Dec. 6, 1960 C. A. KOERNER ET AL 2,963,560

SWITCH

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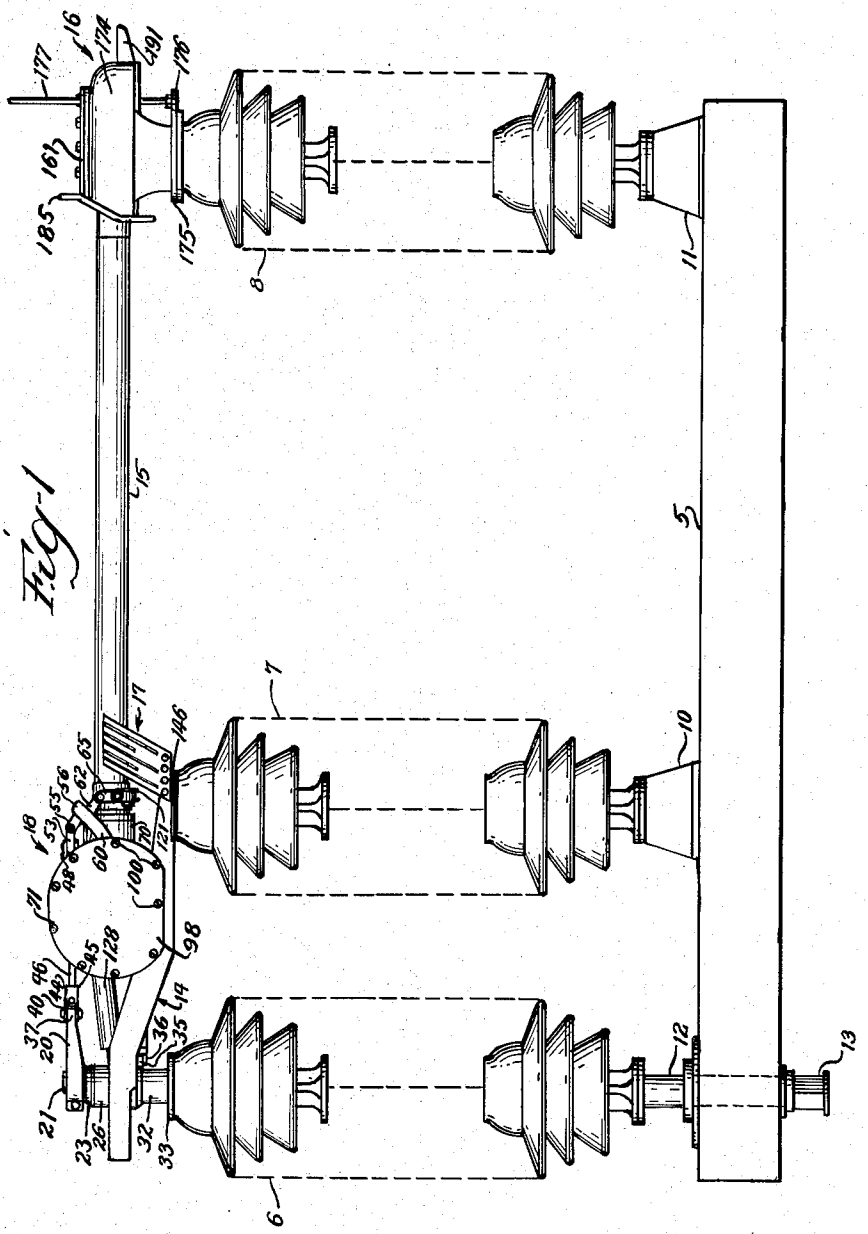


Fig-1

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SWITCH

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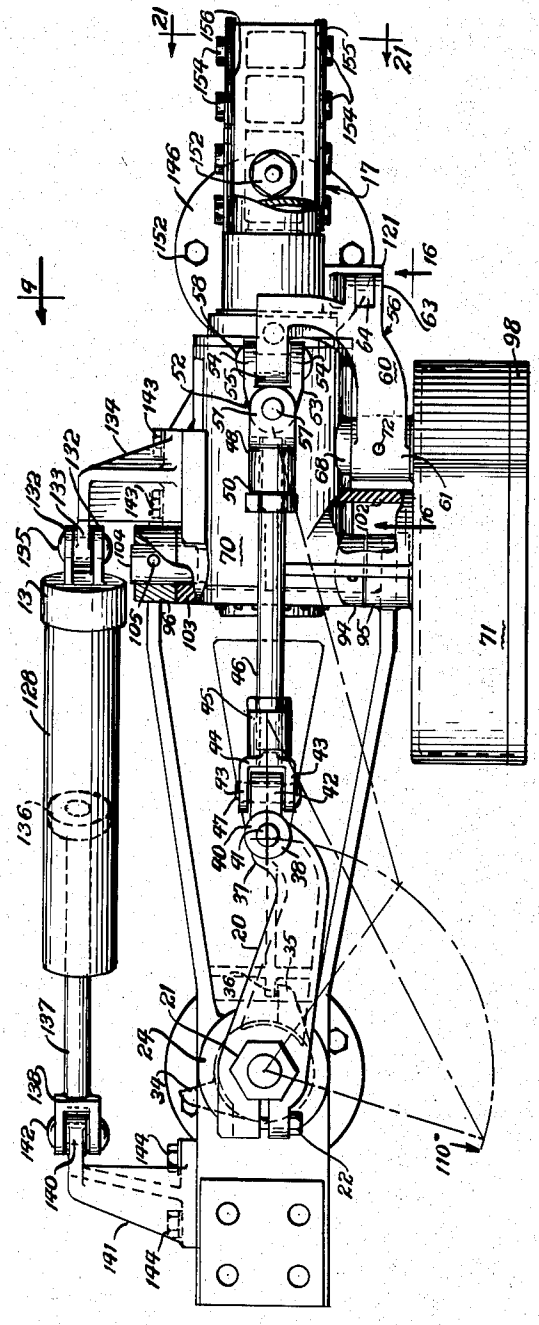


Fig-2

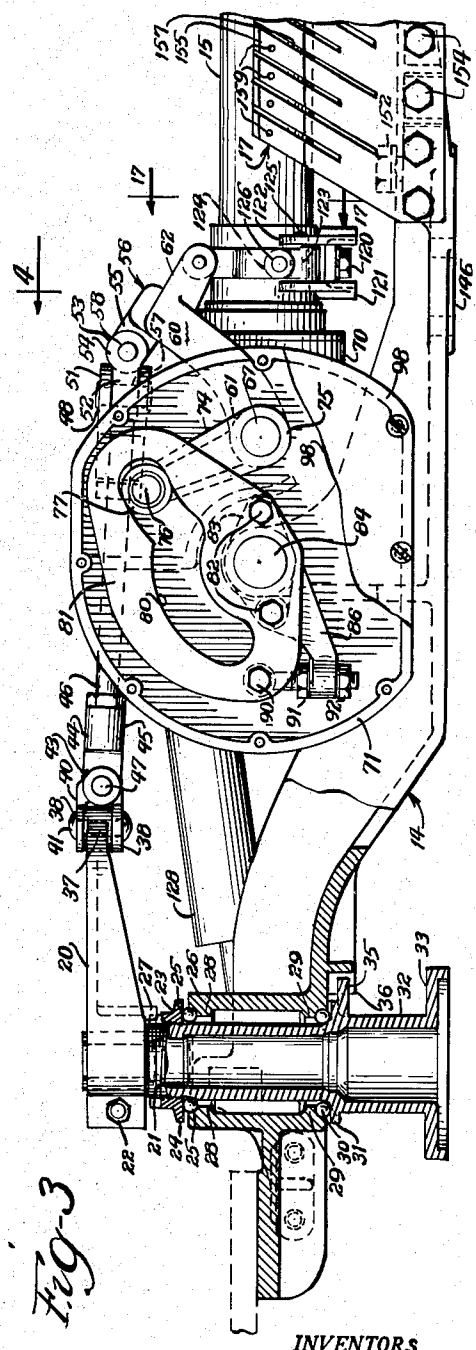


Fig-3

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Dec. 6, 1960 C. A. KOERNER ET AL 2,963,560

