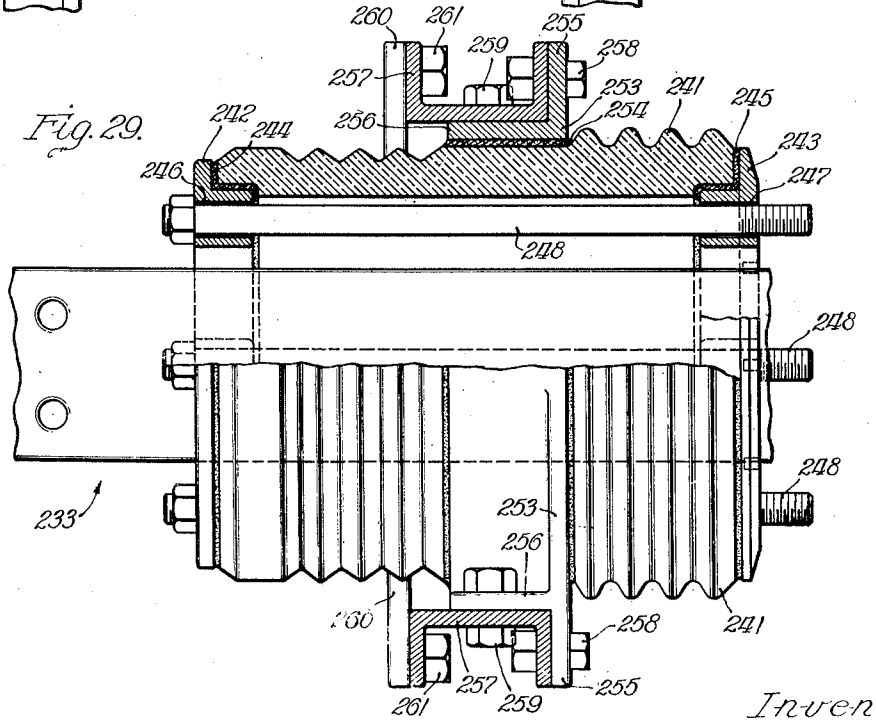


Fig. 29.

Inventor:
Allan Ramsey

By: Brownfaerson Bowers & Dinner

Attys

Dec. 24, 1940. A. RAMSEY 2,226,386

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Fig. 30.

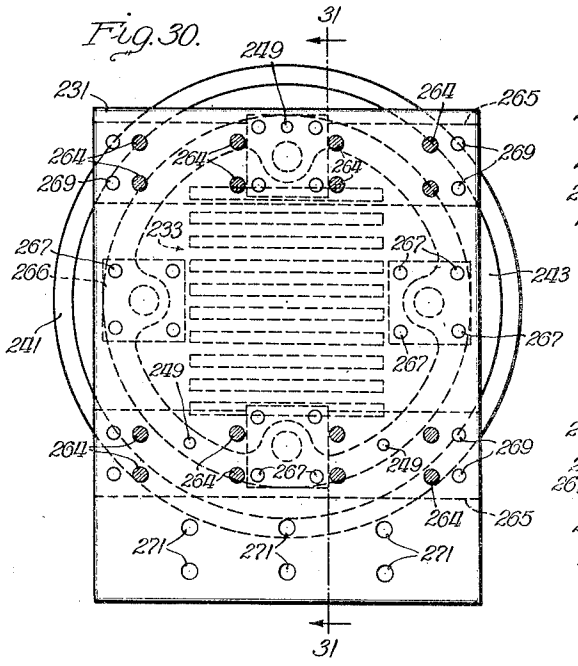


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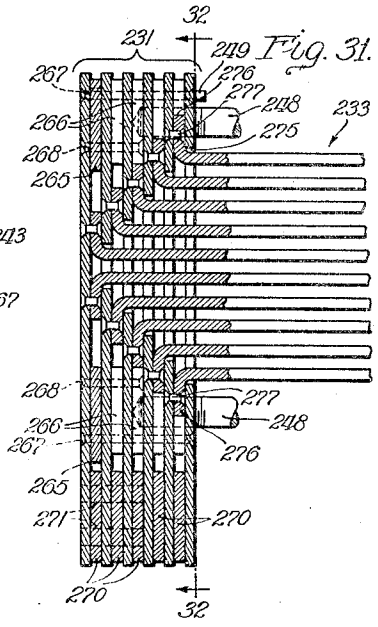


Fig. 33.

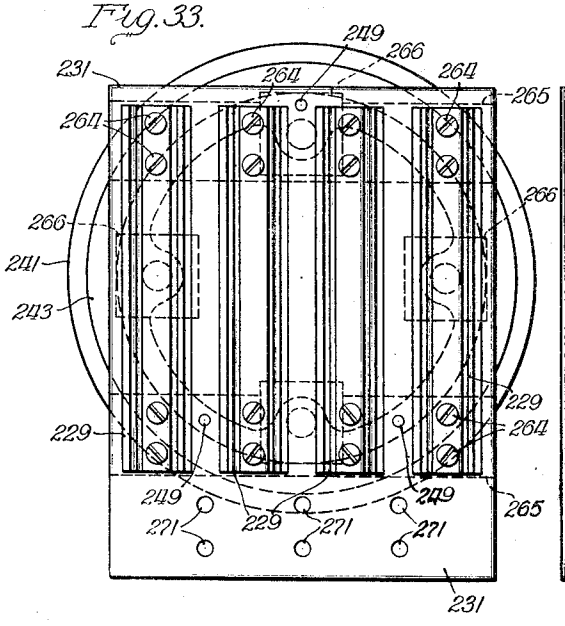
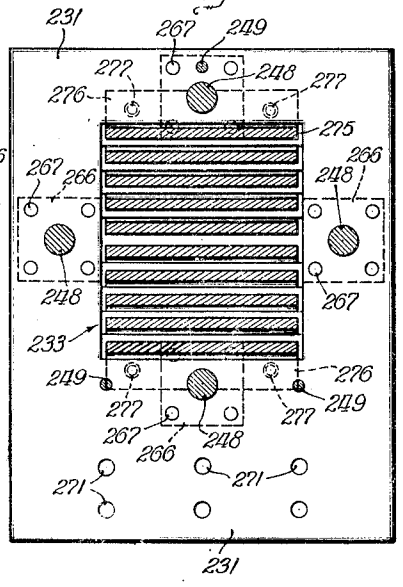


Fig. 32.



Inventor:
Allan Ramsey

By: Brownson & Mason & Cousens
Dennis.

Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

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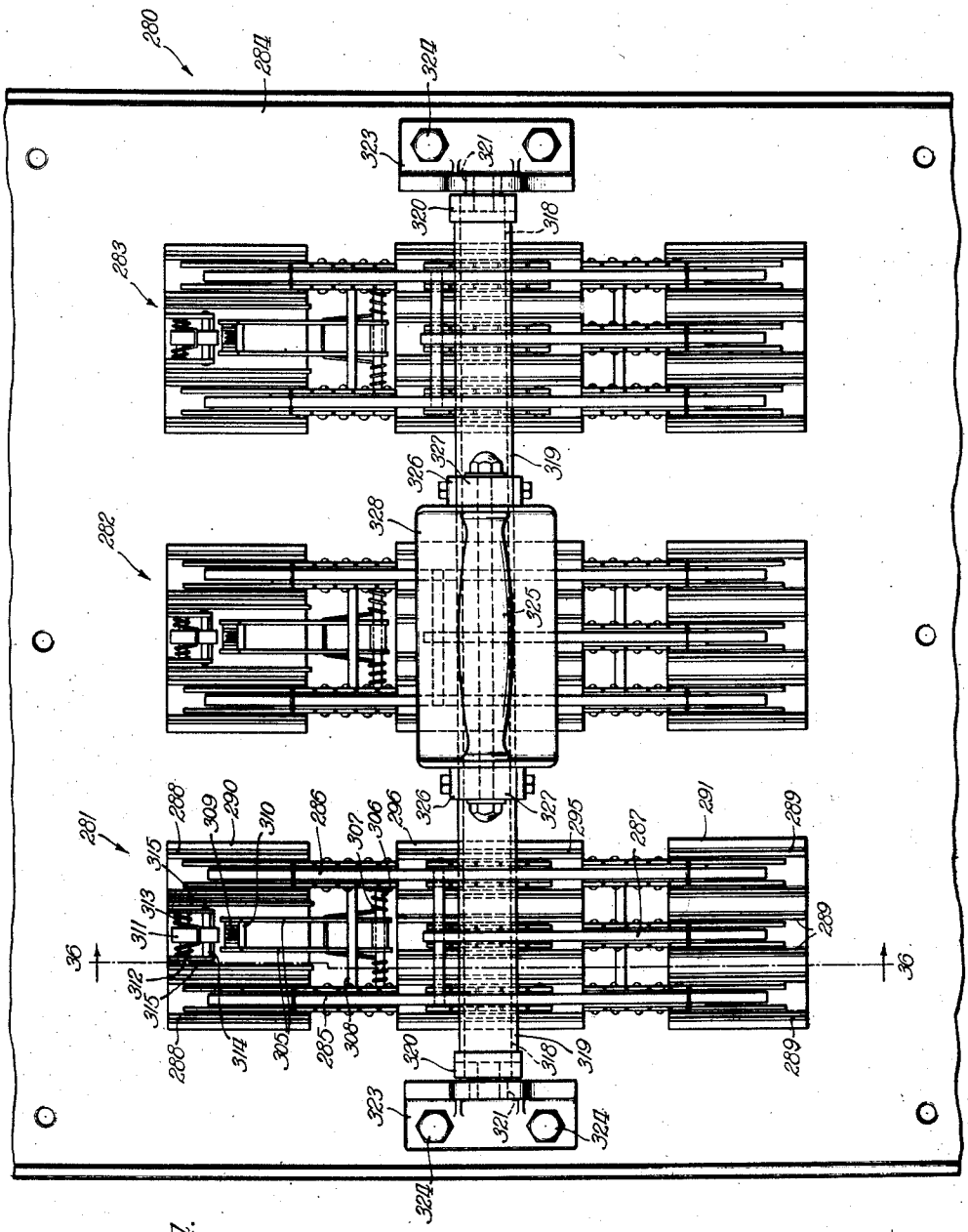


Fig. 34.

Inventor:
Allan Ramsey

By: Brown, Jackson, Boettcher & Dienner.

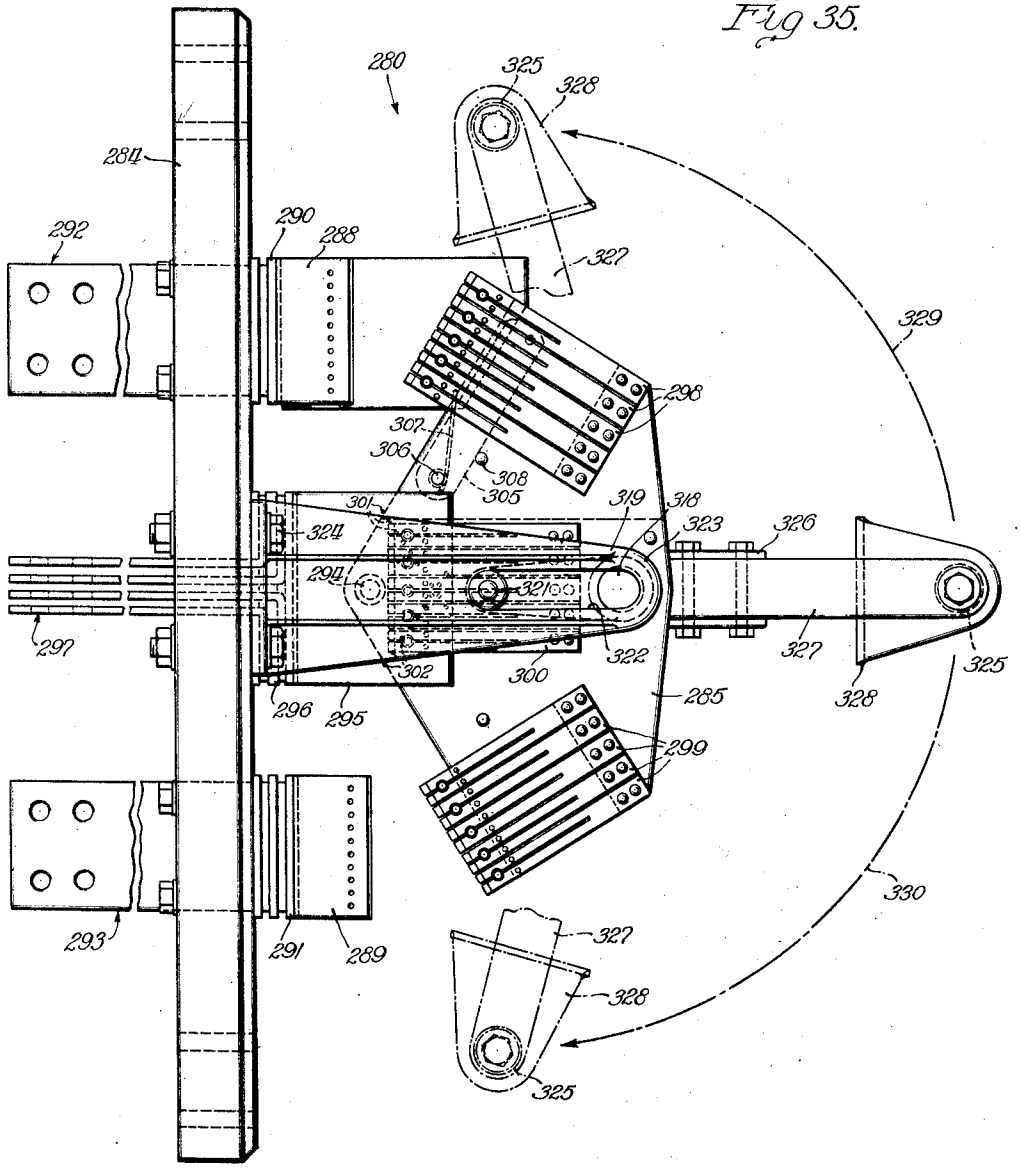
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig 35.



Inventor:
Allan Ramsey

By: Brown, Jackson, Boettcher & Dienner.

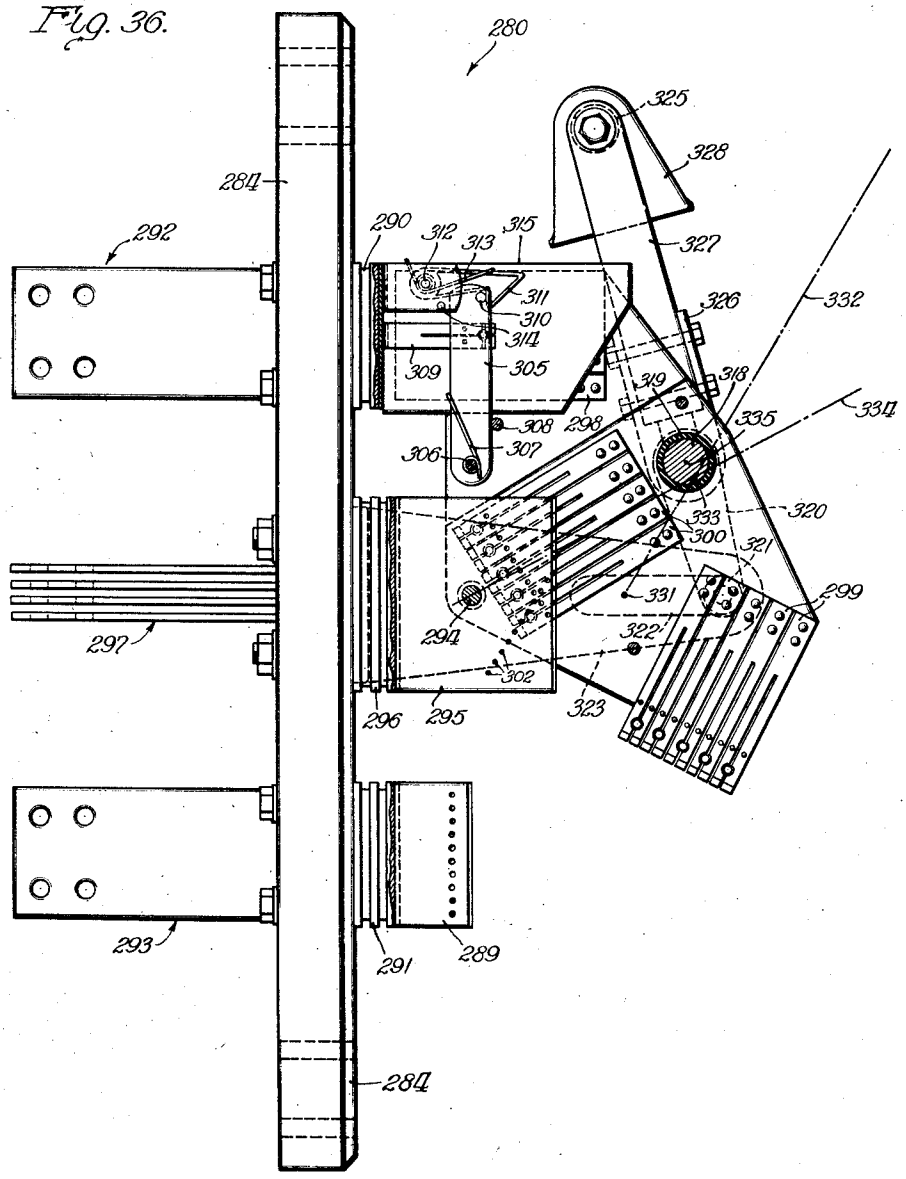
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 36.



Inventor:
Allan Ramsey

By: Brown, Jackson, Boettcher & Dennison.

Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

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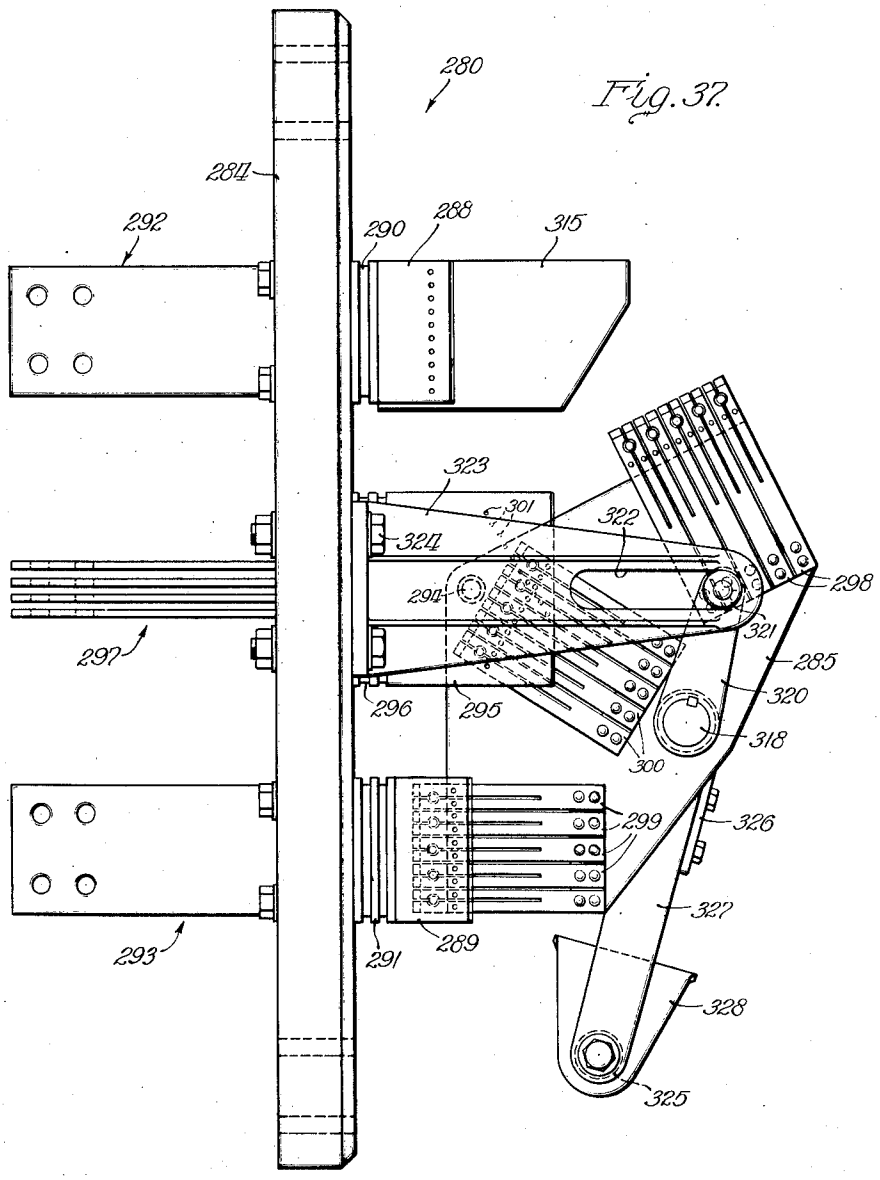


Fig. 37.