SWITCH

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Fig-4

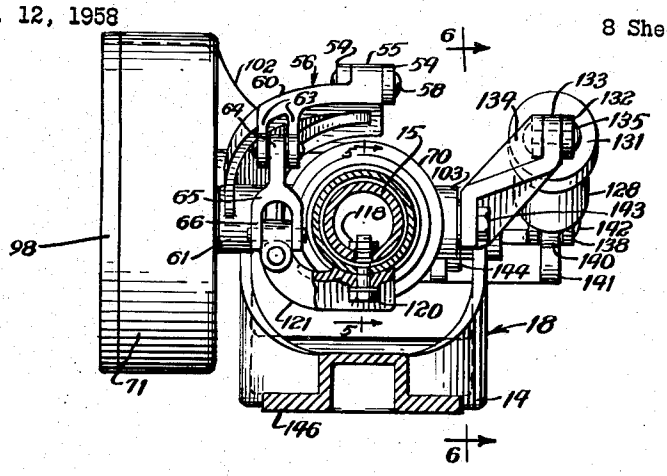


Fig-5

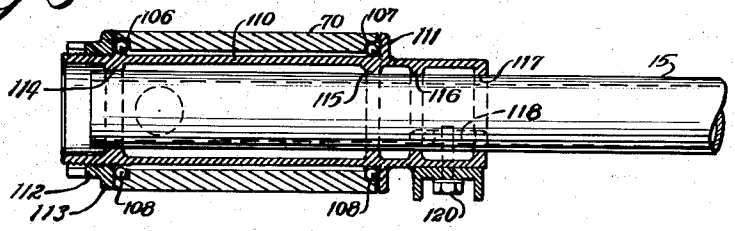
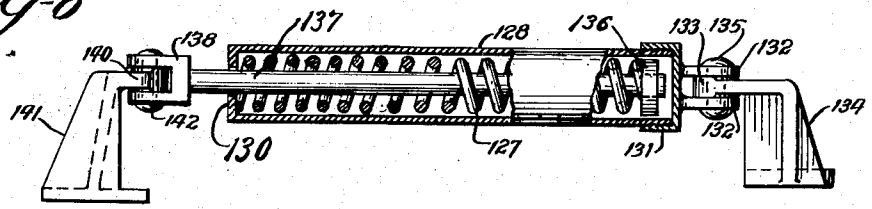


Fig-6



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Dec. 6, 1960 C. A. KOERNER ET AL 2,963,560

SWITCH

Filed Feb. 12, 1958 8 Sheets-Sheet 4

Fig-8

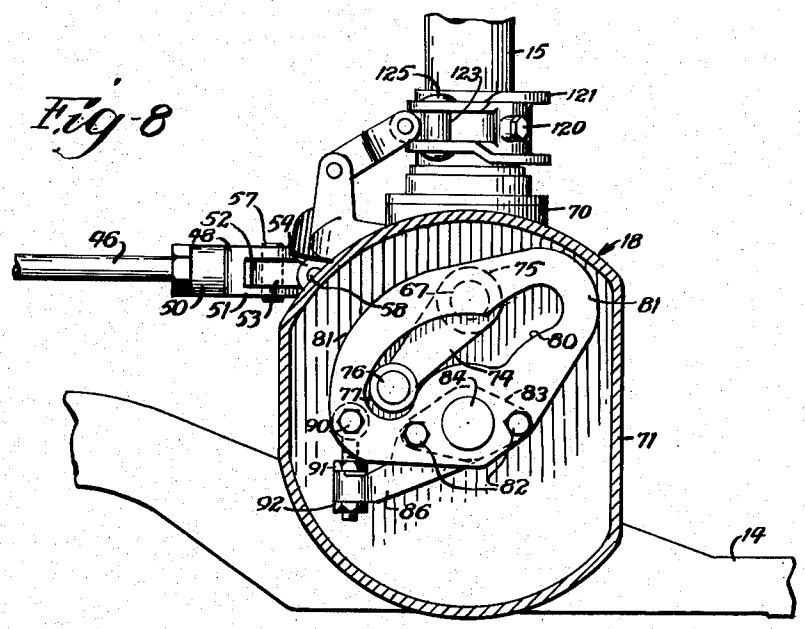
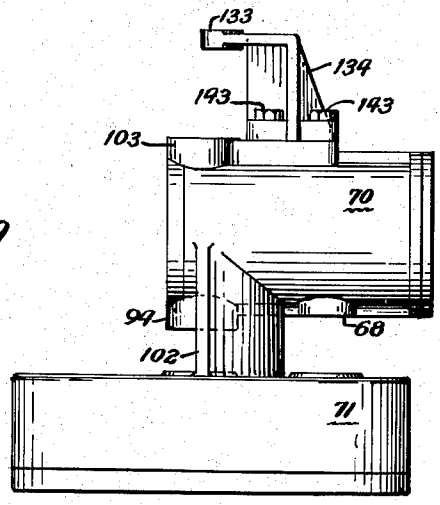


Fig-20



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Dec. 6, 1960 C. A. KOERNER ET AL 2,963,560

SWITCH

Filed Feb. 12, 1958 8 Sheets-Sheet 5

Fig-9

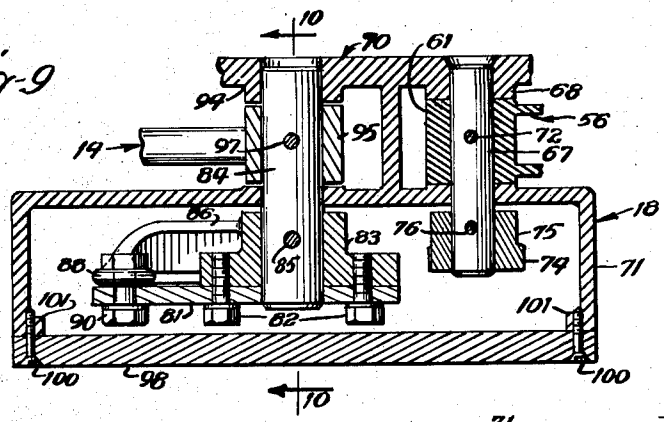


Fig-7

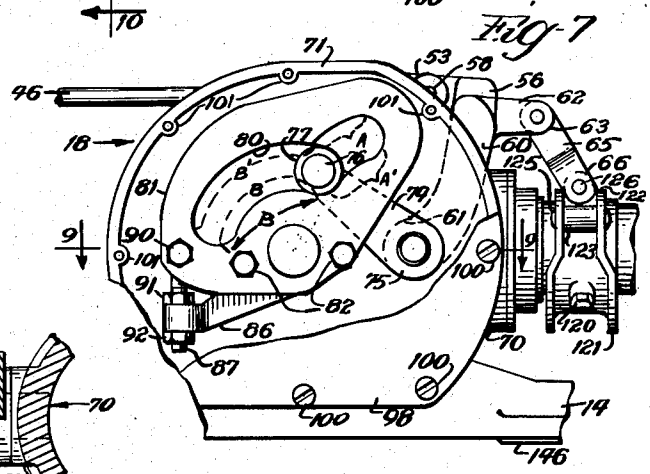


Fig-10

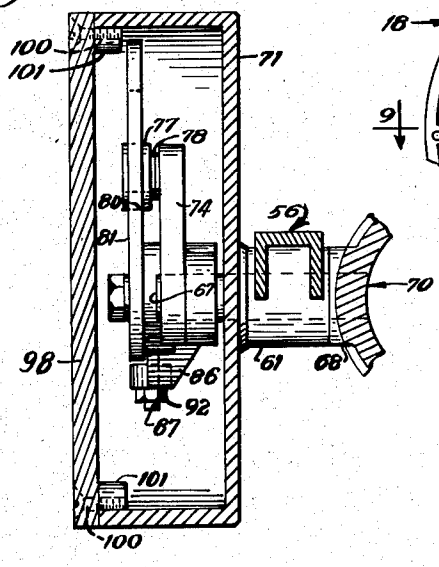


Fig-14

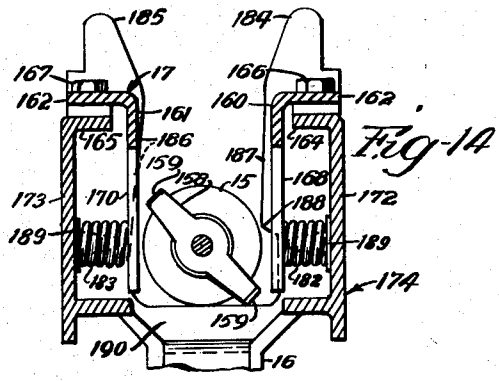
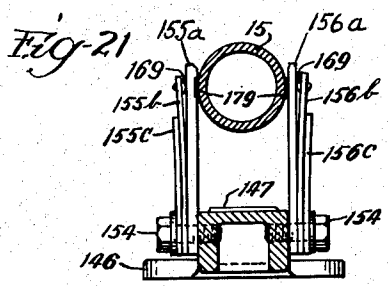


Fig-21



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SWITCH

Filed Feb. 12, 1958 8 Sheets-Sheet 6

Fig-12

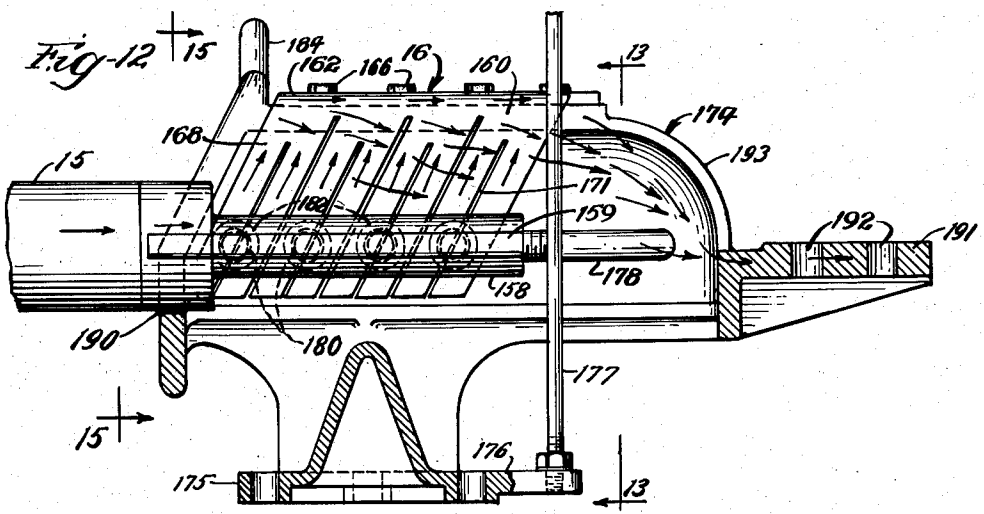


Fig-11

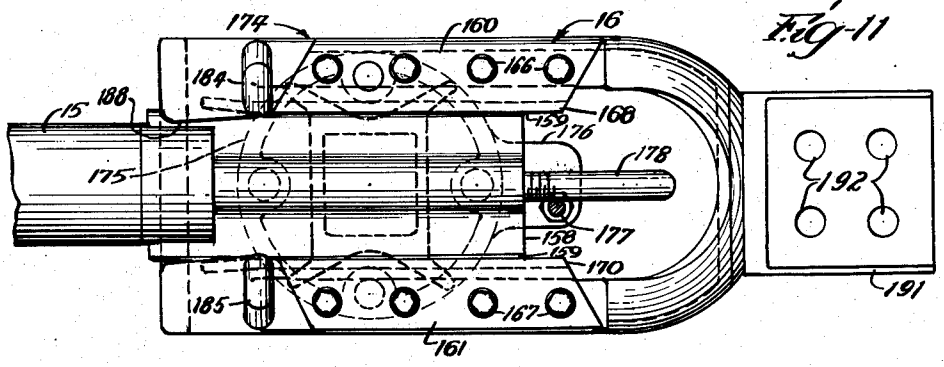


Fig-13

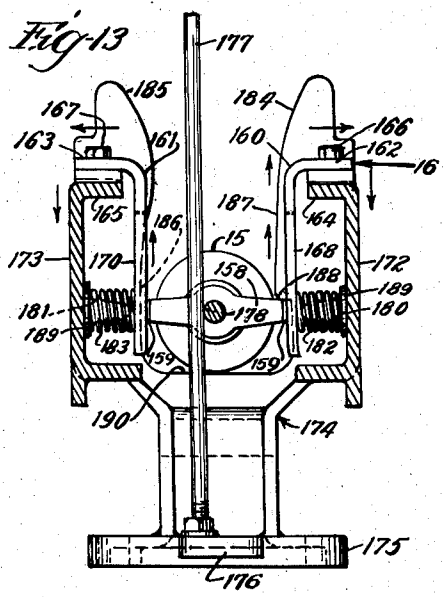
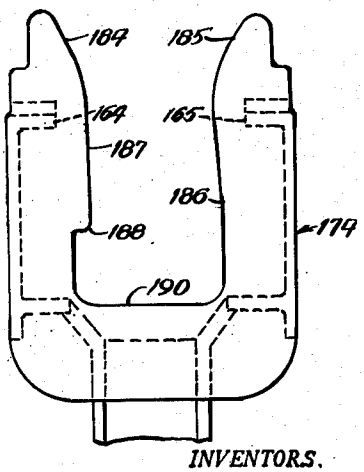