Inventor:
Allan Ramsey
By: Bowes, Jackson, Boettcher & Dennis.
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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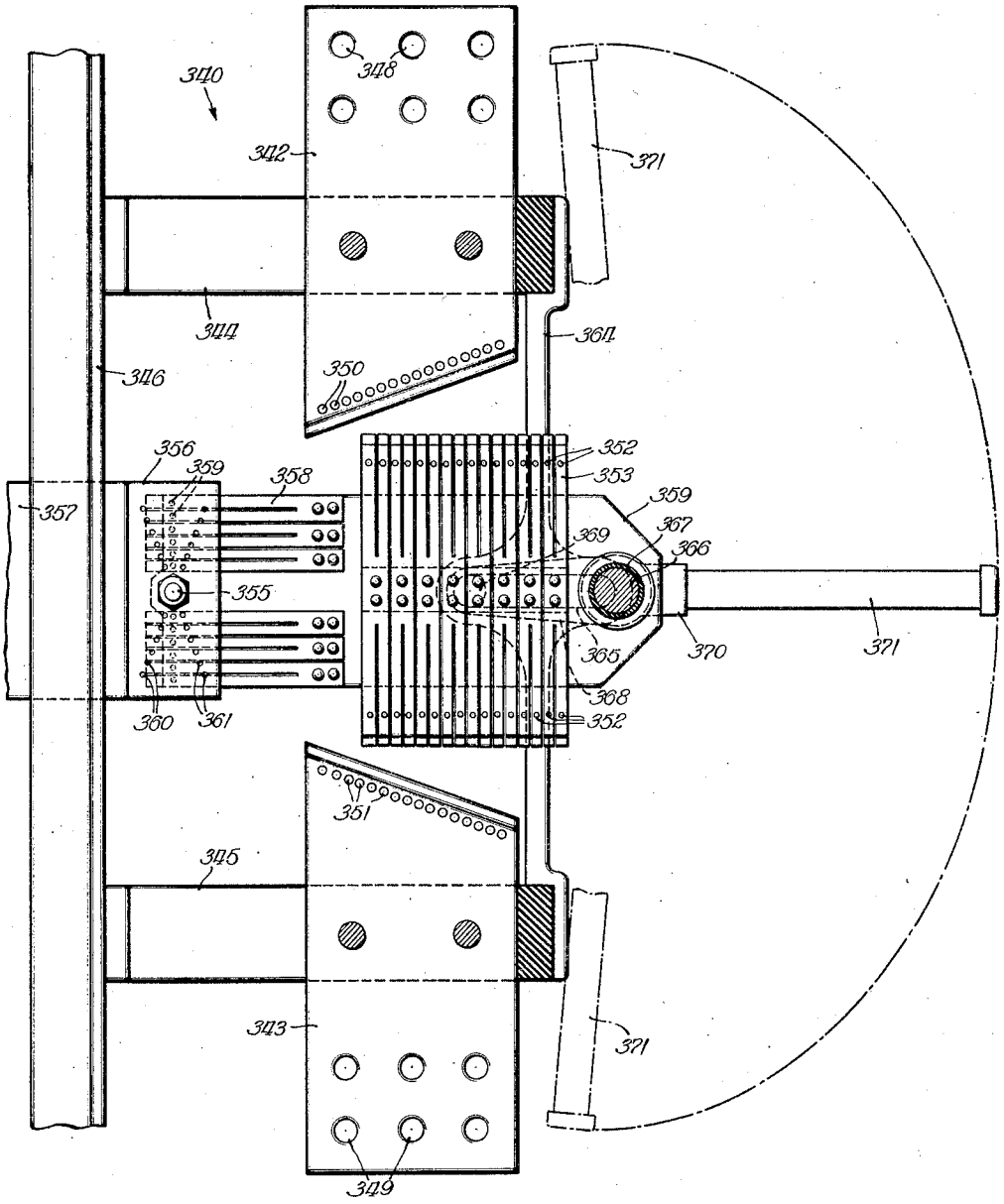


Fig. 38.

Inventor:
Allan Ramsey
By: Brownjacksonbattelle&Dennis
Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

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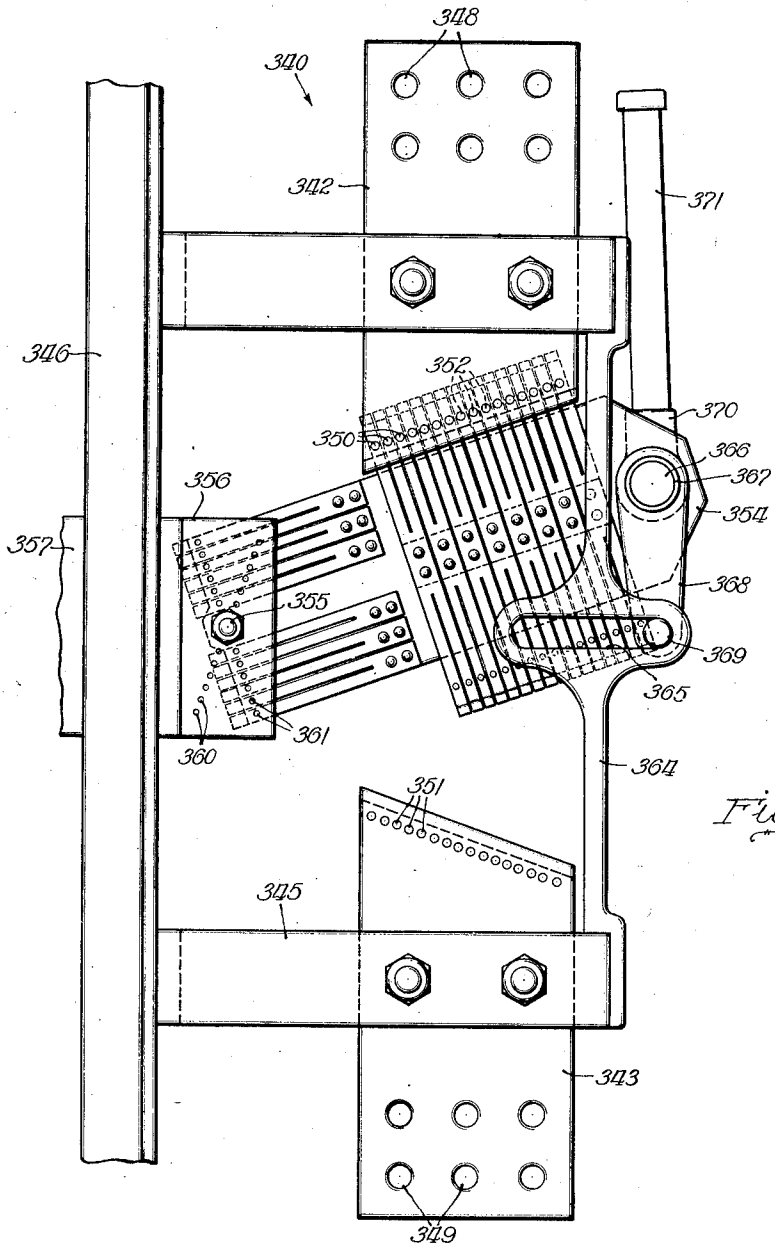


Fig. 39.

Inventor:
Allan Ramsey
By: Brown Jackson Boettcher, Dennis.
Attys

Dec. 24, 1940. A. RAMSEY 2,226,386

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Fig. 40.

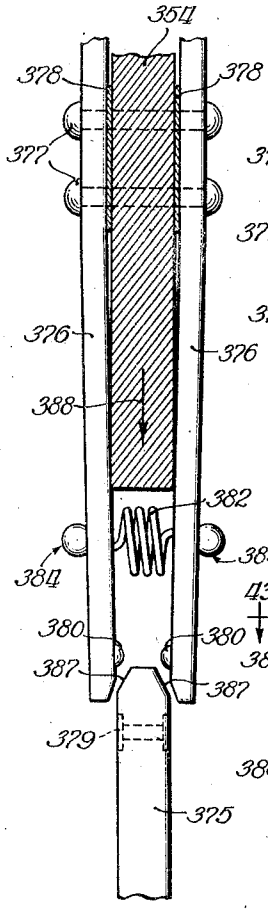


Fig. 41.

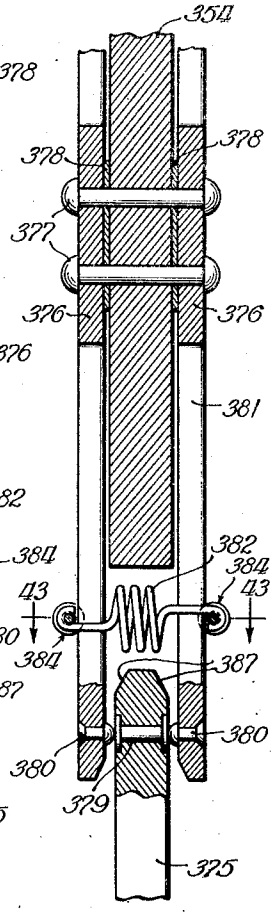


Fig. 42.

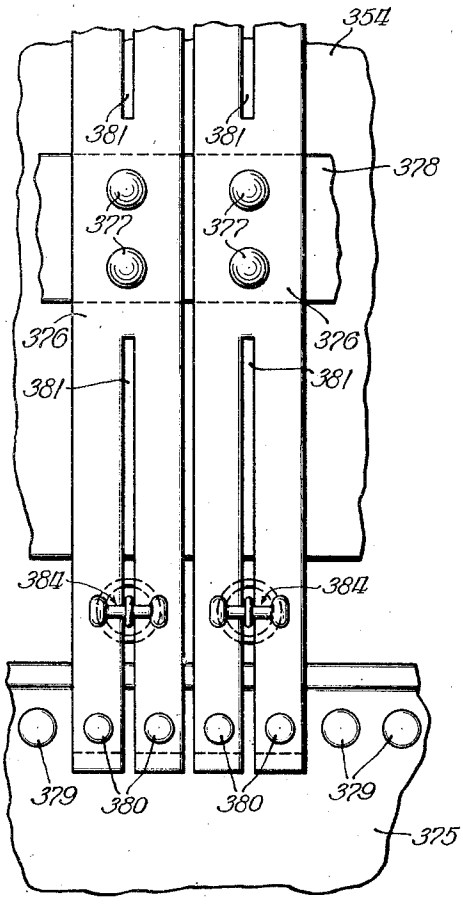


Fig. 43.

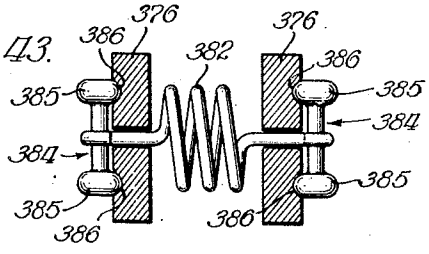
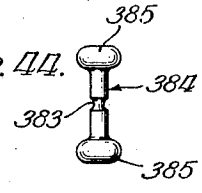


Fig. 44.



Inventor:
Allan Ramsey

By: Brumfield & Brumfield Bartlett & Bauer
Attys

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 45.

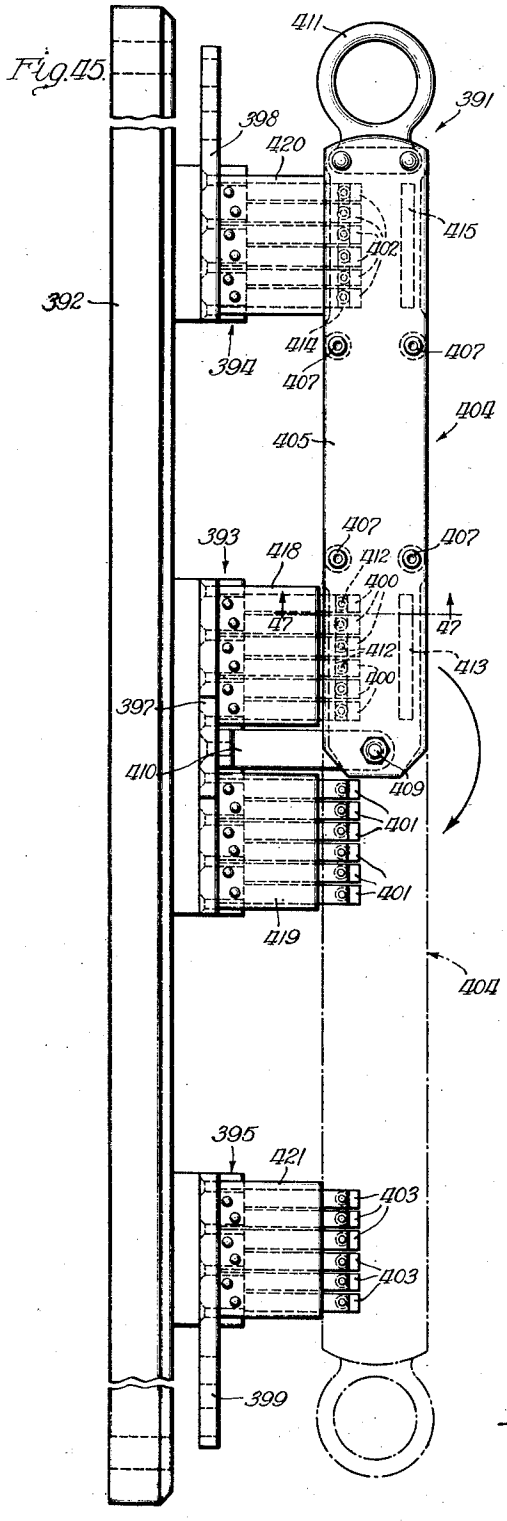
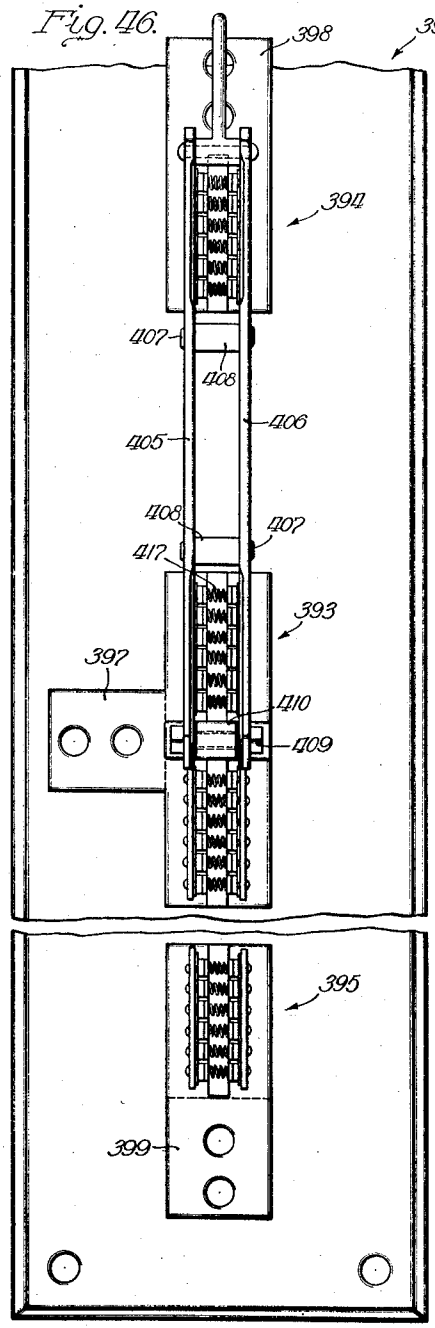


Fig. 46.



Inventor:
Allan Ramsey

By: Brown Jackson Boettcher & Dennes

Attys.

Dec. 24, 1940. A. RAMSEY 2,226,386

SWITCH

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Fig. 47.

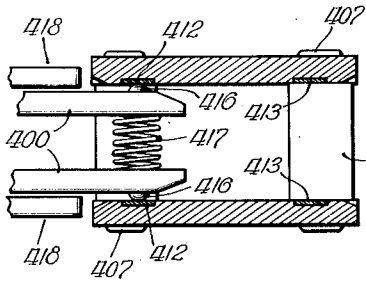


Fig. 49.

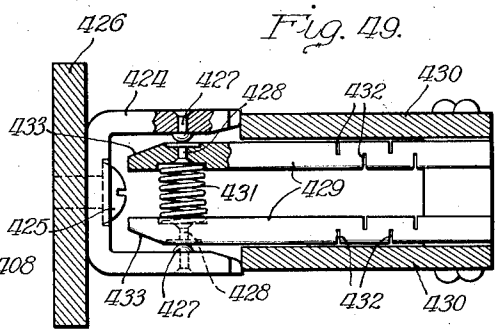


Fig. 50.

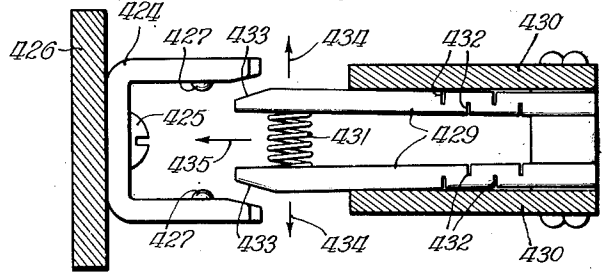


Fig. 48.

Inventor.
Allan Ramsey
By: Brown Jackson Boettcher & Dunner
Attys.

Patented Dec. 24, 1940 2,226,386

UNITED STATES PATENT OFFICE

2,226,386

SWITCH

Allan Ramsey, Evanston, Ill., assignor to Schweitzer & Conrad, Inc., Chicago, Ill., a corporation of Delaware

Application December 14, 1936, Serial No. 115,692

63 Claims. (Cl. 200—162)

My invention relates, generally, to electric switches, and it has particular relation to the construction, mounting, and operation of disconnecting switches and the like. The invention disclosed herein constitutes an improvement upon the switch constructions and contact arrangements disclosed in my copending applications, Serial No. 445,548, filed April 19, 1930, Patent No. 2,063,954, and Serial No. 559,846, filed August 28, 1931, Patent No. 2,091,452, both of which are assigned to the assignee of this application.

In my copending application Serial No. 445,548, Patent No. 2,063,954, I have disclosed a switch having a switch blade that is movable into and out of engagement with a plurality of stationary contact fingers having small area contact surfaces that are individually resilient and prestressed to provide a relatively high contact pressure in the switch closed position while requiring relatively little effort to operate the switch blade to and from the switch closed position. The prestressing effect is obtained by biasing the contact elements or fingers into the path of movement of the switch blade and providing restraining means that limits the movement of the contact elements or fingers to positions that are slightly within this path. Without this restraining means, the contact fingers would be moved under the biasing influence more fully into the path of movement of the switch blade, and, in closing the switch, it would be necessary to exert sufficient effort to move them completely out of the path. When the prestressed contact fingers are limited in their movement to positions slightly within the path of the switch blade, it is only necessary to move them through this slight distance, with the result that a correspondingly small effort is required to operate the switch to and from the switch closed position. At the same time, the contact pressure that is exerted between the individual contact members will be the same as if, on closing the switch, the contact fingers had been moved from an initial unstressed condition to the position corresponding to the switch closed position. The provision of a plurality of individually movable contact fingers having small area contact surfaces acting under relatively high pressure permits the construction of a switch that has many distinct advantages over switches of the prior art.

Advantage is taken of the foregoing described prestressing effect in the construction of the circuit interrupter disclosed in my copending application, Serial No. 559,846, Patent No. 2,091,452. In the embodiment of the invention disclosed therein, the circuit interrupter partakes of the nature of a fuse device and the movable switch member comprises a fuse tube that houses a fusible element. Individually resilient and prestressed contact fingers are mounted near the ends of the fuse tube and are arranged to engage suitably positioned stationary contact members.

An improvement upon the switch construction disclosed in my copending application Serial No. 445,548, Patent No. 2,063,954, is set forth in my copending application, Serial No. 115,691, filed December 14, 1936, and assigned to the assignee of this application. In the latter copending application I have taken advantage of the principle of multiple high pressure contacts of small area individually resilient and prestressed for the construction of disconnecting switches having current carrying capacities of the order of 200 to 800 amperes. In this construction, a plurality of stationary prestressed contact fingers are provided for each circuit terminal and are arranged to be engaged by a switch blade that is rotatably mounted adjacent one of them. The contact fingers are formed of pairs of copper straps and are mounted on a rigid support member at one end. Between the other ends, a compression spring is provided for biasing the fingers apart and into engagement with the switch blade. Each of the sections is provided with a raised spherical portion of small radius to provide a small area of contact surface. Stop members are provided transversely between the contact fingers for limiting the movement apart thereof to such positions that the small area raised contacts are disposed slightly within the path of movement of the switch blade. In this manner a maximum of contact pressure is provided between the relatively movable switch members that requires a minimum of effort to operate the switch to and from the switch closed position.

The small radius portions preferably comprise silver inserts to engage corresponding silver inserts in the switch blade for forming the contact engaging portions therebetween. Silver is employed in order to reduce contact resistance to a minimum and to provide contact surfaces that will be substantially unaffected by the corrosive action of the surrounding atmosphere.