Fig-15



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Dec. 6, 1960 C. A. KOERNER ET AL 2,963,560

SWITCH

Filed Feb. 12, 1958 8 Sheets-Sheet 7

Fig-17

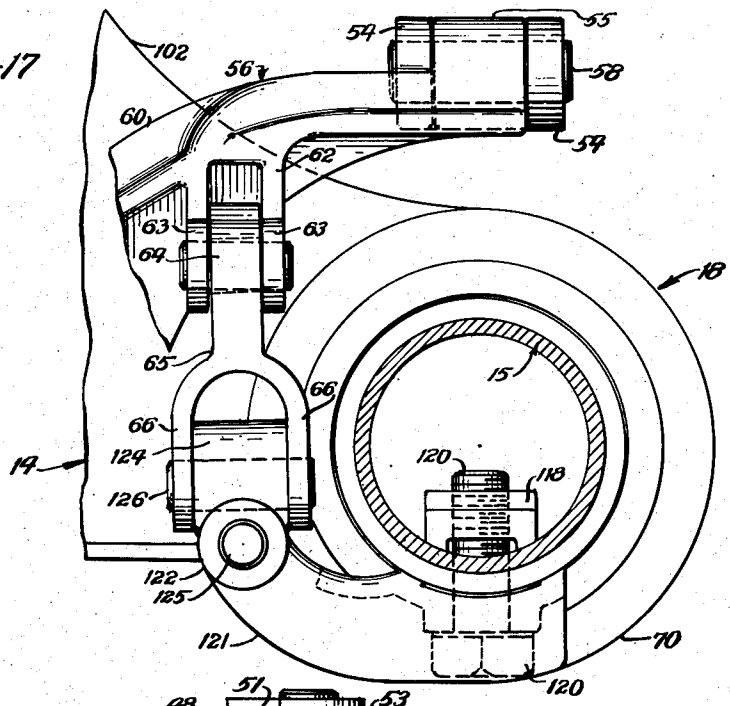
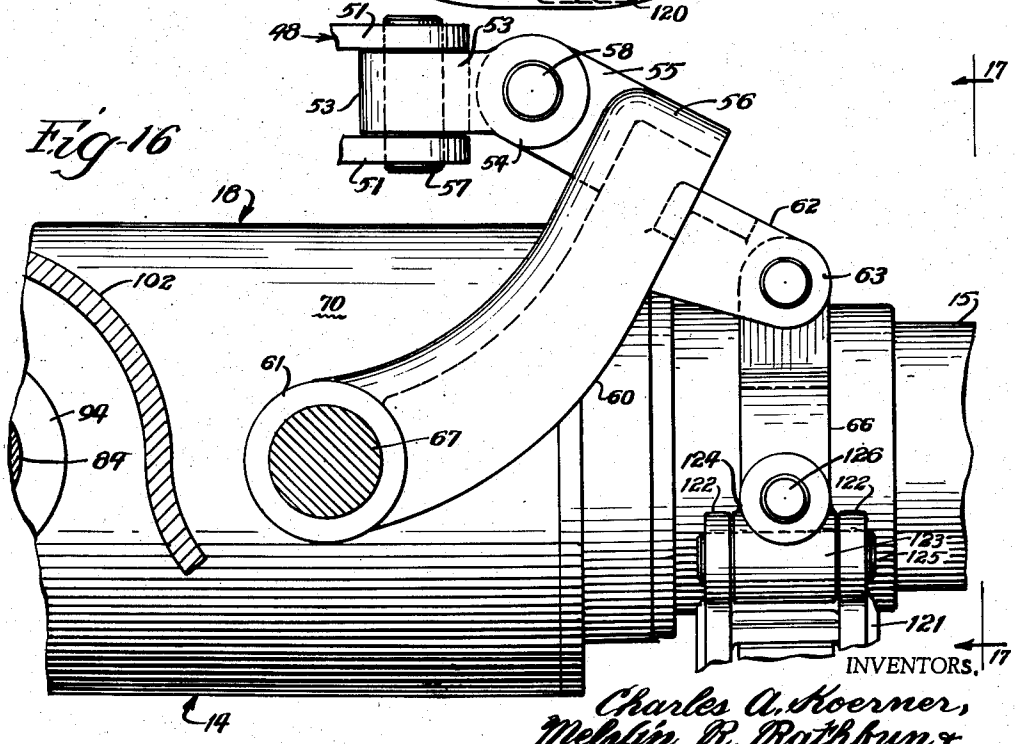


Fig-16



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SWITCH

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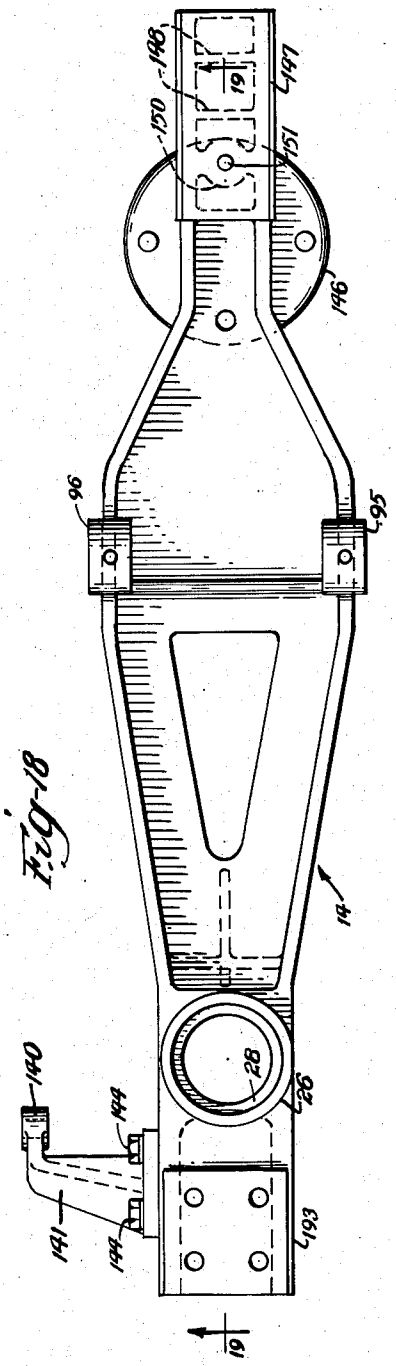


Fig-18

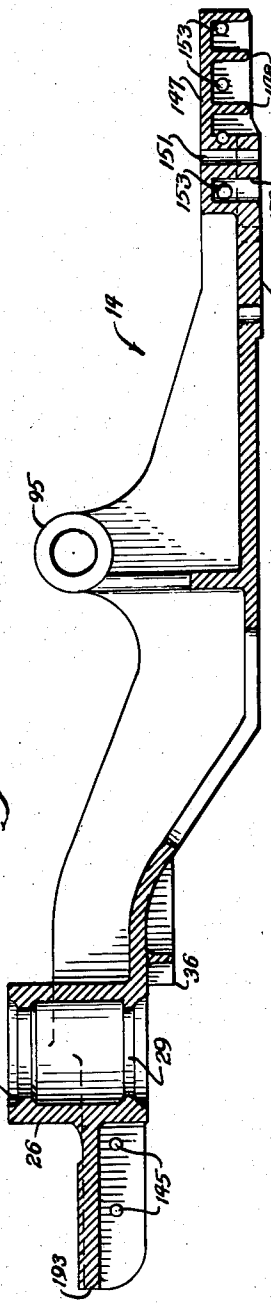


Fig-19

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United States Patent Office 2,963,560 Patented Dec. 6, 1960

2,963,560

SWITCH

Charles A. Koerner, Park Ridge, Oscar B. Alsaker, Bellwood, and Melvin R. Rathbun, Roselle, Ill., assignors to James R. Kearney Corporation, St. Louis, Mo., a corporation of Delaware

Filed Feb. 12, 1958, Ser. No. 714,744

8 Claims. (Cl. 200—48)

This invention relates, generally, to improvements and innovations in disconnecting switches of the type having a flat or so-called "beaver tail" male contact on the outer end of a long tubular switch blade.

The blade of such a switch is rotatable about its longitudinal axis for turning the flat contact into and out of locking engagement with a stationary female contact. In addition, the blades, which are normally horizontal when in closed position, are swingable about their inner ends into approximately the vertical position so as to separate the flat outer contacts from the stationary female contacts. Such switches are normally used outdoors on high voltage systems and are generally operated in gangs of three.

An important object of the invention is the provision of switches of the type described which have materially increased load capacity, especially for high momentary currents.

Another important object of the invention is the provision of disconnecting switches of the class described wherein the flattened male contacts on the outer ends of the blades are securely locked against relative movement and lifting with respect to their stationary female contacts, such locking action being three-fold: against lifting; against downward movement; and, against rotation.

Still another object of the invention is the provision of such switches wherein the magnetic forces created due to current flow through the outer contacts tends to force or hold the switch blade down into the closed and locked position rather than tending to lift or open the switch.

Another important object of the invention is the provision of disconnecting switches of the type described wherein the rotary movement of the switch blade about its longitudinal axis is positively segregated from the swinging movement of the blade about a transverse axis adjacent its inner end.

Still another object of the invention is a switch of the foregoing type in which the segregation or positive isolation of the rotary action and the swinging action of the switch blade is obtained by means of a combined linkage-actuated, cam-controlled arrangement.

Another important object of the invention is the provision of a disconnecting switch of the type described wherein an inner portion of the switch blade serves as a male contact for cooperation with a pair of stationary female contacts.

A further object of the invention is the provision of a disconnecting switch of the type described having an improved front female contact structure which provides magnetic locking features cooperable with other locking features incorporated in the switch whereby all relative movement between the front male and female contacts is eliminated when the switch is closed and locked.

A further object of the invention is a switch of the type described having a stationary cam plate provided with a cam track in the form of an elongated slot in two interconnected sections, with one pair of cam surfaces comprising one side of one slot section and the diagonally

opposed side of the other slot section being engaged by a cam follower when the switch is opened and with the other pair of diagonally opposed cam surfaces being engaged by the cam follower when the switch is closed.

Certain other objects of the invention will, in part, be obvious and will in part appear hereinafter.

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

Fig. 1 is a side elevational view of a disconnecting switch embodying one form of the invention;

Fig. 2 is a top plan view on enlarged scale, and partly broken away, of the left-hand or inner portion of the switch shown in Fig. 1 and including the operating mechanism thereof;

Fig. 3 is a front elevational view, partly in section, of the portion of the switch shown in Fig. 2, with the cover plate of the rotary housing being removed so as to show the interior;

Fig. 4 is a sectional view, partly in end elevation, taken on line 4—4 of Fig. 2;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 4 showing the socket support means for the inner end of the switch blade;

Fig. 6 is a top plan view, partly in section, showing a counter-balance and attaching brackets used in connection with the switch operating mechanism;

Fig. 7 is a fragmentary, elevational view of a portion of the switch operating mechanism as viewed in Fig. 3 but with the parts shown in the positions which they occupy at the point in the operation of the switch where there is a division or separation between the rotary movement of the switch blade and the swinging movement thereof;

Fig. 8 is a view corresponding to Fig. 7 but showing the relationship of the parts when the switch blade is in its fully lifted and open position;

Fig. 9 is a horizontal sectional view on enlarged scale taken on the line 9—9 of Fig. 7;

Fig. 10 is a vetrical sectional view taken on line 10—10 of Fig. 9;

Fig. 11 is a fragmentary top plan view, on enlarged scale, of the front male and female contacts in closed position;

Fig. 12 is an inner elevational view, partly in section, of the front contacts shown in Fig. 11;

Fig. 13 is a vertical sectional view, partly in end elevation, taken on line 13—13 of Fig. 12;

Fig. 14 is a fragmentary view corresponding to Fig. 13 but showing the switch blade in its rotated and unlocked position;

Fig. 15 is a view broken off at the bottom, taken on line 15—15 of Fig. 12 showing the front clip casting which carries the front female contacts;

Fig. 16 is a fragmentary elevational view on an enlarged scale taken on line 16—16 of Fig. 12;

Fig. 17 is an elevational view taken on line 17—17 in Fig. 16;

Fig. 18 is a top plan view of a frame casting for the switch operating mechanism with one of the counter balance mounting brackets attached;

Fig. 19 is a vertical sectional view taken on line 19—19 of Fig. 18;

Fig. 20 is a top plan view of the combined rotary housing and socket support casting, with the front counter balance mounting bracket attached; and

Fig. 21 is a view on enlarged scale taken on line 21—21 of Fig. 2.

Referring first to Fig. 1 of the drawings, a beam 5 which may be in the form of a pair of channel members, serves to support a rotatable insulator stack 6, a rear sta-

tionary insulator stack 7 and a front stationary insulator stack 8. Only the upper and lower insulators in each stack are shown in full line, it being understood that any suitable number of insulators, e.g., four, may be used in each stack. The stationary insulator stacks 7 and 8 are supported on frusto-conical bases 10 and 11 which rest on the top of the support 5, while the rotatable stack 6 is mounted upon a shaft 12 which projects vertically through the left end of the base 5 and has a flat-sided wrench or crank-receiving portion 13 on the lower end. Any suitable bearing means of known type (not shown) may be used for rotatably supporting the shaft 12.

The disconnecting switch means mounted on the tops of the insulator stacks 6, 7 and 8 comprises; a frame casting 14; a tubular switch blade or arm 15 usually formed of a copper pipe or tube; a front contact assembly indicated generally at 16; a pair of inner or hinge female contacts 17 which receive the inner end of the blade 15; the operating mechanism for the switch blade indicated generally at 18; and, an operating arm 20. As shown in Fig. 1, the disconnecting switch is in the closed condition. In operation, to disconnect or open the switch, as will be described in detail hereinafter, the operating mechanism 18 upon being actuated by the arm 20, serves first to rotate the blade 15 about its longitudinal axis so as to unlock the outer contact assembly 16, and then without any further rotation of the blade 15 about its longitudinal axis being permitted, it is caused to swing or lift in a vertical plane and about a transverse horizontal axis extending through the inner end of the blade.