Considerable difficulty has been experienced in providing satisfactory rear connections for high amperage switches, for example switches having a capacity of the order of 2,000 to 10,000 amperes. It has been customary to use a solid slab of cop-

per for mounting on an insulator or on a switch board that is provided with switch jaws extending from one side and short lengths of copper bars extending from the other side. These copper bars are sweated into slots in the rear face of the copper slab and are further secured thereto by means of transverse pins. In another construction, a copper casting is made having a rearwardly extending portion that is slotted by a milling operation to afford a connection to the power bus. These constructions have been unsatisfactory because of the inability thereof to dissipate the heat that is generated therein because of the current flow therethrough. In many instances the heat dissipating qualities of the terminal members of a high amperage switch form one of the factors that limit its capacity more than would otherwise be necessary.

The mounting of high amperage switches that are connected in alternating current circuits has presented considerable difficulty. It is undesirable to employ support members formed of magnetic material, if they are positioned with reference to the electrical circuit in such manner that eddy currents may be set up therein because of the alternating character of the magnetic field surrounding the switch and the conductors connected thereto. At the same time that this factor must be considered, it is also necessary to so design the support structure for the high amperage switch that it will have sufficient strength to withstand the severe stresses that are set up under short circuit conditions. Thus a suitable balance must be maintained between the use of relatively cheap support members formed of magnetic material having high strength and the use of more expensive non-magnetic materials which may have somewhat less strength. Ordinarily, the cost item will be of more importance than the strength item, since high strength non-magnetic materials are available in the open market. However, they are expensive.

The object of the present invention, generally stated, is to embody the principles of switch construction and contact arrangement shown and described in the aforementioned applications and to take advantage of the same in the construction of large and moderate capacity disconnecting switches which shall be simple, efficient and easy to operate, and which shall be readily and economically manufactured and installed, and which will maintain their efficiency of contact and ease of operation in service.

An important object of my invention is to provide a plurality of relatively small area high pressure contacts between the relatively movable switch members of a disconnecting switch, that is used for opening and closing a circuit which normally carries a relatively high current in the switch closed position, and at the same time providing a maximum of electrical clearance between the switch members in the open position with a minimum of relative movement of the switch members.

Another important object of my invention is to provide for locking a high amperage disconnecting switch in the closed position.

Still another important object of my invention is to provide for automatically braking the movement of a switch blade toward the switch open position and for automatically releasing the braking action when the switch blade is moved toward the switch closed position.

Another object of my invention is to mount the pre-stressed contact fingers carrying the small area high pressure contacts on the opposite sides of a switch blade along the edge remote from the stationary switch member engaged thereby and to extend the contact fingers beyond the edge of the switch blade adjacent the stationary contact member to provide the required flexibility in the contact fingers and a maximum of electrical clearance with a minimum of movement of the switch blade.

Another object of my invention is to provide a contact finger which is relatively thick in proportion to its length and which, by a simple mechanical modification of its uniform cross section, acquires a large increase in flexibility with only a slight increase in electrical resistance and slight decrease in short time maximum current carrying capacity.

A further object of my invention is to provide for prying a switch blade into and out of contact engagement with a stationary switch member between which a relatively high contact pressure is maintained within a narrow range of movement to and from the switch closed position.

Another object of my invention is to provide for retarding the movement of a switch blade from engagement with a stationary switch member toward the switch open position, between which a relative high contact pressure is maintained within a limited range of movement from and to the switch closed position, only after the switch blade is moved beyond its limited range and the high contact pressure has been relieved.

A further object of my invention is to ventilate the stationary switch members of the high amperage switch by providing a laminated rather than a solid construction therefor.

A still further object of my invention is to mount a high amperage alternating current switch on a frame formed of magnetic and non-magnetic materials in such manner that it will be capable of withstanding short circuit stresses and so arranged that substantially no eddy currents will be induced in the frame.

Still another object of my invention is to provide for effecting a quick final break in a circuit in which a disconnecting switch, having small area high pressure contact fingers, is employed when the switch is operated to the open position.

A further object of my invention is to embody the principles of prestressed contact finger construction in a high amperage gang operated multi-pole switch, and to provide for locking the switch in the closed position.

Another object of my invention is to provide within the assembly of a multi-pole double throw switch an operating mechanism which will provide a maximum lever ratio between operating handle and switch blade at the beginning and end of its travel, and a minimum ratio at the mid-point or position, and which will lock the switch in either of its closed positions.

A still further object of my invention is to provide prestressed contact fingers on the movable blades of a high amperage gang operated multi-pole double throw switch and for locking the switch in either of its alternate positions by the continued movement of a single operating member.

Other objects of my invention will, in part, be obvious and in part appear hereinafter.

My invention, accordingly, is disclosed in the embodiments thereof shown in the accompanying drawings, and it comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in

the constructions hereinafter set forth, and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a view, in side elevation, of a concrete embodiment of a high amperage disconnecting switch employing small area high pressure contact surfaces on prestressed contact fingers carried by the switch blades, and being arranged for front connection to an electrical power bus;

Figure 2 is a view, in front elevation, of the switch shown in Figure 1;

Figure 3 is a view, in front elevation, of the switch shown in Figure 1, the switch blades being omitted and certain parts being broken away in order to more clearly show the construction and arrangement of the stationary contact members;

Figure 4 is a view, in side elevation, of the high amperage disconnecting switch shown in Figure 1, the outside blade being omitted and certain parts being shown in section, in order to more clearly illustrate the construction of the latching and braking mechanisms;

Figure 5 is a view, in top plan, of the stationary switch member and switch blade shown in Figure 1;

Figure 6 is a view, similar to Figure 5, and showing the position to which the pull ring is first operated to unlock the switch blade;

Figure 7 is a view similar to that shown in Figure 5, illustrating the position to which the pull ring is operated to move the switch blade out of engagement with the upper stationary switch member;

Figure 8 is a view, partly in side elevation and partly in section, illustrating the position to which the pull ring and associated parts are operated immediately after the prestressed contact members or fingers have been moved out of contact engagement with the upper stationary switch members;

Figure 9 is a detail sectional view taken along the line 9—9 of Figure 4, to show the position of the lever stops when the switch is in the closed position;

Figure 10 is a detail view, similar to Figure 9, showing the position to which the lever stops are operated when the switch blade is moved out of engagement with the stationary switch members;

Figure 11 is a view in side elevation of the brake mechanism, the members of the switch to which it is attached being shown in section;

Figure 12 is a detail sectional view taken along the line 12—12 of Figure 11;

Figure 13 is a detail sectional view taken along the line 13—13 of Figure 11;

Figure 14 is a view, partly in top plan and partly in section, at an enlarged scale of one pair of the prestressed contact fingers mounted on the switch blade and the cooperating stationary contact member;

Figure 15 is a fragmentary view illustrating the relative positions of the prestressed contact fingers and the stationary contact member just prior to engagement;

Figure 16 is a fragmentary view, in side elevation, of one of the prestressed contact fingers;

Figure 16a is a fragmentary perspective view of one of the prestressed contact fingers;

Figure 17 is a sectional view of a modified form of holding device for limiting the movement apart of the prestressed contact fingers;

Figure 18 is a fragmentary view, similar to Figure 14, illustrating another embodiment of the prestressed contact arrangement that is suitable for use in a switch such as that shown in Figure 1;

Figure 19 is a detail sectional view, at an enlarged scale, taken along the line 19—19 of Figure 18;

Figure 20 is a view, in end elevation, of one of the prestressed units shown in Figure 19;

Figure 21 is a view, in side elevation, of a switch employing the principle of multiple high pressure small area prestressed contact construction that is shown in Figures 18 and 19;

Figure 22 is a view, in front elevation, of the switch shown in Figure 21, certain parts being broken away to more clearly illustrate the construction;

Figure 23 is a sectional view taken along the line 23—23 of Figure 21;

Figure 24 is a view, similar to Figure 23, showing the relative positions of the contact fingers just prior to the closing of the switch;

Figure 25 is a view, in side elevation, of another embodiment of a switch employing the prestressed contact fingers, as shown in connection with a quick break mechanism, certain parts being broken away in order to more clearly illustrate the invention;

Figure 26 is a view, in front elevation, of the switch shown in Figure 25, the operating rod being omitted;

Figure 27 is a view, in side elevation, of a high amperage disconnecting switch that is arranged for back connection in an alternating current circuit;

Figure 28 is a detail sectional view taken generally along the line 28—28 of Figure 27;

Figure 29 is a detail sectional view taken generally along the line 29—29 of Figure 27;

Figure 30 is a detail sectional view taken generally along the line 30—30 of Figure 27;

Figure 31 is a sectional view taken along the line 31—31 of Figure 30;

Figure 32 is a sectional view taken along the line 32—32 of Figure 31;

Figure 33 is a view, in end elevation, of the lower stationary switch member of the switch shown in Figure 27, with the switch blade and fulcrum members being omitted;

Figure 34 is a view, in front elevation, of a multipole double throw switch in which are incorporated the various features of my present invention;

Figure 35 is a view, in end elevation, of the switch shown in Figure 34;

Figure 36 is a sectional view, taken along the line 36—36 of Figure 34;

Figure 37 is a view, in end elevation, of the switch shown in Figure 34 operated to the lower position;

Figure 38 is a view, partly in end elevation and partly in section, illustrating another embodiment of my invention;

Figure 39 is a view, in end elevation, of the switch shown in Figure 38 operated to its upper position;

Figure 40 is a fragmentary view, partly in section, showing a modified form of contact ar-

rangement for the switch shown in Figures 38 and 39;

Figure 41 is a view similar to Figure 40 showing the contact members in the closed position;

Figure 42 is a fragmentary view, in side elevation, of the modified form of contact construction;

Figure 43 is a detail sectional view, taken along the line 43—43 of Figure 41;

Figure 44 is a view, in top plan, of one of the equalizers that is employed in the contact construction shown in Figures 40 through 43;

Figure 45 is a view, in side elevation, of a double throw switch employing stationary small area high pressure contact fingers;

Figure 46 is a view, in front elevation, of the switch shown in Figure 45;

Figure 47 is a detail sectional view taken generally along the line 47—47 of Figure 45;

Figure 48 is a view, in bottom plan, of the switch shown in Figure 45;

Figure 49 is a view, partly in side elevation and partly in section, showing a modified form of contact construction; and

Figure 50 is a view similar to Figure 49, and showing the relative positions of the contact fingers just prior to closure of the switch.

According to my present invention, I mount one or more pairs of contact fingers on the opposite sides of a switch blade that is mounted for movement relative to a pair of stationary switch members forming the circuit terminals. The contact fingers are anchored to the edge of the switch blade remote from the stationary switch members, and they extend beyond the adjacent edge. The stationary switch members comprise U-shaped members having outwardly flared edges between the upstanding sides of which the contact fingers are positioned. Since the stationary switch members are only of sufficient height to engage properly the ends of the contact fingers and do not extend across the entire width of the switch blade, a maximum of electrical clearance is provided between the stationary switch members and the switch blade with a minimum of movement of the latter. At the same time, the required degree of flexibility in the contact fingers is provided because of their attachment along the remote edge of the switch blade.

Instead of employing contact fingers in the form of wires, as provided in my copending application Serial No. 445,548, Patent No. 2,063,954, I provide relatively heavy copper straps riveted at one end to the remote edge of the blade. A saw cut extends from the other end to provide a bifurcated construction and permits a limited degree of flexibility in each of the sections thus formed. This relatively sturdy construction is capable of resisting the heating effects that are set up under short circuit conditions which may not be the case when contact fingers in the form of wires are used.

Since the contact fingers are mounted on the switch blade rather than on the stationary switch members, and since the stationary switch members are relatively short, the heat that is generated in the switch is readily dissipated since it does not have to flow through the contact fingers in order to reach the bus bar system structure in which the switch is connected. Therefore only the heat that is generated in the switch blade and the contact fingers themselves is required to be dissipated thereby. Since a relatively large radiating surface is exposed, it will be obvious that very little heat will be required to be conducted away through the contact fingers themselves.

As indicated hereinbefore, the prestressed high pressure contact effect is obtained by compression springs that are positioned between the free ends of the contact fingers. A stop member in the form of a rivet or its equivalent extends through suitable aligned apertures near the ends to limit the movement apart of the contact fingers. In this location the springs are out of the path of current flow, and thus retain their resiliency and do not become annealed as is otherwise often the case if they are so located as to be required to carry some or all of the current. Moreover, when the springs are thus located, they are in a position to apply the contact pressure most effectively at the points where it is most required.

The prestressed contact fingers are provided with raised surfaces of small radius. These surfaces may be in the form of rivets, as indicated, the heads of which project outwardly from the fingers to constitute the contact engaging portions thereof. The inserts may be formed of silver or silver alloy. Since the actual contact engagement takes place only within a narrow range of movement of the switch blade from and to the switch closed position, it will be obvious that there is a limited amount of frictional engagement between the switch blade and the stationary switch members. That is, after the switch blade has been moved toward the open position to a very slight extent, the contact engagement with the stationary switch members is largely relieved and no additional work need be done to withdraw the switch blade other than that required to move the blade itself. This is in contradistinction to the conventional type of knife switch in which the switch blade is designed to engage the stationary switch members across its entire width. In such a switch it is necessary to move the switch blade a relatively long distance in order to relieve the frictional engagement with the stationary switch members. Because of the release of the frictional engagement between the switch members in the switch constructed in accordance with the present invention, a minimum of work or effort is required to operate to the closed or open position.

Advantage is taken of the fact that the greater part of the work required to close the switch is used to move it in a narrow range into the switch closed position. A simple and compact lever arrangement is provided at one end of the switch blade, and it is so constructed that a minimum of effort is required to move it through this narrow range into the switch closed position, although the force that is required to effect this operation is relatively great. Such a mechanism would be impractical if applied to the conventional type of switch because of the comparatively wide range of its movement during which sufficient force must be exerted to overcome the friction between the relatively movable contact members.

Ordinarily the switch blade of a high amperage switch comprises two or more bars of copper that are comparatively heavy. Since the frictional engagement between the switch blade and the stationary contact members is relieved almost immediately upon the movement of the switch blade toward the open position, the switch blade is free to fall under the influence of gravity, assuming that it is mounted in a vertical position and hinged at its lower end. Therefore, it is desirable to provide a braking mechanism

which will be effective after the contact pressure has been relieved and which will retard the falling of the switch blade. A simple and compact braking mechanism has been provided, as will be hereinafter set forth in detail. It is further pointed out that this brake mechanism is so arranged as to be released on movement of the switch blade toward the closed position so that it is only necessary to overcome the force of gravity and the slight friction at the fulcrum to bring it to a position where the lever mechanism will be effective to move it to its final closed position.

Instead of using a solid copper slab to form the main parts of the stationary switch members, I construct them of copper bars that are spaced apart in such manner as to permit the free circulation of air therethrough, thereby ventilating them. This laminated construction readily lends itself to the construction of front or rear connected switches, as the case may be.

When a high amperage alternating current switch is mounted on a metallic switch base and arranged for rear connection, it is necessary to so construct the support structure that eddy currents will not be set up therein to such an extent that undue heating takes place. For this purpose I have provided a novel form of switch base that is constructed by using structural members of magnetic material that are readily obtainable on the open market, in combination with certain non-magnetic members, or used in conjunction therewith. A sturdy support structure is thereby provided which is readily capable of withstanding the severe stresses to which the switch may be subjected on the occurrence of a short circuit.

As will be apparent hereinafter, advantage is taken of mounting the prestressed contact fingers on the switch blade to construct a double throw switch, in one embodiment a three pole switch, and an operating mechanism is provided which not only serves to move the switch blade, but also serves to lock it in either position. The locking feature is provided by a continued movement of a single operating handle. Such a construction is possible because of the relatively narrow range of movement that is required to bring the contact fingers into complete contact engagement with the stationary switch members. It will be understood, of course, that this operating and locking arrangement may be used in a single throw switch a swell as in a double throw switch.

Referring now particularly to Figures 1, 2, and 3 of the drawings, it will be noted that the reference character 1 designates, generally, a high amperage disconnecting switch of the type that is known as a front connected switch. The switch 1 comprises stationary switch members, shown generally at 2 and 3, forming the terminal members of a circuit which is bridged by a switch blade, shown generally at 4. Throughout the specification the term "switch blade" will be employed to designate a bridging assembly which may comprise one or more conductors or switch blades. Generally, the blades will be formed of flat copper bars, but, it will be understood, that my invention is not limited to this particular form of conductor. In the embodiment of the invention shown in these figures, the switch blade 4 comprises three switch blades 5, 6 and 7, and in the specific embodiment illustrated, they are formed of copper bars three-eighths of an inch thick, five inches wide, and twenty-on inches long.

The stationary switch members 2 and 3 are mounted on suitable insulators 8 and 9 which, in turn, may be mounted, as illustrated, on a suitable channel base 10. It will be understood that the voltage of the circuit in which the switch 1 is connected will determine the type and size of the insulators 8 and 9 that are used. The particular switch illustrated is designed for use on a 7,500 volt alternating current circuit, and it has a continuous carrying capacity of 4,000 amperes.

The bus bars forming the circuit in which the switch 1 is connected are connected to the stationary switch members 2 and 3 and secured thereto by suitable bolts positioned in apertures 11 that are located in the ends of clip bases 12 and 13. As shown, the clip bases 12 and 13 are of laminated construction, being formed by a plurality of copper bars which not only readily interfit with the bus bars of the power circuit, but also provide a construction which may be readily ventilated. The clip bases 12 and 13 are suitably bolted to spacers 14 and 15 which, in turn, are bolted to caps 16 and 17 on the insulators 8 and 9. The copper bars forming the clip bases 12 and 13 are spaced apart by spacers such as illustrated at 18 and 19. When the clip bases 12 and 13 are assembled, these spacers are positioned between the bars and riveted thereto in locations which correspond to the positions of the bolts that are provided for securing them to the adapters 14 and 15, and also those bolts which are used for mounting the various parts on the outer sides thereof. The arrangement and construction of the clip bases 12 and 13 and the manner in which the parts thereof are soldered together will be illustrated and described in further detail hereinafter. At the present time it is sufficient to indicate that the clip bases are formed of a plurality of copper bars that are spaced apart in such manner as to permit the free circulation of air therebetween for cooling purposes. It will be obvious that the adapters 14 and 15 may be omitted, and that the clip bases 12 and 13 may be bolted directly to the caps 16 and 17. However, in order to facilitate construction and to employ insulators 8 and 9 that were available in the open market, the arrangement described hereinbefore was used.

Mounted on the outermost bar of the clip bases 12 and 13 are switch clips 20 and 21 for receiving contact fingers 22 and 23 therebetween. The switch clips 20 and 21 are generally of U-shape with outflared edges to facilitate the insertion of contact fingers 22 and 23. As illustrated, the switch clips 20 and 21 are mounted on the clip bases 12 and 13 by suitable bolts.

It will be recalled that the switch blade 4 comprises three switch blades 5, 6 and 7. These blades are assembled as a unit and secured in such relation by a bolt 25 at the upper end, by bolts 26 and 27 intermediate the ends and by a bolt 28 at the lower end. The switch blades 5, 6 and 7 are secured in the proper spaced relation by tubular spacers 29, 30 and 31 that fit snugly around the bodies of the bolts on which they are positioned with the ends abutting the inner surfaces of the switch blades. When this construction is employed, an accurate alignment of the switch blades is provided and maintained.

It will be observed that the switch blade 4 is hinged on the bolt 28 as an axle, and that it is positioned in suitable U-shaped fulcrum mem-

bers 32 that are secured by suitable bolts to the clip base 13. It will be understood that the switch blade 4 swings about the bolt 28 as an axis to open and close the circuit between the stationary switch members 2 and 3 by movement of the contact fingers 22 and 23 into and out of engagement with the switch clips 20 and 21, respectively. The U-shaped fulcrum members 32 do not fit closely into the spaces between the switch blades 5, 6 and 7, but they are somewhat narrower to permit self-alignment between the fingers 22 and 23 on the blades and the clips 20 and 21 on the base.

With a view to operating the contact fingers 22 and 23 into and out of engagement with the switch clips 20 and 21, and to latch them in the closed position, a combined operating and latching mechanism, shown generally at 35, is provided at the upper end of the switch blade 4, see Figure 4. The details of construction of the operating and latching mechanism will be presently set forth.

Since the switch blade 4 is composed of individual blades of copper having a relatively massive section and, consequently, considerable weight, it is desirable to provide some means for retarding the movement of the switch blade 4 to the open position under the influence of gravity after the contact fingers 22 have been moved out of engagement with the switch clips 20 and 21. For this purpose two brake assemblies, shown generally at 36, are provided between the blades 5 and 6, and 6 and 7, as illustrated, for effecting this function. The brake assemblies 36 are pivoted in bearing brackets 37 that are secured to the outermost bar of the clip base 13 and between the switch clips 21, as illustrated more clearly in Figures 3 and 4 of the drawings.