Reference may now be had to Figs. 2 and 3, and particularly the left-hand portions thereof, for a description of the means for supporting and rotating the operating arm 20. It will be seen that it is mounted on the projecting upper end of a hollow shaft indicated at 21. The upper end of the shaft is hex-shaped for receiving the hex-shaped eye formed on the end of the arm 20. For convenience in installation the eye is split at the outer end of the arm 20 so that it may be easily slipped over the hex-shaped end of the shaft 21 and then tightened thereon by means of the bolt 22. The shaft 21 is exteriorly threaded adjacent the top for receiving a nut 23 having a flange portion 24 at the bottom which rides upon ball bearings 25 which are retained in a groove formed in the upper end 28 of the vertical journal portion 26 (Figs. 1 and 20) of the casting 14. The nut 23 may be slotted or castellated at the upper end as indicated in Fig. 3 for receiving in inter-locking relationship downward projections 27 formed on the underside of the arm 20. The shaft 21 engages with the ball bearings 25 for centering the shaft at the upper end, and at the bottom engages with a lower set of ball bearings 30 retained in a raceway formed by a groove in the lower end 29 of the journal portion 26 and a flange 31 projecting from the shaft 21. In this manner the shaft 21 is centered for rotation at the bottom of the journal 26. The bottom portion of the shaft 21 is designated at 32 and is provided at the bottom with a mounting flange 33 which fits over the top of the upper insulator as shown in Fig. 1.

In order to restrict the rotary movement of the arm 20 between desired angular limits, the shaft 21 is provided with a pair of projecting dogs 34 and 35 (Figs. 2 and 3) which are adapted to engage from opposite sides a projection 36 integrally formed on the casting 14. The angular spacing of the dogs 34 and 35 is such that the arm 20 may be rotated through an angle of approximately 110 degrees.

The projecting end of the arm 20 is provided with an eye 37 which is received between the spaced ears 38—38 of a universal joint member 40 with a pin 41 providing the pivoted connection. The eye 42 of the member 40 projects in between the spaced ears 43—43 of a second universal joint member 44 provided with a socket end 45 which screws onto the adjacent end of a link or rod 46. A pin 47 serves to pivotally interconnect the two universal joint members 40 and 44. The link 46 is one element of the switch blade operating mechanism indicated, generally, at 18 in Fig. 1. This mechanism will now be described in detail in connection with Figs. 2–10 and Figs. 16–19.

The link 46 carries on the right end a universal joint member 48 comprising an internally threaded socket portion 50 which screws onto the end of the link 46 and a pair of ears 51—51 which fit over or straddle the eye portion 52 of another universal link member 53. This latter member also has a pair of spaced apertured ears 54—54 which straddle or fit over the eye portion 55 of a crank arm 56 having several integral portions thereto. The universal link member 48 is pivotally connected to the link 53 by means of a pin 57 while the universal link member 53 is pivotally connected to the eye portion 55 of the crank arm 56 by means of the pin 58.

The crank arm 56 is conveniently made in the form of a casting the shape and construction of which are shown in Figs. 2, 3, 4, 16 and 17. The crank 56 may be said to have a main body portion designated at 60 which is curved as viewed in three directions. In plan view, as shown in Fig. 2, it will be seen that the main body portion 60 is curved intermediate the integrally formed eye 55 on one end and an integrally formed eye 61 on the opposite end. Referring to Figs. 3 and 16 where the crank 56 appears in side elevation, it will be seen that the arm portion 60 is upwardly curved from the eye 61 to the eye 55. In end elevation as viewed in Figs. 4 and 17, it will be seen that the crank 56, made up of the main portion 60 is also upwardly curved from the eye 61 to the eye 55. In addition to the eyes 55 and 61, the crank arm 56 has integrally formed thereon a projection 62 which is bifurcated so as to provide apertured ears 63—63 which receive therebetween the eye portion 64 of a link member 65 having a bifurcated portion providing a pair of spaced ears 66—66 to which further reference will be made below.

For lightness in weight it will be seen that the arm 56 may be generally hollow-shaped. It will be understood that instead of being in the form of one casting, the crank arm 56 may be formed in several pieces and secured together as by welding, or bolts.

The eye portion 61 on the crank arm 56 fits over a crank shaft 67 (Fig. 9). This shaft 67 projects at one end into a socket 68 integrally formed on the side of a receiver or swingable socket 70 (Fig. 20) which receives and holds the inner end of the switch blade 15. This cylindrical housing or socket 70 may be a part of a multi-part casting which also includes a rotary housing 71.

It will be seen from Figs. 2 and 9 that the eye portion 61 of the crank 56 fits in between the protruding socket portion 68 and the adjacent or back side of the housing 71. In order to prevent relative movement between the crank arm 56 and the crank shaft 67, a pin 72 is provided which extends through both the shaft and the eye so as to lock them together. The shaft 67 also extends through an opening provided therefor in the rear wall of the housing 71 as shown in Fig. 9. On its outer end, the shaft 67 carries an arm 74, the eye 75 on the bottom of which fits over the end of the shaft 67 and is pinned thereto by means of a pin 76. It will be seen that the crank arm 56, shaft 67, and arm 74 constitute a rigidly interconnected assembly rotatable as a unit around the longitudinal axis of the shaft 67.

The arm 74 serves as the support for a cam roller 77 (Figs. 3 and 10) which is rotatably mounted on a projection 78 on the front side. The roller 77 operates or rolls in a cam track or cam slot 80 provided therefor, in a cam plate 81. The formation or configuration of the cam slot or track 80 will be described below. The cam plate 81 is secured by means of a pair of bolts 82—82 (Figs. 3 and 9) onto a hub member 83 (Fig. 9) which is secured onto the end of a stationary axle shaft 84 by a pin 85. There is integrally formed on the left side of the hub 83 as viewed in the drawings a projec-

tion 86 (Figs. 9 and 10) the outer end of which is horizontal and provided with a vertical aperture for receiving the threaded portion of an eye bolt 87 the upper end of which is in the form of an integral eye 88 (Fig. 9). The eye is tapped for receiving a bolt 90 projecting through the plate 81. A pair of nuts 91 and 92 (Fig. 7) are carried on the threaded portion of the bolt 87 on opposite sides of the projection 86.

In order to provide for accurate adjustment of the position of the cam plate 81 with respect to the hub portion 83 which is pinned to the shaft 84, the holes in the cam plate 81 through which the bolts 82 project have a sloppy fit relative thereto. It will be seen that by loosening these clamping bolts 82 and the nuts 91 and 92, this sloppy fit can be taken advantage of and the plate 81 may be tilted and shifted slightly in any direction. Once the desired adjustment has been obtained, the nuts 91 and 92 and the clamping bolts 82 are tightened, thereby securing the cam plate 81 in exactly the desired position on the supporting hub 83.

Referring to Fig. 9, it will be seen that the stationary shaft 84 extends through an opening therefor in the rear wall of the housing 71 and into a boss 94 integrally formed therefor on the adjacent side of the cylinder 70. Still referring to Fig. 9, it will be seen that the shaft 84 also passes through a journal 95, being one of two journals 95 and 96 (Figs. 18 and 19) integrally formed on the frame casting 14. The shaft 84 is pinned into the journal 95 by means of a pin designated at 97, and since the journal 95 is stationary it will be seen that the shaft 84, hub 83 and the cam plate 81 are likewise all stationary or fixed members.