As indicated hereinbefore and as will be set forth in detail hereinafter, the contact engagement between the switch blade 4 and the stationary switch members 2 and 3 takes place within a narrow range of movement of the switch blade 4. Stated differently, the frictional engagement between the relatively movable switch members takes place within a limited range of movement to and from the switch closed position. During this limited range of movement, a considerable force must be exerted to effect the final contact engagement in the switch closed position. However, since this force need be exerted only during a relatively short or limited movement of the switch blade, it is possible to provide a compact operating mechanism employing relatively short levers that operate at a mechanical advantage, thereby requiring the exertion of a relatively small force to move the switch blade through this limited final range to the switch closed position. The same mechanism may also be used for moving the switch blade out of engagement with the stationary switch members. The combined operating and latching mechanism 35 serves this purpose, and its construction and operation is illustrated in more detail in Figures 4 through 10 of the drawings, to which reference will now be had, particular reference being first directed to Figures 4 and 5.

As illustrated in these two figures, the operating and latching mechanism 35 comprises a pair of lock levers 39 that are mounted for rotation on opposite sides of the switch blade 6 on a bolt 40 that extends through the three switch blades. The lock levers 39 are formed preferably of cast hard bronze, and have integrally formed therewith outwardly projecting bosses 42 that are arranged to interfit with upwardly opening slots 43 in stationary latch arms 44 that are mounted on the outermost bar of the clip base 12 adjacent the upper end of the switch clip 20. The bosses 42 engage the right hand sides 45 of the slots 43 when the switch blade 4 is operated to the switch closed position, and they engage the left hand side 46 when the switch blade 4 is moved from the switch closed position. The lock levers 39 are provided at their inner ends with nose portions 47 that engage a stop pin 48 extending transversely through the middle blade 6. The stop pin 48 is threaded at its central portion, and it extends through a suitable clearance hole in the blade 6 and is secured in position by lock nuts on the opposite sides thereof, as illustrated. When the lock levers 39 engage the stop pin 48, no further rotation thereof takes place relative to the switch blade 6, and the continued application of force results in the movement directly of the entire switch blade to the open position.

An operating member 50, having a pull ring 51 integrally formed therewith is rotatably mounted on a pin 52 that extends through and has a pressed fit with the lock levers 39. The ends of the pin 52 project beyond the sides of the lock levers 39, as at 53, for engagement with apertures 54 in latch spring members 55. The latch spring members 55 are preferably formed of phosphor bronze spring strip material, and they are mounted on the bolt 25 and between the spacers 29 thereon. The latch spring members 55 are secured against rotation about the bolt 25 in addition to the frictional engagement therewith by the spacers 29 by means of a rivet 56 that extends transversely through the middle blade 6 and through tubular spacers 57. The latch spring members 55 are moved out of engagement with the projecting ends 53 of the pin 52 by means of cam members 58 that are engaged by cooperating cam members 59 carried by the operating member 50. The cam members 58 are in the form of short rivets, the inside ends of which are rounded to suitably engage the coacting surface of the cam members 59.

The latching members 55 should be released before the lock levers 39 are rotated to pry the switch blade 4 out of the closed position. In order to combine the locking and operating feature in the single movement of the operating member 50, slots 60 are provided therein to permit relative movement of the operating member 50 with respect to the lock levers 39 as limited by a pin 61 that extends through the lock levers 39. The slots 60 are of sufficient length to permit the movement apart of the latch spring members 55 by movement of the cam members 59 before any torque is applied to rotate the lock levers 39 themselves.

It is desirable to maintain the nose portions 47 of the lock levers 39 adjacent the stop pin 48 after the switch blade 4 has been moved a slight distance from the closed position until it is returned to this position. When the movement of the lock levers 39 is thus limited, the outwardly extending bosses 42 from the lock levers 39 will register with the upwardly opening slots 43 in the stationary latch arms 44 to permit operation of the switch blade 4 to its final closed position through the lever action of the operating mechanism 35. It is for this purpose that a pair of lever stops 64 is provided and rotatably mounted on pins 65 that extend through bearing blocks 66 which are mounted on opposite sides of the mid-

dle switch blade 6, as is more clearly illustrated in Figure 9 of the drawings. The lever stops 64 are provided with integrally formed stop arms 67 that are biased into the path of movement of the nose portions 47 of the lock levers 39 by means of leaf springs 68 that are secured to the inside of the lever stops 64 and bear against the adjacent faces of the switch blade 6. The lever stops 64 are held against the biasing force of the springs 68 by plates 69 that are secured, as by rivets, to the inner surfaces of the stationary latch arms 44. The outer ends of the plates 69 are provided with beveled edges 70 which first engage nose portions 71 of the lever stops 64 when the switch blade is operated to a position that is close to the closed position, at which time the lock levers 39 should be released to permit the bosses 42 to enter the slots 43, as will be readily understood. When the switch blade has been moved a slight distance from its closed position, the nose portions 71 no longer engage the plates 69, and the lever stops 64 rotate to the position shown in Figure 10 of the drawings.

For the purpose of describing the functioning of the combined operating and latching mechanism 35, it will first be assumed that the switch blade 4 is in the closed position, as illustrated in Figure 4 of the drawings. The position of the operating member 50 at this time is more clearly illustrated in Figure 5, where the latch spring members 55 are shown in engagement with the ends 53 of the pin 52, thereby locking the switch blade 4 in the closed position and preventing its being forced open under short circuit operating conditions. The pull ring 51 is engaged by a suitable hook stick, and is rotated in the direction indicated by the arrow 72, Figure 4, to the position shown by the broken lines. This rotation is limited by the one end of the slots 60 engaging the transverse pin 61. During this rotation, however, the latch spring members 55 are moved out of engagement with the ends 53 of the pin 52, as is indicated more clearly in Figure 6 of the drawings. The switch blade 4 is now unlocked and the continued application of force to the pull ring 51 will now initiate the movement of the switch blade 4 toward the open position.

Since the right hand end of the slots 60, as viewed in Figure 4, is in engagement with the pin 61, the lock levers 39 now rotate together therewith. The bosses 42 engage the left hand sides 46 of the slots 43 in the stationary latch arms 44 to pry the switch blade 4 out of the engagement with the stationary switch members 2 and 3 and cause it to rotate about the bolt 28 as an axis in the direction indicated by the arrow 73, Figure 4. In Figure 7, the position of the lock levers 39 is shown just after the prying action has been completed and before the lever stops 64 have been released. The frictional engagement between the relatively movable switch members will have been released when the lock levers 39 have been rotated to the position shown in Figure 8, at which time the nose portions 47 are in engagement with the ends of the stop pin 48. Immediately thereafter the nose portions 71 of the lever stops 64 are moved out of engagement with the plates 69, and the stop arms 67 are moved to positions directly underneath the nose portions 47 of the lock levers 39 as is illustrated more clearly in Figure 10. The switch blade 4 is then moved directly with the operating member 50 in the direction indicated by the arrow 74 to the open position. This position is indicated by the outline of the switch blade 4 shown by the broken lines in Figure 4.

When it is desired to operate the switch blade 4 to the switch closed position, the hook stick is inserted in the pull ring 51, and it is first rotated about the pin 52 until the opposite end of the slots 60 engage the pin 61. Since the nose portions 47 of the lock levers 39 are engaged by the stop arms 67 of the lever stops 64, the lock levers 39 are prevented from rotating about the bolt 40, and the switch blade 4 is moved directly in conjunction with the movement of the operating member 50. During this portion of the movement of the switch blade 4 to the closed position, it is only necessary to exert sufficient force to overcome the force of gravity as applied to the switch blade 4 and a slight amount of friction that may be involved at the fulcrum point. The continued movement of the switch blade 4 toward the closed position finally causes the nose portions 71 of the lever stops 64 to engage the beveled edges 70 of the plates 69, with the result that the stop arms 67 are moved out of engagement with the nose portions 47 of the lock levers 39, at which time the bosses 42 register with the slots 43. The lock levers 39 are now free to rotate about the bolt 40, and the bosses 42 engage the right hand sides 45 of the slots 43 to pry the switch blade 4 into the closed switch position. During this operation, the pin 52 moves along a path that is indicated by the broken line 75, Figure 8, and the ends 53 engage the outflared ends of the latch spring members 55 to move them apart. In the final position, the ends 53 register with the apertures 54 in the latch spring members 55 and serve to lock the switch blade 4 in the closed position.

With reference to the action of the lock levers 39, it will be observed that the length of the work arm is substantially the distance between the center of the bolt 40 and the center of the bosses 42. The length of the lever arm is substantially the distance between the point at which the hook stick engages the pull ring 51 and the center of the bosses 42. It will be apparent that this provides a relatively high ratio of length of lever arm, or power arm, to work arm, and thus a relatively great force may be applied to move the switch blade 4 to its final position with the exertion of a comparatively small force on the pull ring 51. This of course applies to either direction of operation of the switch blade 4. During this final movement of the switch blade 4 to the closed position the lock levers 39 are rotated through substantially 90 degrees while the switch blade 4 is only moved a comparatively slight distance. However, during this relatively narrow range of movement, the principal part of the work is done in operating the switch blade 4 from one position to the other. This is permitted by the particular construction of the contact fingers 22 and 23 and the cooperating switch clips 20 and 21 which will be described in detail hereinafter. With the contact arrangement as indicated herein, it is feasible to provide a lever action having a relatively high ratio of length of power arm to work arm for operating the switch blade into and out of the switch closed position which would not otherwise be the case if the conventional knife blade and jaw construction is employed.

It will be recalled that the frictional engagement between the relatively movable switch members is released shortly after the switch blade 4 starts to move to the open position. Since the switch blades 5, 6 and 7 are heavy and, further,

since they are substantially free to fall under the influence of gravity once this frictional engagement has been released, it is desirable to provide some means for braking the movement of the switch blade 4 to the open position, for otherwise it may get out of the control of the operator, causing possible damage if it is allowed to freely fall to the open position. It is for this purpose that the brake assemblies 36 are provided. The construction and functioning of the brake assemblies 36 are more clearly illustrated in Figures 4, 11, 12 and 13 of the drawings, to which reference will now be had.

In Figures 11, 12 and 13, the details of construction of one of the brake assemblies 36 are shown. It will be understood that both of the brake assemblies 36 are identical in construction and that a detail description of one will be sufficient. The number of assemblies that is used will depend, of course, upon the size of the switch blade 4. Therefore, while two brake assemblies 36 have been illustrated, it will be understood that a lesser or a greater number may be employed without departing from the scope of my invention.

Referring now particularly to Figures 4, 11 and 12 of the drawings, it will be observed that a stop link 80 is provided, formed preferably of brass, and pivotally mounted on a pin 81 that extends through the upstanding ears of the bearing bracket 37. The stop link 80 is provided with a longitudinally extending slot 82, the surfaces 83 of the adjacent sides providing braking surfaces, the function of which will be set forth presently. The end of the slot 82 away from the pin 81 is rounded as at 84 to abut the spacer 30 around the bolt 27 for the purpose of limiting the movement of the switch blade 4 to the open position. It will be understood that the bolt 27 is not inserted in the switch blade 4 during the assembly thereof until after the stop link 80 has been placed in such position that the bolt 27 will extend therethrough.

With a view to braking the movement of the switch blade 4 toward the open position, brake shoes 85 and 86 are provided on opposite sides of the stop link 80 in such manner that the spacer 30 and the bolt 27 project therethrough as illustrated. Buttons 87, formed of a friction material, are disposed in suitable recessed apertures on the inner faces of the brake shoes 85 and 86, and are arranged to frictionally engage the braking surfaces 83 of the stop link 80. The brake shoes 85 and 86 and the buttons 87 of friction material are urged toward each other by a pair of compression springs, one of which is shown at 88 in Figure 13. Each of the springs 88 is mounted in a cylinder 89 and around a bolt 90 that extends through both of the brake shoes. A washer 91 is provided underneath the head of the bolt 90 to provide a seat for the spring 88. The cylinder 89 is provided at one end with an inwardly extending flange 92, and, as illustrated, the spring 88 is disposed between this flange 92 and the inner face of the washer 91. At the other end of the cylinder 89 an outwardly extending flange 93 is provided that interfits with the countersunk portion of an aperture 94 in the brake shoe 86. The bolt 90 extends through a suitable clearance hole 95 in the brake shoe 85. Since the compression spring 88 bears at one end against the inner surface of the washer 91, thereby applying a force to the bolt 90 in such direction as to move the brake shoe 85 toward the brake shoe 86, and since the other end of the compression spring 88 bears against the inner surface of the flange 92, thereby urging the brake shoe 86 toward the brake shoe 85, it will be apparent that the buttons 87 of friction material will be urged into frictional engagement with the braking surfaces 83 on the stop link 80. It will be obvious that it is undesirable to space the blades 5, 6 and 7 at a great distance apart, and therefore it is necessary to adopt a construction of biasing means for the brake shoes 85 and 86 that will require a minimum of space.

In addition to the two bolts 90 that extend through the brake shoes 85 and 86, a bolt 96 is provided extending through a clearance hole 97 in the brake shoe 86 and through a tapped hole 98 in the brake shoe 85. A lock nut 99 secures it in position. It will be noted that a suitable slot 100 is provided in the stop link 80 and forms an extension of the slot 82 to take care of the bolt 96.

In order to release the brake and to move the brake shoes 85 and 86 apart when the switch blade 4 is operated toward the closed position, a hinge 101, having oppositely extending arms 102 and 103 positioned in suitable recesses 104 and 105 in the inner surfaces of the brake shoes 85 and 86, is provided. When the switch blade 4 is moved toward the closed position, the spacer 30 engages the adjacent central portion of the hinge 101 and forces the brake shoes 85 and 86 apart, thereby releasing the frictional engagement between the buttons 87 and the brake surfaces 83 and permitting the free closure of the switch blade 4.

It will be observed that the brake shoes 85 and 86 are provided with registering openings 106 that are elongated to a slight extent. Thus a certain degree of movement of the switch blade 4 in either direction can take place before the brake shoes 85 and 86 are engaged by the spacer 30 that surrounds the bolt 27. When the switch is in the closed position, as illustrated in Figure 4 of the drawings, the slotted openings 106 permit sufficient movement of the switch blade 4 without moving the brake shoes 85 and 86 to largely free the contact fingers 22 from frictional engagement with the switch clip 20 and the contact fingers 23 from engagement with the switch clip 21. Thus, it is only necessary to apply sufficient force by the operating and latching mechanism 35 to overcome the frictional engagement between the relatively movable switch members, and the retarding effect of the brake assemblies 36 is not called into play until after this frictional engagement has been largely released, at which time the switch blade 4 is substantially free to fall under the influence of gravity. It will be noted that only a slight slack is required in this movement in order to permit proper operation of the brake shoes 85 and 86. Only this slight amount of movement is required because of the particular arrangement and construction of the contact fingers 22 and 23 that requires only a limited movement of the switch blade 4 to effect the complete release thereof. This construction and arrangement will presently be set forth in detail.

In Figure 11 of the drawings, the location of the spacer 30 relative to the brake shoes 85 and 86 is shown in the switch open position. As there indicated, the spacer 30 is abutted against the rounded end 84 of the slot 82 and serves to prevent further movement of the switch blade 4. In this position the spacer 30 is spaced slightly from the adjacent edge of the hinge 101, thereby

providing sufficient clearance for its movement to permit the springs 88 to bring the buttons 87 of friction material into sufficient engagement with the braking surfaces 83 as will provide the required retarding effect. In Figure 12, the arrow 107 indicates the direction of movement of the spacer 30, shown by broken lines, relative to the stop link 80 when the switch blade 4 is moved toward the open position. The arrow 108 indicates the relative movement of the spacer 30 when the switch blade 4 is moved toward the closed position. The distance between the positions of the spacer 30, shown by the broken lines, indicates the slack that must be taken up before the braking action is applied when the switch blade 4 is moved from the closed position or is released when it is moved toward this position from the open position.

As indicated hereinbefore, only a slight movement of the switch blade 4 is required to engage or disengage the stationary switch members 2 and 3. Because of this limited range of movement that is required, it is possible to provide the operating and latching mechanism 35 and the brake assemblies 36 that might not otherwise be possible if the conventional type of switch were employed, in which the switch blade is in frictional engagement with the stationary switch members over a comparatively large portion of its total travel. The construction which permits this desired functioning is illustrated more clearly in Figures 14, 15 and 16, to which reference will now be had. For the purpose of illustration, the switch blade 5 is illustrated in conjunction with one of the switch clips 20 of the stationary switch member 2. However, it will be understood that the same contact arrangement is employed with the other switch blades and switch clips.

As illustrated, the contact fingers 22 are secured to the switch blade 5 along the edge thereof that is remote from the switch clip 20 by any suitable means, such as the rivets 111, and they are spaced therefrom by spacers 112 formed of relatively thin copper strips. If desired, the spacers 112 may be tinned and the entire assembly may be sweated into a substantially unitary construction. The contact fingers 22 extend across the entire width of the switch blade 5 and beyond the edge that is adjacent the switch clip 20. The free ends are slotted, as indicated at 113, by a saw cut to form a bifurcated construction that includes branches or sections 114 and 115.

Since I have discovered that point contact engagement rather than surface contact engagement takes place in switches of the conventional knife blade type, I have provided for obtaining the point contacts under the best possible conditions. For this purpose the branches or sections 114 and 115, which are somewhat independently movable within a limited range, are provided with rivets 116 that are formed preferably of silver. The ends of the silver rivets 116 that project outwardly from the contact fingers 22 are provided with rounded heads, as illustrated, and in the switch closed position they are aligned with and in contact engagement with silver rivets 117 that are located in the upstanding sides of the switch clip 20. Silver is preferably employed, since its contact resistance is relatively low and remains constant over long periods of time.

While it is desirable to form the inserts or rivets 116 of silver, it will be obvious that the small area contact surface may be provided by upsetting the bifurcated ends of the contact fingers 22 to form small radius spherical contact surfaces. As indicated, it is preferable to employ silver or a silver alloy for forming the rivets 116, but it will be understood that any other material having similar characteristics that may later be discovered, or which may be economical for use, that has the contact surface characteristics of silver may be employed with equal advantage. Instead of providing the small radius, and thereby small area, contact surfaces on the contact fingers 22, I may position them on the switch clip 20 and form the contact fingers 22 with plane surfaces. In either construction, the ends of the contact fingers 22 or the adjacent edges of the switch clip 20 should be beveled or flared outwardly as the case may be, in order to properly engage the small radius spherical contact surface portions with a sliding movement so that they may be readily moved out of the path of relative movement of the switch members with a minimum of wear on the contact surfaces that are disposed to engage with each other. These various features of construction make practical the use of multiple small area high pressure contact surfaces that are so mounted as to be individually resilient and prestressed as will be readily understood.

Since it is desirable to provide a relatively high contact pressure between the silver rivets 116 and 117, a compression spring 118 is positioned between the free ends of the contact fingers 22. The spring 118 is provided with a sufficient degree of resiliency to apply the required contact pressure between the silver rivets 116 and 117.

The spring 118, if not limited in the application of its resilient force in biasing the contact fingers 22 apart, would move them apart a considerable distance. Each time that the switch is closed, it would be necessary to compress the spring 118 from this extended position to its position as shown in Figure 14. This would require a considerable amount of work to be done. Moreover, the ends of the contact fingers 22 would remain for a greater portion of the travel of the switch blade 4 in frictional engagement with the switch clip 20. For the purpose of limiting the movement apart of the contact fingers 22 and, at the same time, taking advantage of the full resiliency of the compression spring 118, aligned countersunk apertures 119 are provided in the contact fingers 22 on the center line of the saw cut 113. A tension stud or rivet 120 is positioned in the apertures 119, and its ends 121 are headed over inside of the countersunk portions of the apertures 119. The central portion of the tension stud or rivet 120 is enlarged, as at 122, to serve as a guide for the compression spring 118 that surrounds it. The rivet 120 is formed preferably of a copper rod having a diameter initially the same as the diameter of the enlarged central portion. The ends are machined to provide the necked down end portions for slidable mounting in the apertures 119. The ends of the necked down portions are drilled to facilitate the formation of the heads 121. In order to provide substantially point contact engagement between the ends of the compression spring 118 and the flanges or sections 114 and 115 of the contact fingers 22, a ridge 123, Figure 16a, is upset along the inner surfaces of the contact fingers 22 and in alignment with the apertures 119. In this manner, any tendency for cocking of the fingers is reduced to a minimum and the spring 118 acts more or less independently on each bifurcated section.

The relative positions of the contact fingers 22

and the rivet 120 as the switch blade 5 is moved toward the closed position in the direction indicated by the arrow 124, are shown in Figure 15. As there illustrated, the headed ends 121 of the rivet 120 are in engagement with the bottom surfaces of the countersunk portions of the apertures 119, and thereby limit the movement apart of the contact fingers 22. The headed outer ends of the rivets 116 come into frictional engagement with the outflared ends of the switch clip 20 at a distance from the silver rivets 117 mounted therein that is indicated at 125, Figure 14. It will be understood that it is only during this relatively limited movement that frictional engagement between the relatively movable switch members takes place, and that it is during this movement that a relatively large force is required to effect the final movement of the switch to the closed position. In this position it will be observed that the contact fingers 22 have been moved toward each other a sufficient extent to relieve the headed ends 121 of the rivets 120 of the pressure that was applied thereto in the switch open position by the compression spring 118. This spring is then free to apply its full resilient force to maintain the required contact pressure between the rivets 116 and 117. However, the amount of work that is required to be done in addition to the friction force described above in obtaining this high degree of resilient force is only that which is required to move the contact fingers 22 toward each other through a limited distance for relieving the tension stud or rivet 120 of the pressure applied thereto by the spring 118. In like manner, when the switch blade is moved toward the open position, frictional engagement between the relatively movable members takes place only over a comparatively short distance as indicated at 125, at which time the tension studs or rivets 120 limit further movement apart of the contact fingers 22, and thereafter no additional work need be done in withdrawing the switch blade from the switch closed position. This small inward movement of the contact fingers 22 is only enough to assure that the pressure is transferred from the rivet 120 to the inserts 116 on each of the sections 114 and 115. This feature assures that every contact point bears on the switch blade at about the same contact pressure, and thereby avoids the necessity for making fine adjustments in the manufacture or maintenance of the contact fingers as to their positions in the open switch position.

In Figure 17 of the drawings, I have illustrated an alternative form of tension stud that may be employed in place of the rivet 120 illustrated and described hereinbefore. As shown, a tubular member 126 is provided for slidably mounting in the apertures 119. The tubular member 126 is internally threaded to receive machine screws 127, the heads of which are positioned in the countersunk portions of the apertures 119. These countersunk portions are made sufficiently deep and the heads of the machine screws 127 are sufficiently thin so that they will not project beyond the outer surfaces of the contact fingers 22. A tubular spacer 128 is positioned around the tubular member 126 and serves to center the spring 118. This construction permits a somewhat more accurate positioning of the contact fingers 22, facilitates assembly and permits more ready disassembly for repair or replacement of the spring 118. It will be understood, however, that either the rivet construction, as shown in Figure 15, or the threaded construction, as shown in Figure 17, may be employed.

Another embodiment of the prestressed contact finger assembly is illustrated in Figures 18, 19 and 20 of the drawings. As there shown, a switch clip 129 is provided for mounting on a suitable clip base, such as the clip base 12 shown in Figure 1. It will be observed that the upstanding side members of the switch clip 129 do not extend as far from the clip base as the corresponding side members of the switch clip 20. The reason for this difference will soon be apparent. A switch blade 130 is mounted for movement relative to the switch clip 129. Contact fingers 131 are positioned on opposite sides of the switch blade 130 and are secured thereto by rivets 132 along the edge that is remote from the switch clip 129. Spacers 133 are provided for spacing the contact fingers 131 away from the sides of the switch blade 130. It will be understood that more than one switch clip 129 may be employed as well as more than one switch blade 130. The number used will depend upon the switch capacity that is desired. It will further be understood that the construction illustrated in these figures may be employed in lieu of the construction shown in Figure 1 of the drawings for the high imperage disconnecting switch 1. Since the arrangement of the switch 1 in its entirety using the embodiment of the prestressed contact members shown in Figures 18, 19 and 20 will otherwise be essentially the same as illustrated and described hereinbefore, the complete construction using this embodiment is not illustrated herein.

As shown more clearly in Figure 19, the contact fingers 131 are provided with slots 134 to form the bifurcated construction, thereby permitting a limited degree of independent movement of the branches thus formed. Inserts 135 are provided in the branches thus formed, and they have rounded outwardly extending heads which engage with corresponding inserts 136 in the switch clip 129 to form the contact engaging portions therebetween.

With a view to providing the necessary contact pressure between the inserts 135 and 136 and, at the same time, retaining the prestressing effect, as set forth hereinbefore, a prestressed unit, shown generally at 137, is provided between each of the free ends of the contact fingers 131. The prestressed unit 137 comprises cup washers 138 and 139 that are provided with outwardly extending integrally formed bosses 140 and 141, respectively, that are arranged to interfit with the edges of countersunk portions 142 in the apertures in which the inserts 135 are positioned in the contact fingers 131. The washers 138 and 139 are provided with inturned flanges for centering a coil compression spring 143 therebetween. If desired, the inturned flanges of the cup washers 138 and 139 may be extended toward each other for the purpose of completely enclosing the compression spring 143. A stop member 144, in the form of a rivet, is slidably positioned in a suitable clearance hole 146 in the cup washer 140, and it extends through a hole 147 in the cup washer 139 and is headed over, as illustrated, to secure it in position.

It will be apparent that the compression spring 143 reacts directly upon the inserts 135 and along the line of contact thereof with the corresponding inserts 136 in the switch clip 129. At the same time the prestressing effect is provided in the compression spring 143 by the stop member 144 which limits the expansion of the spring 143 to a position such that the heads of the inserts 135 are positioned slightly within the path of rela-

tive movement with the inserts 136 in the switch clip 129. Since the prestressed unit 137 is aligned with the inserts 135, rather than being spaced therefrom, as shown in Figure 14 of the drawings, it will be obvious that the side members of the switch clip 129 need not be of the height there shown. Moreover, this modified construction reduces the length required for the contact fingers 131 without in any way decreasing the current carrying capacity thereof. A further advantage resides in the fact that the construction of the contact fingers 131 is simplified and the number of machine operations required to form them is reduced to a minimum. Because of the provision of the bosses 140 and 141 interfitting with the depressions 142 in the bases of the silver inserts 135, substantially point contact is provided with the sections formed in the bifurcated ends of the contact fingers 131. A small space between washer 139 and the bifurcated ends of the fingers 131 permits a limited independent movement of each section. Since substantially point contact engagement is provided because of the headed ends of the inserts 135 with the inserts 136, the pressure exerted by the compression spring 143 is directly applied along this line of contact. Thus a maximum of contact pressure is provided between the silver inserts with a minimum of movement of the compression spring 143 and with minimum transfer of heat from the contact surfaces to the springs.

Advantage is taken of the principle of applying the biasing force in line with the contact points to construct the disconnecting switch shown in Figures 21 and 22 of the drawings. This switch is primarily designed to have a capacity from 400 to 800 amperes. The switch, shown generally at 150, comprises a switch blade, shown generally at 151, that is made up of individual blades 152 and 153 that are secured in spaced apart relation by transversely extending rivets 154. A pull ring 155 is provided at the upper end of the blade 151 to permit remote operation by means of a hook stick.

At its lower end, the switch blade 151 is hinged by means of a transversely extending bolt 156 on a fulcrum member 157 that is secured to a clip base 158, in the form of a flat bar conductor, that is provided with apertures 159 to permit the connection of a terminal member or a bus conductor thereto. The clip base 158 is mounted on a spacer 160 which, in turn, is mounted on a suitable base 161 of insulating material.

Between the switch blades 152 and 153, bifurcated contact fingers 162 are mounted at the upper end for contact engagement with a switch clip 163 constituting a stationary switch member. At the lower ends, bifurcated contact fingers 164 are positioned between the switch blades 152 and 153 for contact engagement with a switch clip 165 that is mounted, as indicated, on the clip base 158. The switch clip 163 is mounted on a clip base 166, similar to the clip base 158, and is provided with suitable apertures 167 therein to permit connection thereto. The switch clip 166 is spaced from the base 161 by a suitable spacer 168.

The construction and functioning of the contact fingers employed in the switch 150 are illustrated more clearly in Figures 23 and 24 of the drawings. As there illustrated, the contact fingers 164 are spaced slightly from the inner surfaces of the switch blades 152 and 153 by spacers 170, and they are spaced from each other by means of a spacer 171. Rivets 172, extending transversely through the switch blades 152 and 153, spacers 170, contact fingers 164, and the spacer 171, serve to hold the contact fingers in the desired spaced relation along the edges of the switch blades 152 and 153 that are remote from the stationary contact member comprising the switch clip 165.

With a view to providing point contact engagement with the switch clip 165 and the desired contact surface therebetween, inserts 173 are provided in each of the branches formed in the bifurcated ends of the contact fingers 164, and corresponding inserts 174 are positioned in the switch clip 165. The necessary contact pressure between the inserts is provided by means of a compression spring 175 that is positioned in alignment with the inserts 173 and 174 in suitable recesses 176 in the inner faces of the contact fingers 164. It will be noted that the axis of the compression spring 175 substantially coincides with the line through the contact points between the inserts 173 and 174 in the opposite arms of the switch clip 165. When the spring 175 is located in this position, the maximum contact pressure is provided with a minimum of movement being required on the part of the spring. Since, in this construction, the contact fingers 164 are relatively short, they are annealed for a portion of their length, as indicated at 177. The annealing increases the flexibility of the contact fingers 164 without reducing the current carrying capacity thereof and permits the use of a somewhat lighter spring 175 than might otherwise be required.

Instead of annealing the contact fingers 164 for a portion of their length as indicated at 177, saw cuts 178 may be located in the opposite sides thereof in staggered relation, as indicated, to provide the required degree of flexibility. I have found that the provision of the saw cuts 178 materially increases the flexibility of the relatively thick contact fingers 164, and at the same time the current carrying capacity thereof is not appreciably reduced since the saw cuts 178 are extremely narrow in width.

When the switch blades 152 and 153 are withdrawn from the switch clip 165, the contact fingers 164 are biased apart in the directions indicated by the arrows 179 by the spring 175. The movement thereof apart is limited by the engagement of the outer surfaces of the contact fingers 164 with the edges of the switch blades 152 and 153 adjacent the switch clip 165. Therefore, it is unnecessary to provide any additional stop means for limiting the movement of the contact fingers 164 apart, and, at the same time, the prestressed effect of the spring 175 is retained. In this position, the heads of the inserts 173 are positioned slightly within the path of relative movement with the switch clip 165. When the switch blades 152 and 153 are moved toward the switch closed position in the direction indicated by the arrow 180, the contact fingers 164 are moved toward each other and the spring 175 is compressed still further so that the full strength thereof is available to provide the required degree of contact pressure between the silver inserts 173 and 174.

In Figures 25 and 26 of the drawings, I have illustrated a high amperage switch, shown generally at 182, which embodies the prestressed small area high pressure contact construction in combination with a quick break mechanism adapted to permit the opening of the switch under load without injury to the main contact

fingers. As there shown, the switch 182 is mounted on a suitable base 183, formed of insulating material, on which are suitably bolted clip bases 184 and 185. These clip bases are formed of a plurality of flat bars spaced apart as by spacers 186 and 187. This arrangement provides a ventilated construction by means of which any heat generated in the clip bases is readily dissipated. The clip bases 184 and 185 are arranged for front connection, and, as shown in Figure 26, they are provided with extensions 188 and 189, respectively, for mounting terminal clamps 190 and 191 thereon. The terminal clamps 190 and 191 are adapted to be connected to flexible current carrying conductors of relatively large current carrying capacity.

Mounted on the clip bases 184 and 185 are switch clips 192 and 193 with which contact fingers 194 and 195, carried on opposite sides of switch blades 196 and 197 are arranged to engage. The construction of the switch clips 192 and 193 and the contact fingers 194 and 195 may be such as illustrated in Figure 14 or in Figure 18 of the drawings. It will then be understood that the contact fingers 194 and 195 are of the small area high pressure prestressed type, having inserts therein to engage corresponding inserts in the switch clips 192 and 193 to form the contact engaging portions therebetween.

The switch blades 196 and 197 are mounted in spaced apart relation by suitable spacers and bolts in a manner similar to the construction of the switch shown in Figure 1 of the drawings. At the lower end, the switch blades 196 and 197 are mounted on a bolt 198 for rotation on a fulcrum member 199 that is mounted on the clip base 185. At the upper end, an operating mechanism, shown generally at 200, is provided which is similar to the operating mechanism 35, shown in Figure 1. Since its prying and locking action is the same as that described hereinbefore in connection with the mechanism 35, a description thereof will not be set forth. Instead of the pull ring 51, Figure 1, a lever 201 is provided to which an operating rod 203 is attached for remote operation. The rod 203 is constructed of a suitable insulating material, such as wood.

Since the switch 182 is to be opened under load, it is desirable to provide auxiliary quick break means that will remain closed until the switch blades 196 and 197 are moved to a predetermined position from the closed position so that no arc will be formed between the contact fingers 194 and the switch clip 192. For this purpose, an auxiliary or quick break blade 206 is provided, and it is rotatably mounted on a bolt 207 that extends transversely through the switch blades 196 and 197. The auxiliary blade 206 is arranged to engage an auxiliary switch clip 208 that is mounted in any suitable manner on the uppermost bar of the clip base 184, as shown. A removable arcing tip 209 is provided at the upper end of the auxiliary blade 206, and it is so shaped as to have locking engagement with a latch 210 that is pivotally mounted in a suitable bearing between the switch clips 192 and which is biased for rotation in a clockwise direction by a spring 211. Its movement in this direction is limited by a nose portion 212 of the latch 210 after the auxiliary blade 206 is released.

The auxiliary blade 206 is biased from engagement with the auxiliary switch clip 208 by a spring 213 that is positioned around the bolt 207, one end being positioned behind a pin 214 extending through the switch blades 196 and 197 and the other end being positioned behind a pin 215 that extends through the bifurcated lower end of the auxiliary blade 206.

With a view to insuring that the auxiliary blade 206 will be moved out of engagement with the auxiliary switch clip 208, a link 216 is mounted on the pin 215 and is provided with a slot 217 in which a pin 218, extending between the switch blades 196 and 197, is positioned. The link 216 and the pin 218 not only serve to insure the movement of the auxiliary blade 206 to the open position, but also they provide a stop for limiting its movement in this direction and for causing conjoint movement thereof with the switch blades 196 and 197 when they are moved to the switch closed position.

When the operating rod 203 is pulled downwardly, the operating and latching mechanism 200 is released and the switch blades 196 and 197, together with the contact fingers 194 and 195 carried thereby, are pried out of engagement with the switch clips 192 and 193. During this operation and until the switch blades 196 and 197 are moved an appreciable distance from the switch clip 192, the auxiliary blade 206 remains in contact engagement with the auxiliary switch clip 208, although during this time it has rotated relative thereto to a slight extent. It will be apparent that the auxiliary blade 206 is retained in this position by the latch 210. When the switch blades 196 and 197 have been moved to a predetermined distance from the switch clips 192, which distance will be determined by the necessary clearance to prevent arcing as determined by the voltage of the circuit in which the switch is connected, the auxiliary blade 206 will be released from the latch 210 and will leave it and the auxiliary switch clip 208 with a snap action under the influence of the spring 213. Any arc that may tend to be formed will be rapidly drawn out and interrupted by this snap action. While the switch blades 196 and 197 are being moved to the open position, the pin 218 is being moved toward the right hand end of the slot 217. If sufficient friction should be present between the auxiliary blade 206 and the auxiliary switch clip 208 as would prevent the separation thereof under the influence of the spring 213, the continued movement of the switch blades 196 and 197 will cause the auxiliary blade 206 to be moved out of engagement with the auxiliary switch clip 208, as will be readily understood. When the auxiliary blade 206 is released, it moves in a clockwise direction until the left hand end of the slot 217 in the link 216 engages the pin 218. On movement to the switch closed position, the pin 218 insures the conjoint movement of the auxiliary blade 206 and the switch blades 196 and 197.

Because of the particular bus construction and arrangement, it is often desirable to provide for connecting one or both of the stationary terminal members of a high amperage disconnecting switch at the rear rather than at the front. In Figure 27 of the drawings, I have shown a high amperage disconnecting switch that is suitable for back or rear connection which embodies the prestressed small area high pressure contact finger construction together with a novel form of clip base and connections thereto. In addition, the particular manner in which the clip bases are mounted on a support structure is new insofar as I am aware. While both stationary terminal members of the switch shown in Figure 27 are adapted for back connection, it will be understood that either or both may be so arranged while the other terminal

member is arranged for front connection, as shown in Figure 1 of the drawings.

Referring now particularly to Figure 27, it will be observed that a high amperage disconnecting switch is there shown generally at 221. The switch 221 comprises a pair of spaced apart aligned stationary switch members 222 and 223 that are arranged to be bridged by a switch blade, shown generally at 224. The particular embodiment of the switch 221 shown is adapted for continuously carrying 6,000 amperes, and it is provided with four blades near each end of which nine pairs of contact fingers 226 and 227 are secured for contact engagement with switch clips 228 and 229 that are mounted respectively on clip bases 230 and 231. The rear connections are provided by a plurality of conductor members 232 and 233 in the form of flat copper straps that are individually connected to the plates or laminations forming the clip bases 230 and 231, in a manner which will be presently set forth. It will be understood that the arrangement of the contact fingers 226 and 227 and the cooperating switch clips 228 and 229 may be as shown in Figure 14 or in Figure 18 of the drawings, as may be desired. A combined operating and latching mechanism, shown generally at 235 at the upper end of the switch blade 24, may be provided and constructed similar to the mechanism 35 shown in Figure 1 for prying the switch blade 224 into and out of the switch closed position, and for locking it in the switch closed position. In like manner, a brake, shown generally at 236, may be provided that is similar to the brake assembly shown at 36 in Figure 1 of the drawings and described hereinbefore in detail. At its lower end, the switch blade 224 is rotatably mounted by means of a transversely extending bolt 237 on fulcrum members 238 that are suitably secured to the clip base 231.

It will be observed that the conductor members 232 and 233 are mounted in spaced apart relation in and extend through tubular insulator bushings 240 and 241. The bushings 240 and 241 are formed preferably of porcelain, thereby requiring that special consideration be given to the manner in which the conductor members 232 and 233 and the clip bases 230 and 231 connected thereto are mounted thereon. In Figure 29 of the drawings, the preferred construction in connection with the insulator bushing 241 is illustrated. It will be understood that the arrangement and construction of the insulator bushing 240 is identical with that of the bushing 241 and, therefore, a description of the latter will serve for both.

As shown in Figure 29, the insulator bushing 241 is provided with seating rings 242 and 243 at each end that are formed of non-magnetic metal. Since the switch 221 is intended for connection in an alternating current circuit, it is desirable that no complete magnetic circuit be positioned around the circuit formed by the conductor members 233 for the purpose of avoiding stray losses and undue heating. The seating rings 242 and 243 are cemented, as indicated at 244 and 245, to the ends of the porcelain insulator bushing 241, and they are each provided with four registering clearance holes 246 and 247. Stud bolts 248 extend through these registering clearance holes 246 and 247 and into suitable tapped holes in the laminated clip base 231. Suitable nuts are provided at the outer ends of the stud bolts 248 that are drawn up to secure the clip base 231 in position. Since it is highly desirable that the switch clips 228 and 229, carried by the clip bases 230 and 231, be maintained in substantial alignment throughout the life of the switch 221, dowel pins 249 are positioned in suitable drilled holes that extend through the clip base 231, for example (Figures 28 and 33), and into the retaining ring 243. In this manner, any tendency for the clip base 231 to shift relative to the seating ring 243, as permitted by the clearance holes 247, is avoided, and the desired substantial alignment is accurately maintained.

It is essential that a substantial support structure be provided for mounting the insulator bushings 240 and 241 in the desired alignment. Moreover, the mounting must be such that the switch structure will be capable of withstanding the severe stresses to which it may be subjected under short circuit load conditions. For this purpose, each of the insulator bushings 240 and 241 is provided midway the ends thereof with support rings 252 and 253 that are formed of non-magnetic material for the reasons set forth hereinbefore. As indicated in Figures 28 and 29, the support ring 253 is secured to the outer surface of the insulator bushing 241 by a suitable cement, as indicated at 254. It will further be observed that the support ring 253 is provided with outwardly extending flanges 255 and downwardly extending flanges 256 at right angles thereto for interfitting with side frame members 257 in the form of channel-shaped structural members. It will be understood that angles rather than channels may be employed. With a view to providing relatively high strength and, at the same time, an economical construction, the side frame members 257 may be formed of steel. When the side frame members 257 are positioned as shown in the drawings, their magnetic properties are not of importance, since they are not positioned as to be materially affected by the magnetic field generated by the alternating current flowing through the circuit in which the switch 221 is connected. Bolts 258 and 259 are provided for securing the support ring 253 to the side frame members 257, as indicated. If it is desired to provide additional transverse members between the side frame members 257 in addition to the support rings 252 and 253, end frame members 260 may be provided and secured to the ends of the side frame members 257 by suitable tap bolts 261. The end frame members 260 are formed of non-magnetic material in order to prevent the induction of eddy currents therein and in the side frame members 257, as will be readily understood. Suitable apertures may be provided in the end frame members 260 for mounting the entire switch assembly in a suitable support structure.

It will be obvious that the switch 221 may be mounted for rear connection on a switchboard panel rather than for mounting in the open type of framework as illustrated in Figure 27. In such case the insulators 240 and 241 would be omitted, and in lieu thereof suitable apertures would be provided in the switchboard panel and the necessary holding means would be provided to secure the switch 221 in position, as will be readily understood.