Since the disconnecting switches are normally mounted outdoors, the rotary housing 71 is provided with a cover plate 98 which seals the housing, keeping out dirt, snow, rain, ice, etc. and also prevents unauthorized access to the interior. The cover plate 98 is secured in place by means of screws 100—100 extending through apertures provided in the periphery of the plate 98 in alignment with tapped bosses 101 formed on the interior of the housing 71 (Fig. 9).

For a proper understanding of the functioning of the operating mechanism 18 it is important to note that the housing 71 is integrally connected to the cylindrical socket housing 70 by means of an interconnecting curved web 102 as best shown in Fig. 20 and also in Figs. 2, 4, 16 and 17. The cylindrical socket housing 70 is cradled or rotatably supported in the frame casting 14 between the journals 95 and 96 as shown in Fig. 2. The housing 70 has integrally formed thereon a hollow boss 103 in axial alignment with the boss 94 whereby both of these bosses 94 and 103 fit in between the journals 95 and 96 respectively. As described above the shaft 84 projects through the journal 95 into the opening provided therefor in the boss 94 so as to serve as a trunnion for the adjacent side of the housing 70. In like manner a stub shaft 104 projects through the journal 96 and into the socket opening provided therefor in the boss 103. The shaft 104 is preferably pinned to the journal 96 as by means of a pin 105. In this way the inwardly projecting end of the stub shaft 104 serves as a trunnion for the adjacent side of the housing 70. By means of this arrangement it will be seen that the cylindrical socket housing 70 is pivotally supported on the frame 14 for rotation about a horizontal axis passing through journals 95 and 96, the hub portions 94 and 103, and coaxial with the shafts 84 and 104.

Reference is now made to Figs. 4, 5, 16 and 17 for a description of the manner in which the switch blade 15 is received and mounted in the cylindrical socket housing 70. Referring first to Fig. 5, it will be seen that the housing 70 is provided on opposite ends with annular grooves 106 and 107 each of which serves as one race for a set of balls 108—108. Slidably fitting into the housing 70 from right to left is a cylindrical sleeve member 110. On its right end (as viewed in Fig. 5) the sleeve 110 is provided with an integrally formed, radially extending flange 111 which fits against the outside of the adjacent balls 108 and serves to retain them in the track groove 107.

The sleeve member 110 projects from the left hand side of the housing 70 a substantial distance and it is externally threaded on the projecting portion so as to receive a large flanged nut 112, the flange 113 of which is adjusted so as to fit against the outside of the balls 108. By means of this arrangement it will be seen that the sleeve 110 is co-axially supported within the housing 70 for easy rotation therein.

On the interior of the sleeve 110 from left to right the sleeve is provided with four inwardly projecting circumferential ribs 114, 115, 116 and 117. These ribs are accurately machined to receive the outer diameter of the tubular blade 15 so that the blade may be slid through the sleeve 110 and supported therein at the four places along its length. The blade 15 is locked into the sleeve 110 by means of a clamping arrangement provided by a nut 118 (Fig. 17) which receives the inner end of a bolt 120. The bottom of the nut 118 is curved so as to conform to the inner surface of the blade 15 so as to prevent rotation and allow tightening of the bolt 120 from the outside.

The bolt 120 projects from the outside upwardly through an aperture provided therefor in a clamping member or arm 121 an upper portion of which is shaped to conform to the curvature of the exterior of the sleeve 110. On the left hand side of the clamping member 121, as viewed in Fig. 17, there is a projecting portion which provides a pair of apertured ears 122—122 (Figs. 16 and 17) for receiving therebetween the eye portion 123 of a universal link member having at the top another eye 124 which fits between the spaced ears 66, previously mentioned. The ears 122 are pivotally connected to the eye portion 123 by means of a pin 125 while the ears 66 are pivoted to the eye 124 by means of a pin 126.

By means of the foregoing arrangement it will be seen that the bolt 120 and nut 118 serve not only to fasten the switch blade 15 to the sleeve 110 but also to connect the clamping member 121 to the sleeve 110 whereby it may be interconnected through the two universal links or joints to the crank arm 56.

For ease of operation in lifting the switch blade 15 from the horizontal position to the vertically raised position, it is desirable to provide counterbalance means. While various types of such means could be used, a convenient one comprises a compression spring 127 (Fig. 6) housed in a tubular casing 128, closed at one end by means of an apertured end wall 130 and at the other by means of a screwed-on cap 131. The cap 131 has a pair of spaced ears 132 projecting therefrom which receive therebetween an eye 133 integrally formed on a bracket member 134. The eye 133 and the ears 132 are apertured and a connecting pin 135 extending therethrough serves to pivotally connect the casing 128 to the bracket 134. In order to compress the spring 127 a plunger 136 is provided carried on the right hand end of a connecting rod 137 which extends through the left end of the casing 128 and is provided with a bifurcated end member 138. The eye 140 of a bracket member 141 fits in between the opposite sides of the member 138 and the same are pivotally joined together by means of a pin 142 extending therethrough.

Referring to Fig. 2 it will be seen that the bracket member 134 is bolted to the side of the cylindrical socket housing 70 by means of a pair of bolts 143. Similarly the bracket 141 is bolted to the left end of the frame casting 14 by means of a pair of bolts 144 which extend through bolt holes 45 (Fig. 19) provided therefor. When the switch blade 15 is in the horizontal and closed position, the distance between the brackets 134 and 141

is at a maximum with the result that the plunger **136** holds the spring **127** in compression as indicated by the position of the plunger **136**, in Fig. 7. As will be explained in greater detail below, when the operating mechanism **18** is actuated so that the switch blade **15** is turned or raised into its vertical position (Fig. 8), the distance between the bracket **134** and the bracket **141** is at a minimum so that pressure on the spring **127** is relieved with the spring force being used to help lift (i.e. counterbalance) the weight of the blade **15**.

Referring to Figs. 18 and 19, it will be seen that the frame casting **14**, at its right hand, is provided with an integrally formed circular mounting base **146** which serves to support the frame on the top of the upper insulator in the insulator stack **7** as shown in Fig. 1. Immediately to the right of the mounting base **46** the frame is provided with an integrally formed portion **147** which is hollow and reinforced on the underside by integral cross webs **148**, and an integrally formed transverse portion **150** which is provided at the center with a vertical aperture **151** for receiving one of the bolts **152** (Figs. 2 and 3) used in mounting the frame on top of the insulator stack **7**.

The vertical sides of the end portion **147** are provided with apertures **153—153** which are tapped for receiving screws or bolts **154** (Fig. 2) by means of which two female contact assemblies **155** and **156** may be secured on the end of the frame casting **14**. The assembly **155** is made up of a contact bar **155***a*, a leaf spring **155***b*, and shorter leaf spring **155***c*. Similarly, the contact assembly **156** consists of a contact bar **156***a*, a leaf spring **156***b*, and a shorter leaf spring **156***c*. These contact assemblies **155** and **156** are provided with a series of slots **157** extending clear through each as shown in Fig. 3 so as to in effect provide the multiplicity of spring fingers which yieldably receive therebetween the adjacent portion of the switch blade **15** when this is in the horizontal position, as shown in Fig. 3. As shown in Figs. 3 and 21, the back up springs **155***b* and **156***b* are provided with rivet buttons **169—169** for applying spring pressure to the upper ends of the spring fingers formed in the contact bars **155***a* and **156***a*. The latter bars are provided with silver inlays **179—179** for engaging opposite sides of the blade **15**.