As indicated hereinbefore, it is desirable to provide a ventilated construction for the base that supports the switch clips rather than to provide a solid block from which the heat generated therein is not readily dissipated. For this purpose each clip base is constructed of a plurality of plates or laminations of copper that are spaced apart by suitable spacers positioned at

selected positions therebetween in such manner as to permit the circulation of air therethrough to effect the desired ventilation. The spacers are located in such positions that tapped holes may be provided for mounting the clip base on the supporting structure and for securing the switch clips thereto. A typical type of ventilated clip base construction is illustrated in Figures 30 through 33, to which reference will now be had. The clip base 231 there shown is similar in construction to the clip bases 12 and 13 shown in Figure 1 of the drawings. In the present embodiment, the clip base is arranged for rear connection rather than for front connection as shown in Figure 1. Otherwise the features of construction are essentially the same.

As indicated in Figure 33, the switch clips 229 are mounted on the outermost plate or bar of the switch clip base 231 by screws 264, two of which are positioned at each end thereof. The screws 264 are positioned in tapped holes that extend through the top two plates forming the clip base 231. Spacers 265, in the form of flat copper straps, are positioned between these two plates to space them apart and to provide sufficient body for the tapped holes. Additional small square spacers 266 are provided between each of the plates forming the clip base 231 in alignment with the stud bolts 258, and suitable tapped holes are provided therein. As shown more clearly in Figure 31, the spacers 265 and 266 are secured in position by means of rivets 267, 268 and 269 of suitable length, as required. Additional spacers 270 are provided in alignment with the fulcrum members 238, and tapped holes 271 are provided therein for bolts 272.

It will be noted that the construction of the switch clip 231, as described thus far, is such as to permit the circulation of air between the plates, with the result that any heat that is generated therein is readily dissipated. If the clip base were arranged for front connection, the plates forming it would be provided with suitable extensions to permit the connection of conductors thereto as indicated in Figure 1 of the drawings. For such a construction the various spacers and plates forming the switch clip base would first be tinned and then assembled with a suitable flux therebetween. The various lengths of rivets will be inserted as required. The entire assembly is then subjected to sufficient heat to cause the tinned surfaces to be sweated together, thereby forming a substantially unitary construction.

Advantage is taken of the open type of construction of the clip bases for ventilating purposes to provide a novel form of connection thereto for a rear connected disconnecting switch. While this form of connection is illustrated and has particular utility in connection with clip bases, it will be understood that it may be employed for making connections between the various connections in a bus structure. For example, the laminations or plates forming the clip base may be considered as a part of a bus conductor to which a connection is to be made. In either case, a ventilated type of construction results that reduces the number of hot spots that might otherwise be present if the conventional type of connection were made.

As illustrated more clearly in Figures 31 and 32 of the drawings, the innermost plate or lamination of the clip base 231 is provided with a rectangular opening 275 having a width that is slightly greater than the width of the conductor members 233. The outermost conductor members 233 have the ends thereof turned in opposite directions as indicated at 276, and they are secured to the next plate or lamination of the clip base 231 as by rivets 277. Each succeeding plate or lamination is provided with a rectangular aperture having the same width as the aperture 275, but having successively shorter lengths, excepting the outermost lamination, and the ends of the next succeeding pair of conductors 233 are turned outwardly and secured in position by rivets. It will be understood that the engaging surfaces of the plates or laminations forming the clip base 231 and the outwardly turned ends of the conductor members 233 will be tinned, and a suitable flux will be inserted therebetween during the assembly process. The entire clip base 231 with the rearwardly extending conductor members 233 is then heated to the necessary temperature to sweat the various engaging surfaces together, as will be readily understood. It will be apparent that this construction provides a very intimate contact engagement between the clip base and the conductor members associated therewith, while at the same time it retains the advantages of the spaced apart relationship for ventilating purposes. As a result, the actual amount of material that is used in constructing the clip bases for a given current carrying capacity may be considerably reduced over that required when the conventional type of construction is used.

Instead of employing a laminated construction for the conductor members 232 and 233, a solid threaded cylindrical conductor may be employed. Such a construction would not provide the relatively large radiating surface that is provided by the laminated construction. However, it may be desirable to use it in some instances. In such case, correspondingly threaded apertures would be provided in the clip bases 230 and 231, and the cylindrical conductor members, on being screwed into them, would be sweat-soldered in position.

I have found it desirable to incorporate the prestressed high pressure low area contact finger construction in a switch of the multi-pole double throw type, such as may be used for shifting a polyphase synchronous converter from the starting to the running connections. For large sizes of synchronous converters, the switch must carry relatively high currents in the starting as well as in the running position. In addition, relatively large capacity quick break switch means should be provided for preventing arcing between the main switch blades and switch clips when the switch is operated from the starting to the running position. Although such a switch will necessarily be of relatively massive construction, its operation should be relatively easy in order to require the exertion of a minimum of effort for operating it.

When the prestressed contact finger construction is employed in a switch of this type that requires a movement within a relatively narrow range in order to effect complete disengagement of the contact members, it is possible to provide a compact construction and at the same time provide the necessary electrical clearances between the relatively movable switch members. Moreover, because of the narrow range of movement during which a relatively large force is required to effect the engagement and disengagement of the contact members, it is possible to employ a variable ratio lever system for effecting the move-

ment of the switch blades to and from either switch closed position, and at the same time requiring the exertion of a minimum effort.

The construction and functioning of a switch of this type are illustrated in Figures 34, 35, 36 and 37. While a multi-pole double throw switch is there shown, it will be understood that the operating mechanism may be employed for a single throw single pole switch if desired.

Referring first to Figures 34 and 35 of the drawings, it will be observed that the multi-pole double throw switch is indicated generally at 280. In the embodiment of the switch 280 there shown, it comprises three poles that are designated generally as 281, 282 and 283. Since the construction of these poles is essentially the same, only one of them will be described in detail and reference characters applied thereto.

As illustrated, the pole 281 comprises a pair of outside switch blades 285 and 286 and an intermediate switch blade 287. At their upper ends, the switch blades 285 and 286 are arranged to engage switch clips 288 and at their lower ends they are arranged to engage switch clips 289. It will be observed that only two switch clips 288 are provided at the upper end, while three switch clips 289 are provided at the lower end. It will further be observed that the intermediate switch blade 287 is slightly more than half as long as the outside switch blades 285 and 286. This construction is employed since the switch 280 is maintained in the upper or starting position during only a comparatively short time, while it remains in its lower or running position indefinitely. The current carrying capacity for the starting position, therefore, is not required to be as great as for the running position. The switch clips 288 and 289 are mounted on clip bases 290 and 291 that are provided with rearwardly extending conductor members 292 and 293. If desired, the construction of the clip bases 290 and 291 and the conductor members 292 and 293 connected thereto may be as illustrated in Figures 31 and 32 of the drawings and described hereinbefore.

The switch blades 285, 286 and 287 are rotatably mounted on a shaft in the form of a bolt 294 that extends transversely through the upstanding side members of intermediate switch clips 295 that are mounted on a suitable clip base 296 having rearwardly extending conductor members 297. It will be understood that the conductor members 292, 293 and 297 may be positioned as illustrated, or at any other suitable angle, depending upon the location of the busses to which the various switch members are to be connected.

The switch blades 285, 286 and 287 are provided with prestressed apart contact fingers 298 and 299 adapted for high pressure low area contact as indicated, and similar contact fingers 300 intermediate the ends thereof. The contact fingers 298 and 299 are arranged to engage corresponding inserts in the switch clips 288 and 289. Two rows of inserts 301 and 302 are provided in the outside switch clips 295 for engaging the corresponding inserts in the contact fingers 300 when the switch blades are operated to either switch closed position. Only a single row of inserts 302 will be provided in the upstanding sides of the intermediate switch clip 295. It will be understood that the construction of the contact fingers 298, 299 and 300 may either be as illustrated in Figure 14 or in Figure 18 for the purpose of obtaining the desired contact effect.

Since considerable current must be broken when the switch 280 is operated from the upper position to the lower position and severe arcing may result, a pair of quick break switch blades 305 is rotatably mounted on a pin 306 that extends transversely through the switch blades 285 and 286. A spring 307 is provided around the pin 306 for biasing the blades 305 in a clockwise direction, as viewed in Figure 35, for effecting the quick break action, which movement is limited by a stop pin 308 that also extends transversely through the switch blades 285 and 286. As indicated more clearly in Figure 36 of the drawings, the switch blades 305 are arranged to have contact engagement with a prestressed contact finger assembly 309 which may be constructed as illustrated either in Figure 14 or Figure 18 of the drawings. It will be understood that the contact finger assembly 309 is arranged to engage suitable inserts along the inner surfaces of the blades 305. A transverse pin 310 is provided at the upper end of the blades 305 for engagement with a latch 311 that is rotatably mounted on a pin 312 that is suitably supported between the switch clips 288, as illustrated. A spring 313 serves to bias the latch 311 in a clockwise direction, as viewed in Figure 36, and its movement in this direction is limited by a stop pin 314. Sufficient current carrying capacity is provided by the prestressed contact finger assembly 309 during the transfer operation and after the contact fingers 298 have been moved out of engagement with the switch clips 288. Whatever arcing occurs takes place between the upper ends of the blades 305 or the pin 310 and the latch 311. These parts are readily replaceable and are relatively inexpensive as compared to the contact fingers 298. Barriers 315 of suitable insulating material are positioned between the switch clips 288 and alongside of the upper ends of the blades 305 in order to confine the arcing therebetween and prevent injury to the contact fingers 298 and the switch clips 288.

As indicated hereinbefore, each of the three poles forming the switch 280 is identical in construction with the other poles. The manner in which the switch blades of each pole are commonly operated will now be set forth.

Referring now particularly to Figures 34 and 35 of the drawings, it will be observed that a shaft 318, surrounded by a suitable tube 319 of insulation, extends through each of the blades 285, 286 and 287 of each of the switch poles 281, 282 and 283, and that it extends slightly beyond the two outer poles. It will be readily understood that the tube 319 of insulation is provided to prevent short circuiting of the switch poles by the shaft 318 which is preferably formed of metal in order to provide the desired strength. The shaft 318 and surrounding tube 319 are rotatably mounted in the switch blades of each switch pole for a purpose which will presently be apparent. At each end of the shaft 318 an arm 320 is secured, on the lower end of each of which a roller 321 is positioned. The rollers 321 are guided in slotted openings 322 that are positioned in upstanding guide members 323 which may be secured, as by bolts 324, to the panel or base 284, as illustrated. It will be observed that the slotted openings 322 are positioned in alignment with the bolts 294 forming the axis of rotation of the switch blades in each switch pole and the shaft 318 when the switch is in the intermediate position, as shown in Figure 35. An operating handle 325 is secured to the shaft 318 and tube 319 of insulation surrounding it by suitable clamps 326,

and it rotates therewith. As illustrated, the handle 325 is of such shape as may readily be grasped by one hand, and it is secured between a pair of arms 327, formed preferably of insulating material, to which the clamps 326 are secured. A guard 328, formed preferably of insulating material, is positioned between the arms 327 and between the handle 325 and the switch blades for the purpose of protecting the hand of the operator from any arcs that may be drawn on operation of the switch, and from accidental contact with current carrying parts of the switch.

When the handle 325 is in the position shown in Figures 34 and 35 of the drawings, the switch blades 285, 286 and 287 of the three poles of the switch 280 are in the intermediate position, and the contact fingers 298 and 299, carried thereby, are spaced from the switch clips 288 and 289 at a distance that is generally determined by the voltage on the circuit in which the switch is connected. The movement of the handle 325 in the direction indicated by the broken line 329 in Figure 35 causes a corresponding movement of the switch blades to engage the upper switch clips 288. Likewise, when the handle 325 is moved in the direction indicated by the broken line 330 in this same figure, the switch blades are moved or rotated about the shafts 294 to engage the lower switch clips 289.

As indicated, the switch blades 285, 286 and 287 of each of the poles rotate about a common stationary axis that extends through the shafts or bolts 294 that are positioned in the stationary intermediate switch clips 295. The handle 325 that is attached to the arms 327 rotates with the shaft 318 relative to the switch blades 285, 286 and 287, thereby rotating about an axis that itself rotates about the stationary axis formed by the shafts or bolts 294, and, at the same time, it also rotates about the axis of the rollers 321 that are guided in the slotted openings 322. It will be noted that the axis of the rollers 321 moves substantially in a plane containing the stationary axis about which the switch blades rotate, which plane is substantially normal to the base or panel 284.

The rotation of the handle 325 about the axis of the shaft 318 is controlled by the movement of the rollers 321 in the slots 322. It will be recalled that the rollers 321 are carried by the arms 320 that are secured to and rotate with the shaft 318. It will then be understood that the arms 320, shaft 318 and its tube 319 of insulation surrounding it, arms 327 clamped thereto, and handle 325, constitute a single operating member or lever for effecting the movement of the switch blades 285, 286, and 287 into either of the switch closed positions.

Considering first the movement of the handle 325 in the direction, indicated by the broken line 329, to operate the switch 280 to the upper position into engagement with the switch clips 288, it will be observed that initially the handle 325 moves substantially conjointly with the switch blades 285, 286, and 287. However, during the initial movement of the switch blades, it is only necessary to overcome the force of gravity and whatever friction may be present tending to prevent rotation of the switch blades. The single operating member or lever operates during this initial movement at a relatively slight mechanical advantage, which operation is desired because of the relatively little force required to move the switch blades. During this initial movement, the axis of the rollers 321 will be moved to the point indicated at 331 in Figure 36, and the handle 325 and the arms 327 will then lie along a position indicated by the broken line 332. At the same time, the axis of the shaft 318 will have moved to a position indicated by the point 333, and the center line of the switch blades 285, 286 and 287 will lie along the broken line indicated at 334. In order to effect the final movement of the switch blades to the switch closed position, it is only necessary to move the axis of the shaft 318 from the position indicated at the point 333 to the position indicated at 335, during which movement the handle 325 and arms 327 are moved through a relatively great distance from the position indicated by the broken line 332 to the position shown by the full lines in Figure 36. During this final portion of the movement of the operating arm or lever, it operates at a relatively great mechanical advantage to move the contact fingers 298 into contact engagement with the switch clips 288. It is during this final relatively narrow range of movement that considerable force must be exerted in order to overcome the frictional engagement between the prestressed contact fingers 298 and the switch clips 288. Since this frictional engagement takes place only during a relatively narrow range of movement of the switch blades to and from the switch closed position, the switch is particularly adapted for operation in connection with the lever mechanism that operates first at a slight mechanical advantage during the principal portion of the movement of the switch blades, and then during the final movement thereof through a narrow range, it operates at a relatively great mechanical advantage. As a result, a minimum of effort is required to be exerted by the operator in moving the switch to and from the switch closed position.

Since the switch blades 305, forming the quick break attachment, are positioned in front of the stop pin 308, they are forced into contact engagement with the prestressed contact fingers 309, as will be readily understood. The pin 310 forces the latch 311 to rotate in a counterclockwise direction as the switch blades 285, 286 and 287 are being rotated to the upper switch closed position, and when they reach this position the head of the latch 311 engages the pin 310, as indicated in Figure 36.

On movement of the handle 325 from its position indicated in Figure 36 to move the contact fingers 298 out of engagement with the switch clips 288, the reverse of the foregoing described operation takes place. That is, the operating mechanism or lever formed by the arms 320, the shaft 318, the arms 327 and the handle 325 operate first at a relatively great mechanical advantage in order to pry the contact fingers 298 out of contact engagement with the switch clips 288. After this operation has been completed, it will be understood that the operating arm or lever operates with a decreasing mechanical advantage, and finally moves conjointly with the switch blades 285, 286 and 287 at the intermediate position thereof.

Because of the engagement of the pin 310 by the latch 311, the switch blades 305 are not immediately released on movement of the switch blades 285, 286 and 287 as just described. Movement of these blades takes place until the contact fingers 298 carried thereby are moved to a substantial distance from the switch clips 288, at which time the entire current is carried by the switch blades 305 and the prestressed contact

fingers 309. It will be understood that the switch blades 305 rotate about the pin 306 to such a position that the pin 310 is released from the latch 311, and the switch blades 305 are then operated with a snap action under the influence of the spring 307 to provide a final quick break in the circuit.

In Figure 37 of the drawings, I have illustrated the relative position of the various parts of the switch 280 when it has been operated to the lower position. The initial movement of the operating lever formed by the arms 320, shaft 318, arms 327, and handle 325 downwardly initially takes place substantially conjointly with the movement of the switch blades 285, 286 and 287. During the initial movement, the operating lever operates at a slight mechanical advantage. The continued movement of the operating lever finally causes it to operate at a relatively great mechanical advantage to effect the final movement of the contact fingers 299 into contact engagement with the switch clip 289 in the manner described hereinbefore.

The operating lever formed by the arms 320, shaft 318, arms 327, and the handle 325, not only serves to effect the movement of the switch blades 285, 286 and 287 of the three poles of the switch 280 in the desired manner, but, by virtue of the particular construction and arrangement thereof in connection with the guide members 323 and the slots 322 therein, it serves to lock the switch 280 in either of the closed positions. It will be observed that the plane containing the axes of the shaft 318 and the rollers 321 is inclined from the vertical toward the switch base or panel 284 in either of the switch closed positions shown in Figures 36 and 37. Any component of force applied to the switch blades 285, 286 and 287 that would tend to move them from either of the switch closed positions is resolved into a component in either of these planes that reacts with the outer ends of the slots 322 and cannot in any way be effective to open the switch as long as the operating lever remains in either of the positions shown in these figures. The plane containing these two axes must not only be rotated to a vertical position, as viewed in these two figures, but it must be rotated to a position beyond the vertical before the switch 280 is unlocked from either of its switch closed positions.

It is again pointed out that the combined operating and locking features of the mechanism shown in Figures 34, 35, 36 and 37 may be incorporated in a single pole single throw switch, or in a multi-pole single throw switch as will now be readily apparent.

In Figures 38 and 39 of the drawings, I have illustrated a single pole double throw switch of high amperage capacity that is particularly adapted for relatively low voltage applications such as occur in electrolytic or battery charging apparatus. In such applications, little consideration need be given to electrical clearances, and for this reason only a slight break distance between the relative movable switch members is required. The switch indicated generally at 340 is of this type.

The switch 340 comprises a pair of stationary switch members 342 and 343 that are mounted on suitable insulating support members 344 and 345 that are suitably secured to a panel or base 346. The switch members 342 and 343 are provided with suitable apertures 348 and 349 through which suitable bolts may be positioned for securing the bus conductors thereto. In the particular embodiment of the switch 340 illustrated, it is arranged for front connection. If desired, the stationary switch members 342 and 343 may be positioned at right angles to the positions illustrated, and they may extend through the panel or base 346 to provide for rear connection thereto.

Each of the stationary switch members 342 and 343 is provided with a row of inserts 350 and 351 that are arranged to be engaged by corresponding inserts 352 in prestressed apart contact fingers 353 that are carried by and secured to a switch blade 354. Each of the stationary switch members 342 and 343 comprises a pair of spaced apart copper bars having the flat head portions of the inserts 350 and 351 on the inner surfaces thereof for contact engagement with the corresponding silver inserts 352 in the contact fingers 353. It will be understood that the contact finger construction may be either as illustrated in Figure 14 or as illustrated in Figure 18. However, attention is directed to the fact that the contact fingers 353 are secured at their intermediate portions to the switch blade 354 and that the ends thereof are slotted to provide the bifurcated construction at each end rather than to provide two individual contact fingers.

It will be noted that the switch blade 354 is mounted for rotation on a shaft formed by a bolt 355 that extends transversely through the upstanding side members of a switch clip 356 having rearwardly extending conductor members 357 for rear connection thereto. At its lower end the switch blade 354 is provided with contact fingers 358 having inserts 359 therein for engaging either of two sets of inserts 360 or 361 in the side members of the switch clip 356. It will be understood that the two sets of inserts 360 and 361 are provided for registration with the inserts 359 in either of the switch closed positions.

Mounted on the support members 344 and 345 and extending therebetween is a pair of brackets 364 having slotted openings 365 intermediate the ends thereof in alignment with the bolt 355. A shaft 366 is rotatably mounted in a suitable bushing 367 of insulation in the switch blade 354, and it has secured thereto a pair of arms 368. Rollers 369 are mounted on the arms 368 and are arranged to move in the slotted openings 365 in the brackets 364. A socket 370 is mounted on the shaft 366 for rotation therewith, and an operating arm or handle 371 is inserted therein.

The functioning of the operating mechanism for the switch 340 is similar to that for the switch 280 shown in Figure 34 of the drawings and described hereinbefore. When the handle 371 is moved from its position as shown in Figure 38, its movement will be initially substantially conjoint with the movement of the switch blade 354 about the shaft or bolt 355 as an axis. During this initial portion of its movement, it operates at a relatively slight mechanical advantage. During the final portion of the movement of the handle 371, during which the switch blade 354 is moved only through a distance sufficient to provide the required contact engagement between the contact fingers 353 and the stationary switch member 342, it operates at a relatively great mechanical advantage to permit the movement to the final switch closed position by the exertion of a minimum of effort. In moving the switch blade 354 from either of the closed positions, this functioning will be reversed, as will be readily understood.

As illustrated in Figure 39, the axes of the shaft 366 and of the rollers 369 are positioned in a

plane that is slightly inclined to the vertical. In this position the switch blade **354** is locked in the switch closed position and cannot be moved therefrom until the handle **371** is rotated from the switch closed position and past the dead center position.

It will be understood that the stationary switch members **342** and **343** each comprises a pair of spaced apart plate-like members between which the contact fingers **353** are positioned. This spacing may be such that it is inconvenient to connect the circuit conductors thereto without using one or more spacers. It is possible to construct the stationary switch members **342** and **343** of single plate-like members to facilitate connection thereto.

Such an alternate construction is illustrated in Figures 40 through 44 of the drawings, in which the arrangement and construction of the switch blade **354** are illustrated in conjunction with the prestressed contact fingers and one stationary switch member to illustrate how the modified construction may be made. Since the upper stationary switch member will be a duplicate of the lower stationary switch member, only the latter has been illustrated. Instead of employing a pair of spaced apart plate-like switch members **343**, I have provided a single stationary switch member **375** that is arranged to be engaged by flexible contact fingers **376** which are secured to the switch blade **354** by rivets **377** and spaced therefrom by suitable thin spacers **378**. The switch member is provided with a plurality of inserts **379** that are engageable by corresponding inserts **380** in the individual sections of the fingers **376** that are formed by the longitudinal slots **381** in the manner described hereinbefore. The inserts **379** and **380** are formed preferably of silver in order to provide the desired contact surface conditions.

The contact fingers **376** are biased toward each other by a coil tension spring **382**, the ends of which are hooked around a reduced central portion **383** of equalizers, one of which is shown generally at **384** in Figure 44 of the drawings. The equalizers **384** are generally dumb-bell shape, having enlarged rounded ends **385** that fit in correspondingly shaped recesses **386** in the sections of the fingers **376** formed by the slots **381**. It will be observed that the recesses **386** are centrally located in each of the sections of the fingers **376**. It will also be observed that the intermediate portions of the equalizers **384** are spaced from the outside surfaces of the contact fingers **376** so that the spring **382** is caused to react substantially individually on each of the individual sections of the fingers **376** to, in effect, provide for individually biasing the same.

The movement of the contact fingers **376** toward each other under the influence of the tension spring **382** is limited by the switch blade **354** itself. The proportions are such that the heads of the inserts **380** are positioned slightly within the path of relative movement with the stationary switch member **375**, the adjacent end of which is beveled as at **387** in order to wedge the heads of the inserts **380** outwardly to apply the full resilient force of the spring **382** for making the desired pressure contact engagement between the inserts **379** and **380**.

When the switch blade **354** is moved in the direction indicated by the arrow **388** in Figure 40, the heads of the inserts **380** are caused to engage the beveled edges **387** of the stationary switch member **375**, and the contact fingers **376** are lifted from engagement with the edge of the switch blade **354**. The continued movement in the direction indicated by the arrow **388** finally causes the inserts **380** to engage the heads of the inserts **379** in the stationary switch member **375**. The operating mechanism, previously described, provides the necessary stop for accurately aligning the inserts **379** and **380**.

In the construction of a double throw switch, it may be desirable to stationarily mount the prestressed contact fingers and to rotatably mount the switch blade for engaging them rather than to position the prestressed fingers on the blade. When the prestressed contact fingers are stationarily mounted, the construction of the switch blade is considerably simplified, and in some modifications it is less expensive. Such a switch is illustrated in Figures 45, 46 and 48 to which reference may now be had.

As there shown, I have provided a single pole switch **391** that may be mounted on a suitable base **392** of insulating material. The switch **391** comprises a common stationary switch member, shown generally at **393**, and upper and lower stationary switch members that are shown generally at **394** and **395**, respectively. Terminal straps **397**, **398** and **399** individual to the switch members **393**, **394** and **395**, respectively, are provided with suitable apertures to permit connection thereto of the circuit conductors.

The common switch member **397** is provided with two sets of prestressed apart contact fingers **400** and **401**, while the upper and lower switch members **394** and **395** are provided, respectively, with sets of prestressed apart contact fingers **402** and **403**. It will be understood that the contact fingers **400**, **401**, **402** and **403** may be of the bifurcated construction described hereinbefore, or they may be individual contact fingers, or they may be cut from a single plate of conducting material such as copper.

A switch arm, shown generally at **404**, is provided, and it comprises a pair of switch blades **405** and **406** that are secured together by rivets **407** extending transversely therethrough and through spacers **408** that serve to space the blades **405** and **406** apart, as will be readily understood. The switch arm **404** is rotatably mounted on a bolt **409** that is mounted in a fulcrum member **410** carried by the common switch member **393**. A pull ring **411** is provided between the switch blades **405** and **406** in order to permit operation of the switch arm **404** by a hook stick.

The contact engaging portions of the contact fingers **400** are arranged to engage an insert **412** when the switch arm **404** is in the position shown in the drawings by full lines, and the contact fingers **401** are arranged to engage an insert **413** located adjacent the opposite edges of the switch blades **405** and **406** when the switch arm **404** is operated to the position shown by the broken lines. In like manner, the contact fingers **402** are arranged to engage an insert **414** when the switch arm **404** is in the position shown by the full lines, and the contact fingers **403** are arranged to engage an insert **415** when it is moved to the alternate position.

As illustrated more clearly in Figure 47 of the drawings, the contact fingers **400** are provided with inserts **416** having headed ends of small radius to provide small area contact engaging portions with the inserts **412**. A compression spring **417** positioned as described hereinbefore, between the ends of the fingers **400**, serves to provide the desired contact pressure. The move-

ment apart of the contact fingers 400 when the inserts 416 are out of engagement with the switch blades 405 and 406 is limited by stop members 418 that are secured to the common switch member 393 and are in the form of relatively rigid plates. The stop members 418 are spaced apart sufficiently far to position the heads of the inserts 416 slightly within the path of relative movement with the switch blades 405 and 406. The contact fingers 401 are provided with like stop members 419. The contact fingers 402 and 403 are also provided with stop members 420 and 421 which are slightly higher than the stop members 418 and 419. The stop members 420 and 421 not only serve to limit the movement apart of the contact fingers 402 and 403, but also they serve as a stop for the movement of the switch arm 404 to the closed position with either the switch member 394 or the switch member 395. This construction insures that the heads of the inserts 416 will be accurately aligned with the corresponding inserts 412, and likewise that the similar inserts in the other contact fingers will be aligned with their respective strips in the switch blades 405 and 406.

The inserts 412, 413, 414 and 415 are preferably formed of solid silver. These inserts may be constructed as described in my copending application, Serial No. 115,694, filed December 14, 1936, and assigned to the assignee of this application. For the reasons set forth hereinbefore, it is preferable that the inserts 416 be formed of silver also.

Since it is necessary to move the contact fingers 400, 401, 402 and 403 inwardly away from the associated stop members 418, 419, 420 and 421, respectively, the opposite edges of the switch blades 405 and 406 that first engage the inserts carried thereby are beveled to readily permit the necessary wedging action and, at the same time, to reduce to a minimum the wear on the inserts. In this manner, each of the individual contact fingers is completely lifted away from the corresponding stop member and, in a sense, each acts individually in making contact engagement with the insert in the switch blades 405 and 406. When this construction is employed, it is unnecessary to initially align the contact fingers with a high degree of accuracy or to maintain them in alignment with a high degree of accuracy, since each contact finger is individually flexible and substantially individually stressed.

In Figures 49 and 50 of the drawings, I have illustrated a switch construction that is similar to the construction illustrated in Figures 21 and 22 and described hereinbefore. As shown in Figures 49 and 50, I have provided a substantially U-shaped stationary switch member 424 that may be mounted by a screw 425 on a base member 426. Inserts 427 are provided in the walls of the U-shaped switch member 424, and have headed ends that project inwardly for contact engagement with corresponding inserts 428 in contact fingers 429. The contact fingers 429 are carried by a pair of spaced apart switch blades 430, and they are biased apart by the compression spring 431 that is aligned with the inserts 428. Saw cuts 432 may be provided in the contact fingers 429 adjacent the ends that are secured to the switch blades 430 in order to provide the required degree of flexibility without substantially interfering with the current carrying capacity thereof. In this embodiment of the invention, the inserts 428 in the contact fingers 429 are provided with flattened contact engaging portions for engagement with the headed ends of the inserts 427. The ends of the contact fingers 429 are beveled as indicated at 433, in order to engage the headed ends of the inserts 427 with the desired wedging action to lift the contact fingers 429 from their position in engagement with the inner edges of the switch blades 430 as shown in Figure 50.

As illustrated in Figure 50, the compression spring 431 serves to bias the contact fingers 429 in the directions indicated by the arrows 434. The switch blades 430 are spaced apart sufficiently to position the flattened ends of the inserts 428 slightly within the path of relative movement with the headed ends of the inserts 427. When the switch blades 430 are moved in the direction indicated by the arrow 435, the contact fingers 429 are lifted from engagement with the inner edges of the switch blades 430 as soon as the beveled ends 433 engage the headed ends of the inserts 427. The full resilient force of the spring 431 is then available to provide the required contact pressure between the small areas in engagement between the inserts 427 and 428. The movement of the switch blades 430 in the direction indicated by the arrow 435 is limited by the outer edges of the stationary switch member 424 to accurately align the inserts 428 with the inserts 427.

As indicated hereinbefore it is preferable to form the inserts 427 and 428 of pure silver in order to provide the desired contact surface conditions.

In the various types of switch construction disclosed herein, in which inserts are employed on the fixed end movable switch members, it is necessary that the inserts be accurately aligned so that full advantage may be taken of them. The various operating mechanisms described hereinbefore serve to effect this purpose. In the embodiments of the invention in which an operating mechanism is not employed to pry the switch blade into and out of engagement with the stationary switch member, suitable stops are provided by the design of the stationary switch member to limit the movement of the switch blade toward the switch closed position.

It will now be apparent that the use of multiple small area high pressure contact fingers that are individually resilient and prestressed has made possible the construction of switches having improved operating characteristics. Since only a limited degree of relative movement is required to disengage the switch members, it has been possible to take advantage of operating mechanisms that have heretofore been impractical when a conventional knife blade design has been employed. It has also been possible to combine the locking of the switch blade in the closed position with the mechanism that is employed to pry the switch blade into and out of the switch closed position. This construction has also made feasible the use of solid silver inserts to provide the contact engaging portions between the relatively movable switch members. Since the area of contact engagement is comparatively small, only a relatively small amount of silver is required, and consequently the use of this expensive metal becomes practical.

In all of the embodiments of the invention disclosed herein, the flexible contact fingers are of relatively large cross-sectional area. This construction provides a relatively great short-time current capacity that is required under short circuit conditions. Momentarily, this construction

is capable of withstanding severe short circuits, which is not the case when wire contact fingers are employed under comparable operating conditions.

Since certain further changes may be made in the above constructions and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. A switch comprising, in combination, a stationary switch member including a pair of upstanding contact members, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of prestressed apart contact fingers carried by said movable switch member and disposed to engage said upstanding contact members, and means extending transversely through said contact fingers for limiting movement thereof away from each other.

2. A switch comprising, in combination, a stationary switch member including a pair of upstanding contact members, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of prestressed apart contact fingers carried by said movable switch member and disposed to engage said upstanding contact members, a small radius contact engaging portion extending from each of said contact fingers and forming the contact engaging portions with said contact members, and means extending transversely through said contact fingers for limiting movement thereof to positions slightly within the path of relative movement with said upstanding contact members.

3. A switch comprising, in combination, a stationary switch member including a pair of upstanding contact members, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of spaced apart contact fingers carried by said movable switch member and disposed to engage said upstanding contact members therebetween, spring means biasing said contact fingers apart, and stop means extending transversely through said contact fingers for limiting movement thereof apart.

4. A switch comprising, in combination, a stationary switch clip having a pair of spaced apart rigid jaws, a relatively wide switch blade mounted for movement in a plane between said jaws, a plurality of pairs of individually flexible prestressed apart contact fingers carried by said switch blade, said contact fingers being coextensive with and extending transversely across and beyond one edge of said switch blade, and a small radius high pressure contact engaging portion on each of said contact fingers substantially in the plane including said edge of said switch blade and constituting the sole contact engaging portions between said switch blade and said switch clip, said jaws of said switch clip being coextensive with said switch blade for a limited extent sufficient to permit contact engagement therewith by said contact engaging portions whereby limited movement of said switch blade is required to operate it to and from electrical connection with said switch clip.

5. A switch comprising, in combination, a stationary switch member including a pair of upstanding contact members, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of prestressed apart bifurcated contact fingers carried by said movable switch member and disposed to engage said upstanding contact members, and stop means extending transversely through said contact fingers for limiting movement thereof.

6. A switch comprising, in combination, a stationary switch member including a pair of upstanding contact members, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of bifurcated contact fingers carried by said movable switch member and disposed to engage said upstanding contact members, a small radius contact engaging portion extending from each branch of each contact finger and forming the contact engaging portions with said upstanding contact members, and stop means extending transversely through said contact fingers for limiting movement of said small radius contact engaging portions on said branches to positions slightly within the path of relative movement with said upstanding contact members.

7. A switch comprising, in combination, a stationary switch member including a pair of upstanding contact members, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of bifurcated contact fingers carried by said movable switch member and disposed to engage said upstanding contact members, resilient means for biasing said contact fingers into engagement with said contact members, and stop means extending transversely through said contact fingers for limiting movement thereof apart.

8. A switch comprising, in combination, a stationary switch member including a pair of upstanding contact members, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of bifurcated contact fingers carried by said movable switch member and disposed to engage said upstanding contact members, resilient means for biasing said contact fingers into engagement with said contact members, a silver insert in each branch of each contact finger and corresponding silver inserts in said contact members forming the contact engaging portions therebetween, and stop means extending transversely through said contact fingers for limiting movement of said silver inserts carried by said branches to positions slightly within the path of relative movement with said upstanding contact members.

9. A switch comprising, in combination, a stationary switch member, a switch blade movable relative to said switch member to open and close an electric circuit, a pair of flexible contact fingers anchored on opposite sides of said switch blade along the edge remote from said switch member and extending beyond the edge adjacent said switch member, and spring means interposed between said contact fingers for biasing them toward contact engagement with said switch member.

10. A switch comprising, in combination, a stationary switch member, a switch blade movable relative to said switch member to open and close an electric circuit, a pair of flexible contact fingers anchored on opposite sides of said switch blade along the edge remote from said switch member and extending beyond the edge adjacent said switch member, spring means interposed between said contact fingers for biasing them toward contact engagement with said switch mem-

ber, and stop means for limiting the movement of said contact fingers.

11. A switch comprising, in combination, a stationary switch member, a switch blade movable relative to said switch member to open and close an electric circuit, a pair of prestressed apart contact fingers fastened on opposite sides of said switch blade along the edge remote from said switch member and extending beyond the edge adjacent said switch member for engaging it, and stop means for limiting the movement of said contact fingers with respect to each other to positions slightly within the path of relative movement with said switch member.

12. A switch comprising, in combination, a stationary switch member, a switch blade movable relative to said switch member to open and close an electric circuit, a pair of flexible contact fingers anchored on opposite sides of said switch blade along the edge remote from said switch member and extending beyond the edge adjacent said switch member, spring means interposed between said contact fingers for biasing them toward contact engagement with said switch member, silver inserts in said contact fingers and in said switch member forming the contact engaging portions therebetween, and stop means for limiting the movement of said contact fingers in such manner as to position said silver inserts carried thereby slightly within the path of relative movement with said silver inserts in said switch member.

13. A switch comprising, in combination, a stationary switch member, a switch blade movable relative to said switch member to open and close an electric circuit, a pair of prestressed apart contact fingers fastened on opposite sides of said switch blade along the edge remote from said switch member and extending beyond the edge adjacent said switch member for engaging it, inserts in said contact fingers and in said switch member forming the contact engaging portions therebetween, and stop means for limiting the movement of said contact fingers in such manner as to position said inserts carried thereby slightly within the path of relative movement with said inserts in said switch member.

14. In a switch for opening and closing an electric circuit, in combination, a switch blade disposed to be mounted for movement relative to a stationary switch member, a pair of prestressed apart contact fingers fastened on and spaced slightly from opposite sides of said switch blade along the edge remote from said switch member and extend across said switch blade and beyond the edge adjacent said switch member for engaging it, and stop means for limiting the movement of said contact fingers with respect to each other to positions slightly within the path of relative movement with said switch member.

15. In a switch for opening and closing an electric circuit, in combination, a switch blade disposed to be mounted for movement relative to a stationary switch member, a pair of flexible contact fingers having centrally located aligned apertures near one end and anchored at the other end on opposite sides of said switch blade along the edge remote from said switch member and extending beyond the edge adjacent said switch member for engaging it, means at the anchored end for spacing said contact fingers away from the adjacent sides of said blade, a coil spring disposed coaxially with said apertures for biasing said fingers apart, an inwardly extending ridge on each of said contact fingers providing the sole engagement with the ends of said spring, and stop means slidably mounted in said apertures and having headed ends for limiting the movement apart of said fingers.

16. In a switch for opening and closing an electric circuit, in combination, a switch blade disposed to be mounted for movement relative to a stationary switch member, a pair of flexible contact fingers having centrally located aligned apertures near one end and anchored at the other end on opposite sides of said switch blade along the edge remote from said switch member and extending beyond the edge adjacent said switch member, each of said fingers having slots extending from said apertured end toward said other end, a silver insert in each section formed by said slots to provide contact engaging portions with said switch member, a coil spring disposed coaxially with said apertures for biasing said fingers apart, an inwardly extending ridge on each of said sections providing the sole engagement with the ends of said spring whereby substantially point engagement is provided between said spring and said sections, and stop means slidably mounted in said apertures and having headed ends for limiting the movement apart of said fingers.

17. A switch for opening and closing an electric circuit comprising, in combination, a pair of relatively short spaced apart stationary switch members, a relatively wide switch blade mounted for movement in a plane between said switch members, and a pair of prestressed contact fingers anchored on opposite sides of said switch blade along the edge remote from said switch members and extending beyond the edge adjacent said switch members for engaging them, whereby maximum current carrying capacity and maximum electrical clearance are provided with a minimum of movement of and force applied to said switch blade.

18. A switch for opening and closing an electric circuit comprising, in combination, a pair of relatively short spaced apart stationary switch members, a relatively wide switch blade mounted for movement in a plane between said switch members, a pair of prestressed contact fingers anchored on opposite sides of said switch blade along the edge remote from said switch members and extending beyond the edge adjacent said switch members for engaging them, and small radius contact engaging portions extending from said contact fingers and providing the contact engaging portions with said switch members.

19. A switch for opening and closing an electric circuit comprising, in combination, a pair of relatively short spaced apart stationary switch members, a relatively wide switch blade mounted for movement in a plane between said switch members, a pair of prestressed contact fingers anchored on opposite sides of said switch blade along the edge remote from said switch members and extending beyond the edge adjacent said switch members for engaging them, a silver insert near the outer edge of each of said switch members and facing inwardly, and a corresponding silver insert in each of said contact fingers along the edge of said switch blade adjacent said switch members, each of said last named silver inserts having a head portion registering with the face of the corresponding insert in said switch members to provide the contact engaging portions therebetween.

20. A switch comprising, in combination, a pair of stationary switch members constituting the

terminals of an electric circuit and disposed in insulated spaced relation, each of said switch members including a pair of relatively short spaced apart contact members, a fulcrum member aligned with and adjacent one of said switch members, a relatively wide switch blade pivoted on said fulcrum member and swingable in a plane between each pair of said contact members, and a plurality of pairs of prestressed contact fingers anchored on opposite sides of said blade along the edge remote from said switch members and extending beyond the edge adjacent said switch members for engaging said contact members, whereby maximum current carrying capacity and maximum electrical clearance are provided with a minimum of movement of and force applied to said switch blade.

21. A switch comprising, in combination, a pair of stationary switch members constituting the terminals of an electric circuit and disposed in insulated spaced relation, each of said switch members including a pair of relatively short spaced apart contact members, a fulcrum member aligned with and adjacent one of said switch members, a relatively wide switch blade pivoted on said fulcrum member and swingable in a plane between each pair of said contact members, a plurality of pairs of prestressed contact fingers anchored on opposite sides of said blade along the edge remote from said switch members and extending beyond the edge adjacent said switch members for engaging said contact members, and inserts in said contact members and in said contact fingers providing the contact engaging portions therebetween.

22. A switch comprising, in combination, a pair of stationary switch members constituting the terminals of an electric circuit and disposed in insulated spaced relation, each of said switch members including a pair of relatively short spaced apart contact members, a fulcrum member aligned with and adjacent one of said switch members, a relatively wide switch blade pivoted on said fulcrum member and swingable in a plane between each pair of said contact members, a plurality of pairs of prestressed contact fingers anchored on opposite sides of said blade along the edge remote from said switch members and extending beyond the edge adjacent said switch members for engaging said contact members, and a high pressure contact engaging raised portion on each of said contact fingers along the edge of said switch blade adjacent said switch members to provide substantially point contact engagement with said contact members.

23. A prestressed contact assembly comprising, in combination, a pair of spaced apart flexible contact fingers arranged for mounting at one end on a rigid member and having aligned apertures near the other end, a coil spring disposed coaxially with said apertures for biasing said contact fingers apart, an internally threaded tubular member slidably mounted in said apertures, screws in the ends of said tubular member limiting the movement apart of said contact fingers, and a tubular spacer around said tubular member having an outside diameter slightly less than the inside diameter of said coil spring.

24. In combination for a switch having relatively movable switch members for opening and closing an electric circuit, a pair of bifurcated spaced apart contact fingers carried at one end by one of said switch members for engagement near the other end with the other switch member and having aligned apertures at said other end, a headed insert in each branch of each of said contact fingers forming the contact engaging portions thereof with said other switch member, a coil spring disposed coaxially with said apertures for biasing said fingers apart, an internally threaded tubular member slidably mounted in said apertures, machine screws in the ends of said tubular member for limiting the movement apart of said contact fingers to position said headed inserts slightly within the path of relative movement of said switch members, and a tubular spacer around said tubular member having an outside diameter slightly less than the inside diameter of said coil spring.

25. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, lever means carried at the other end of said switch blade, and means cooperating with said lever means for prying said switch blade into and out of engagement with said stationary switch member.

26. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, lever means carried at the other end of said switch blade, means cooperating with said lever means for prying said switch blade into and out of engagement with said stationary switch member, and latching means adapted to be released by said lever means for holding said switch blade in the switch closed position.

27. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, stationary arm means positioned adjacent said switch member, and lever means carried at the other end of said switch blade for cooperating with said arm means to pry said switch blade into and out of engagement with said switch member.

28. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, stationary arm means positioned adjacent said switch member, lever means carried at the other end of said switch blade for cooperating with said arm means to pry said switch blade into and out of engagement with said switch member, latching means cooperating with said arm means and said lever means for holding said switch blade in the switch closed position, and means for releasing said latching means on movement of said lever means to pry said switch blade out of engagement with said switch member.

29. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, stationary arm means positioned adjacent said switch member, lever means carried at the other end of said switch blade for cooperating with said arm means to pry said switch blade into and out of engagement with said switch member, latching means for holding said switch blade in the switch closed position, and means operable first to release said latching means and next to move said lever

means to pry said switch blade out of engagement with said switch member.

30. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, lever means rotatably mounted on the other end of said switch blade, means cooperating with said lever means for prying said switch blade into and out of engagement with said switch member, and stop means carried by said switch blade and cooperating with said lever means to permit the continued application of force thereto to move said switch blade to the full open position after it has been pried out of engagement with said switch member.

31. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, lever means rotatably mounted on the other end of said switch blade for prying it into and out of engagement with said switch member, stop means carried by said switch blade and cooperating with said lever means to permit the continued application of force thereto to move said switch blade to the full open position after it has been pried out of engagement with said switch member, additional stop means carried by said switch blade and cooperating with said lever means to permit the application of force thereto to move said switch blade toward the closed position, and means for operating said last named stop means when said switch blade is moved to a predetermined position to release said lever means for movement to the position required to pry said switch blade into engagement with said switch member.

32. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, lever means rotatably mounted on the other end of said switch blade for prying it into and out of engagement with said switch member, stop means carried by said switch blade and cooperating with said lever means to permit the continued application of force thereto to move said switch blade to the full open position after it has been pried out of engagement with said switch member, latch means carried by said switch blade and detachably connected to said lever means for locking said switch blade in the closed position, and means for releasing said latch means before said lever means is operated to pry said switch blade out of engagement with said switch member.

33. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, lever means rotatably mounted on the other end of said switch blade for prying it into and out of engagement with said switch member, stop means carried by said switch blade and cooperating with said lever means to permit the continued application of force thereto to move said switch blade to the full open position after it has been pried out of engagement with said switch member, latch means carried by said switch blade and detachably connected to said lever means for locking said switch blade in the closed position, means for releasing said latch means before said lever means is operated to pry said switch blade out of engagement with said switch member, additional stop means carried by said switch blade and cooperating with said lever means to permit the application of force thereto to move said switch blade toward the closed position, and means for operating said last named stop means when said switch blade is moved to a predetermined position to release said lever means for movement to the position required to pry said switch blade into engagement with said switch member.

34. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, means for maintaining relatively high contact pressure between said switch member and said switch blade within a narrow range of movement of said switch blade from and to the switch closed position, and means cooperating with the other end of said switch blade and additional means cooperating therewith for prying said switch blade into and out of engagement with said stationary switch member within said narrow range of movement.

35. A switch for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, a pair of levers rotatably mounted on opposite sides of said switch blade having outwardly extending lugs and nose portions at the inner ends thereof, a shaft extending through and projecting beyond said levers near their outer ends, a pair of resilient latch members mounted on opposite sides of said switch blade and having apertured ends for engaging the projecting ends of said shaft, an operating member rotatably mounted on said shaft between said levers and having a slotted opening therein, a pin in said levers extending through said slotted opening to permit limited rotation of said operating member relative to said levers, cam members secured to and extending inwardly from said latch members, cam means carried by said operating member for engaging said cam members to move said latch members out of locking engagement with the ends of said shaft, a stop pin extending through said switch blade and positioned in the path of said nose portions of said levers to permit operation of said switch blade to the open position by continued application of force to said operating member, a pair of arms fastened adjacent said switch member on opposite sides of said switch blade and having slots near the outer ends opening upwardly for cooperating with said lugs on said levers to pry said switch blade into and out of engagement with said switch member, plates secured to the inner surfaces of said arms and having their outer ends bevelled, a pair of lever stops rotatably mounted on opposite sides of said switch blade and having stop arms extending outwardly therefrom, said lever stops being disposed to engage said plates when said switch blade is operated to the switch closed position to move said stop arms toward said switch blade, and means for biasing said stop arms away from said switch blade into the path of said nose portions of said levers to permit operation of said switch blade to the closed position by application of force to said operating member.

36. A switch of the knife blade type for opening and closing an electric circuit comprising, in

combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, a stop link pivotally mounted on a stationary support and slidably and rotatably mounted on said switch blade, a pair of brake shoes carried by said switch blade and cooperating with said stop link, and resilient means biasing said brake shoes into operative engagement with said stop link.

37. A switch of the knife blade type for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, a stop link pivotally mounted on a stationary support and slidably and rotatably mounted on said switch blade, a pair of brake shoes carried by said switch blade and cooperating with said stop link, resilient means biasing said brake shoes into operative engagement with said stop link when said switch blade is moved toward the open position, and means operable on movement of said switch blade toward the switch closed position for moving said brake shoes apart.

38. A switch of the knife blade type for opening and closing an electric circuit comprising, in combination, a stationary switch member, a switch blade rotatably mounted at one end for engaging and disengaging said stationary switch member, means for maintaining relatively high contact pressure between said switch member and said switch blade within a limited range of movement of said switch blade from the switch closed position, a stop member projecting from one side of said switch blade, a stop link pivotally mounted adjacent said one end of said switch blade and having a slotted opening for said stop member to limit the movement of said switch blade to a predetermined open position, a pair of brake shoes mounted on said stop member on opposite sides of said stop link, friction material interposed between said brake shoes and said stop link, resilient means between said brake shoes biasing them toward said stop link, said brake shoes being mounted for limited translatory movement on said stop member to permit movement of said switch blade beyond said limited range of movement before the braking effect is applied, and toggle means interposed between said brake shoes and engaged by said stop means on movement of said switch blade toward the switch closed position for moving said brake shoes apart.

39. A switch comprising, in combination, a pair of switch members mounted for relative movement to open and close an electric circuit, one of said switch members including a pair of spaced apart contact fingers, the other of said switch members being arranged and adapted to engage both said contact fingers, means providing substantially aligned point contact engagement between said contact fingers and said other switch member, and resilient means interposed between said contact fingers and acting along the line of said point contact engagement to bias them apart and provide a predetermined contact pressure.

40. A switch comprising, in combination, a pair of switch members mounted for relative movement to open and close an electric circuit, one of said switch members including a pair of spaced apart contact fingers, the other of said switch members being arranged and adapted to engage both said contact fingers, means providing substantially aligned point contact engagement between said contact fingers and said other switch member, resilient means interposed between said contact fingers and acting along the line of said point contact engagement to bias them apart and provide a predetermined contact pressure, and stop means limiting the movement apart of said contact fingers under the influence of said resilient means.

41. A switch comprising, in combination, a pair of switch members mounted for relative movement to open and close an electric circuit, one of said switch members including a pair of spaced apart contact fingers, the other of said switch members being arranged and adapted to engage both said contact fingers, means providing substantially aligned point contact engagement between said contact fingers and said other switch member, resilient means interposed between said contact fingers and acting along the line of said point contact engagement to bias them apart and provide a predetermined contact pressure, and stop means cooperating solely with said resilient means for limiting the movement thereof whereby said contact fingers are biased apart a predetermined limited distance on operation of the switch from the switch closed position.

42. A switch comprising, in combination, a pair of switch members mounted for relative movement to open and close an electric circuit, one of said switch members including a pair of spaced apart contact fingers, the other of said switch members being arranged and adapted to engage both said contact fingers, means providing substantially aligned point contact engagement between said contact fingers and said other switch member, a coil compression spring interposed between said contact fingers in such position as to act directly along the line of said point contact engagement, and stop means cooperating solely with said coil spring for limiting the expansion thereof on movement of the switch from the closed position.

43. A switch comprising, in combination, a pair of switch members mounted for relative movement to open and close an electric circuit, one of said switch members including a pair of spaced apart contact fingers, the other of said switch members being arranged and adapted to engage both said contact fingers, small radius high contact pressure means on one of said switch members forming contact engaging portions therebetween, and resilient means interposed between said contact fingers in such position as to act directly on said small radius high contact pressure means.

44. A switch comprising, in combination, a pair of switch members mounted for relative movement to open and close an electric circuit, one of said switch members including a pair of spaced apart contact fingers, the other of said switch members being arranged and adapted to engage both said contact fingers, small area high pressure projections on said contact fingers forming the contact engaging portions with said switch members, a coil compression spring interposed between said contact fingers in such position as to act directly in line with said projections, and stop means cooperating with the end turns of said coil spring for limiting the expansion thereof on movement of the switch from the closed position.

45. A switch comprising, in combination, a

stationary switch member, a switch member movable relative to said stationary member to open and close an electric circuit, a pair of spaced apart flexible contact fingers carried by said movable switch member, said stationary switch member being arranged and adapted to engage both said contact fingers, headed inserts in said contact fingers forming the contact engaging portions with said stationary switch member, a coil compression spring interposed between said contact fingers in such position as to act directly on the headed inserts therein, and stop means cooperating with the end turns of said coil spring for limiting the expansion thereof on movement of the switch from the closed position to position the heads of said inserts in said contact fingers slightly within the path of relative movement with said stationary switch member, whereby said coil spring is prestressed before the switch is operated to the closed position.

46. A switch comprising, in combination, a stationary switch member including a pair of spaced apart upstanding contact members, a switch blade movable relative to said stationary member to open and close an electric circuit, a pair of bifurcated contact fingers secured on opposite sides of said switch blade along the edge thereof remote from said stationary switch member and spaced slightly from said switch blade and extending beyond the edge thereof adjacent said stationary switch member for contact engagement with said spaced apart contact members, an insert forming a raised portion in each branch of each contact finger forming the contact engaging portions with said spaced apart contact members, the inner surfaces of said contact fingers having recesses coaxial with the inserts therein, a pair of cup washers interposed between said contact fingers and having integrally formed bosses interfitting with said recesses and spaced from the adjacent surfaces of said contact fingers to permit limited independent movement thereof, a coil compression spring interposed between said cup washers to provide a predetermined contact pressure between said engaging inserts and contact members, and stop means extending between said cup washers for limiting the movement apart thereof on movement of said switch blade from the switch closed position to position said raised portions of said inserts in said contact fingers slightly within the path of relative movement with said stationary switch member, whereby said coil spring is prestressed before said switch blade is operated to the closed position.

47. In combination for a switch having relatively movable switch members for opening and closing an electric circuit, a pair of contact fingers disposed to be carried at one end in spaced apart relation by one of said switch members for engagement at the other end with the other switch member, and a prestressed unit including self-contained spring and stop means interposed between said contact fingers at said other end providing predetermined contact pressure between said contact fingers and said other switch member.

48. In combination for a switch having relatively movable switch members for opening and closing an electric circuit, a pair of bifurcated spaced apart contact fingers disposed to be carried by one of said switch members for contact engagement with the other switch member, a silver insert in each branch of each of said contact fingers forming the contact engaging portions thereof with said other switch member, and a prestressed unit including self-contained spring and stop means interposed between said contact members and arranged and adapted to bias said silver inserts carried thereby into engagement with said other switch member.

49. A switch comprising, in combination, a stationary switch member including a pair of spaced apart contact members, a relatively movable switch member including a pair of spaced apart switch blades, a pair of flexible contact fingers secured opposite each other on the inner surfaces of said switch blades along the edges thereof remote from said stationary switch member, said contact fingers being spaced slightly from said switch blades and extending beyond the edges thereof adjacent said stationary switch member for contact engagement with said spaced apart contact members, and resilient means interposed between the free ends of said contact fingers for biasing them into contact engagement with said contact members.

50. A switch comprising, in combination, a stationary switch member including a pair of spaced apart contact members, a relatively movable switch member including a pair of spaced apart switch blades, a pair of flexible contact fingers secured opposite each other on the inner surfaces of said switch blades along the edges thereof remote from said stationary switch member, said contact fingers being spaced slightly from said switch blades and extending beyond the edges thereof adjacent said stationary switch member for contact engagement with said spaced apart contact members, silver inserts in the free ends of said contact fingers and in said contact members forming the contact engaging portions therebetween, and a compression spring interposed between said free ends in alignment with the silver inserts therein to provide a predetermined contact pressure between said silver inserts, the movement apart of said contact fingers as biased by said resilient means being limited by said adjacent edges of said switch blades on movement thereof from the closed position.

51. A switch comprising, in combination, a stationary switch member, a movable switch member for engaging and disengaging said stationary switch member, means rotatably mounting said movable switch member about an axis fixed with respect to said stationary switch member, an operating member rotatably mounted on said movable switch member, reaction means carried by said operating member, and means arranged and adapted to cooperate with said reaction means for rotatably and slidably mounting the same whereby said operating member is movable about an axis parallel to said fixed axis to provide a mechanical advantage for prying said movable switch member into and out of switch closed position.

52. A double throw switch comprising, in combination, a pair of spaced apart stationary switch members, a switch blade rotatably mounted intermediate said switch members for movement into and out of contact engagement with either of them, an operating lever rotatably mounted intermediate its ends on said switch blade, guide means having a slotted opening disposed in alignment with the axes of rotation of said switch blade and said lever when the former is in the open position, and means carried by one end of said lever and guided in said slotted opening for causing movement of said lever in a predetermined path by application of force to the other

end to effect contact engagement between said switch blade and either of said switch members.

53. A double throw switch comprising, in combination, a pair of spaced apart stationary switch members, a switch blade rotatably mounted intermediate said switch members for movement into and out of contact engagement with either of them, means for maintaining relatively high contact pressure between said switch members and said switch blade within a limited range of movement of the latter to and from either switch closed position, variable ratio lever means operatively connected to said switch blade for effecting said engagement, and guide means for said lever means whereby the same initially operates at a slight mechanical advantage in moving said switch blade from an intermediate position toward either switch closed position and finally operates at a relatively great mechanical advantage in moving said switch blade within said narrow range of movement into and out of said contact engagement.

54. A switch comprising, in combination, a plurality of stationary switch members, a plurality of switch blades each individual to a switch member and rotatably mounted for movement into and out of engagement therewith, means for maintaining relatively high contact pressure between each switch member and the switch blade individual thereto within a limited range of movement of the latter to and from the switch closed position, variable ratio lever means common to said switch blades and operatively connected thereto for effecting said engagement, and guide means for said lever means whereby the same initially operates at a slight mechanical advantage in moving said switch blades toward the switch closed position and finally operates at a relatively great mechanical advantage in moving said switch blades within said narrow range of movement into and out of contact engagement with said switch member.

55. A multi-pole double throw switch comprising, in combination, a plurality of pairs of spaced apart stationary switch members, a plurality of switch blades each rotatably mounted intermediate one pair of switch members and movable into and out of contact engagement with either of them, means for maintaining relatively high contact pressure between each switch member and the switch blade individual thereto within a limited range of movement of the latter to and from either switch closed position, variable ratio lever means common to said switch blades and operatively connected thereto for effecting said engagement, and guide means for said lever means whereby the same initially operates at a slight mechanical advantage in moving said switch blades from an intermediate position toward either switch closed position and finally operates at a relatively great mechanical advantage in moving said switch blades within said narrow range of movement into and out of said contact engagement.

56. A switch comprising, in combination, a stationary switch member, a rotatably mounted switch blade for contact engagement with said switch member, an operating lever rotatably mounted on said switch blade, guide means cooperating with said lever for causing it to move in a predetermined path on rotation thereof relative to said switch blade to move it into and out of said contact engagement, and means cooperating with said guide means and allowing further movement of said lever after the switch is closed to lock said lever in the switch closed position in such manner that the application of force to rotate it relative to said switch blade is required to unlock it.

57. A switch comprising, in combination, a stationary switch member, a switch blade rotatably mounted for movement into and out of contact engagement with said switch member, means for maintaining relatively high contact pressure between said switch member and said switch blade within a limited range of movement of the latter to and from the switch closed position, an operating lever rotatably mounted on said switch blade, and guide means cooperating with said lever and causing it initially to operate at a slight mechanical advantage in moving said switch blade toward the switch closed position and finally to operate at a relatively great mechanical advantage in moving it within said limited range of movement into and out of said contact engagement, said guide means being arranged and adapted to lock said lever in the switch closed position in such manner that the application of force to rotate it relative to said switch blade is required to unlock it.

58. A double throw switch comprising, in combination, a pair of stationary switch members, a rotatably mounted switch blade for movement into contact engagement with either of said switch members, an operating lever rotatably mounted on said switch blade, and guide means cooperating with said lever for causing it to move in a predetermined path on rotation thereof relative to said switch blade to move it into and out of contact engagement with either of said switch members, said guide means being arranged and adapted to lock said lever in either switch closed position in such manner that the application of force to rotate it relative to said switch blade is required to unlock it from either switch closed position.

59. A double throw switch comprising, in combination, a pair of stationary switch members, a switch blade rotatably mounted intermediate said switch members for movement into and out of contact engagement with either of them, means for maintaining relatively high contact pressure between said switch members and said switch blade within a limited range of movement of the latter to and from either switch closed position, an operating lever rotatably mounted on said switch blade, and guide means cooperating with said lever and causing it to initially operate at a slight mechanical advantage in moving said switch blade toward either switch closed position and finally to operate at a relatively great mechanical advantage in moving it within said limited range of movement into and out of said contact engagement, said guide means being arranged and adapted to lock said lever in either switch closed position in such manner that the application of force to rotate it relative to said switch blade is required to unlock it from either switch closed position.

60. A switch comprising, in combination, a stationary switch member including a pair of spaced apart contact members, a relatively movable switch member including a pair of spaced apart switch blades, a pair of relatively short contact fingers having a relatively large cross-section secured opposite each other on the inner surfaces of said switch blades along the edges thereof remote from said stationary switch member and extending beyond the edges thereof adjacent said stationary switch member for contact engage-

ment with said spaced apart contact members, said contact fingers having a plurality of narrow transverse slots adjacent their portions secured to said switch blades for increasing the flexibility thereof, and resilient means interposed between the free ends of said contact fingers for biasing them into said contact engagement.

61. A switch member comprising a bar of conducting material to which an endwise thrust is applied on operation of the switch to the closed position and having a relatively large cross-sectional area in proportion to its length, and having a relatively narrow slot intermediate its ends extending transversely of its longitudinal axis so arranged as to substantially increase the flexibility of the bar with slight decrease in resistance to longitudinal compression stress and in longitudinal current carrying capacity.

62. A switch member comprising a bar of conducting material to which an endwise thrust is applied on operation of the switch to the closed position and having a relatively large cross-sectional area in proportion to its length, and having a plurality of relatively narrow slots intermediate its ends extending transversely of its longitudinal axis so arranged as to substantially increase the flexibility thereof with slight decrease in resistance to longitudinal compression stress and in longitudinal current carrying capacity.

63. A switch member comprising a bar of conducting material having a relatively large cross-sectional area in proportion to its length and having relatively narrow slots in opposite sides thereof extending transversely to the direction of current flow from one end to the other whereby the flexibility of the bar is substantially increased with only slight decrease in resistance to compression stress and in current carrying capacity.

ALLAN RAMSEY.