For a description of the front contact assembly, indicated generally, at **16** in Fig. 1, reference may now be had to Figs. 11–15. As previously mentioned, the switch blade **15** has a flat end portion which constitutes a male contact **158** having silver inlays **159** which in closed condition fit wedgedly in between a pair of spaced female contact members **160** and **161**.

The female contact members **160** and **161** have, at the top, outwardly turned horizontal attaching portions **162** and **163**, respectively, each of which is provided with four holes by which it may be secured to horizontal mounting ledges **164** and **165**, respectively. Screws **166—166** and **167—167** are used to secure the contacts in place. The contacts **160** and **161** are provided with vertical portions **168** and **170**, respectively, these being slotted, as indicated at **171** so as to provide flexible finger portions providing greater resiliency.

The horizontal mounting ledges **164** and **165** for supporting the contacts **160** and **161**, are integrally formed at the top of the side portions **172** and **173**, forming parts of a front clip casting designated generally at **174**. This casting **174** has a circular base **175** for mounting on the top insulator of the front stack **8** as shown in Fig. 1. Projecting from the front or right hand side of the circular base **175** is a lug **176** which serves as a support for an arcing horn **177** of known type. This cooperates with a horizontal arcing horn **178** which projects from the tip end of the flat male contact **158**. Such arcing horns are known in this type of a disconnecting switch and therefore do not require further description.

On the interior, the vertical side portions **172** and **173** are each provided a row of four inwardly projecting protuberances **180—180** and **181—181**, respectively. These serve to locate and support sets of compression springs **182** and **183**, respectively, which bear against back sides of the contact members **168** and **170** opposite the silver inlays **159** of the flat male contact **158**, as shown in Fig. 13. Preferably each of the protuberances **180** and **181** is provided with a washer **189** (Figs. 13 and 14) formed of insulation at the rear of each spring **182** and **183**. The washers **189** provide insulation at the lines of pressure between the springs and the casting.

On the left hand portion of the casting **174**, as viewed in Figs. 11 and 12, there are two upstanding switch blade guiding projections **184** and **185** (Figs. 13, 14 and 15), these being outwardly curved on their upper ends so as to provide for easy entry and guidance of the tip end of the switch blade **15** into place as it is lowered between the female contacts **160** and **161**. Beneath each integrally formed horn **184** and **185** there is a guiding edge **187** and **186** respectively. The guiding edge **187** below the guide **184** is slanted toward the center line as shown. This inclined portion **187** is abruptly terminated just above the axis of the blade **15** so as to provide an overhang or catch **188** which serves as a stop for engagement by the flat male contact **158**, as shown in Fig. 13.

It will be seen that by having the guiding edge **186** slope away from the centerline, clearance is provided so that the silver inlays **159** on the ends or sides of the male contact **158** may wedgingly engage the female contacts **168** and **170** without interference.

A stop **190** is provided beneath the guidance edges **186** and **187** and extends crosswise therebetween so as to serve as a stop to limit the downward movement of the switch blade **15**.

Referring to Figs. 11 and 12 it will be seen that the casting **174** has integrally formed on the right hand side thereof a platform portion **191** provided with four apertures **192** through which cable or conductor terminals may be connected in known manner.

The current path through the disconnecting switch is as follows: First, starting at the left end of the frame casting **14** at the terminal platform **193**, and assuming that the switch is in the closed position as shown in Fig. 1, the current path may be considered as entering the left end of the casting **14** and flowing to the right therethrough up to the stationary hinge contacts **17**. The current path continues upwardly through these contacts to the blade **15**, and then through the blade **15** to the flat male contact **158** on the outer or tip end thereof. The current path then enters from the silver inlays **159** of the male contact **158** into the female contacts **170** and **171** and flows upwardly as indicated by the arrows in Figs. 12 and 13. At the tops of the contacts **170** and **171** the path then extends to the right through the horizontal mounting ledges **164** and **165** and downwardly through the casting **174** around the downwardly curved nose portion **193** to the platform **191**. It will be understood that direction of current flow changes each cycle, but the flow path is the same. By having the female contacts **170** and **171** mounted so that they hang down or are inverted, instead of being turned up, and by having the current path through the front contact assembly **16** generally in the form of an inverted loop, a magnetic locking effect is obtained. That is, the magnetic forces created due to current flow are of such direction as to push the blade **15** down against the stop **190**. The magnetic forces can therefore be utilized to force the switch blade **15** into the closed position rather than to blow it out to the open position.

It is a known expedient in this art to design a contact assembly so that the current flow path is such that magnetic forces created during high momentary loads tend to close, rather than open, disconnecting switches. However, in the present design this magnetic locking effect combines with other locking actions built into the design

so as to produce an unusually large total locking effect for resisting high value momentary currents.

Since the rating of a disconnecting switch is primarily based upon its ability to handle high momentary loads or surges, it will be seen that the total locking effect becomes a very important factor. In this connection, it has been well established that as long as all relative movement (in any direction) between a pair of contacts is prevented, the contacts are able to handle very much larger loads than if even a slight amount of relative movement is permitted. It seems that if there is even any slight movement permitted, in effect, an avalanche of current is unloosed. However, if no movement is permitted at all, then very high momentary loads can be handled.

It the disconnecting switch described above in connection with the drawings, there is a cumulative three-fold locking effect available to handle and cope with high value momentary currents that exist from the time a short circuit originates until it is cleared by the opening of a circuit interrupting device. As already mentioned, the locking action due to magnetic forces tends to hold the switch blade **15** firmly down against the stop **190** and thereby all relative movement of the switch blade in a downward direction is eliminated.

The blade **15** in the closed position is locked against lifting by two combining locking actions. All tendency of the blade **15** simply to lift straight out of the contacts **168** and **170** is effectively resisted by the stop or catch **188** so long as the blade **15** is prevented from rotating. It is positively locked against rotation through the actuating linkage by having the arm **20** (Figs. 2 and 3) a few degrees (e.g. 5° over-center or over-toggle, when the blade is locked. Therefore, any reaction from the blade transmitted through the linkage which would tend to cause rotation is prevented by reason of this over-toggle or over-center condition.

Therefore, it will be seen from the above that once the blade **15** is in the lowered and locked position, there is a three-fold locking action present. First, the rigid stop **190** prevents any downward movement of the blade **15**. Second, the catch **188** prevents any upward movement of the switch blade **15**. Third, the over-toggle or over-center position of the arm **20** prevents any rotation of the switch blade **15**. The magnetic forces also serve to force the blade **15** down, as explained. In other words, the blade is locked against the downward, upward, or rotary movement, these being the only relative movements possible between the contact **158** and the female contacts **168** and **170**.

In operation: Assuming that the circuit in which the disconnecting switch is located has been broken or interrupted by other known means (e.g. an oil circuit breaker), and it is desired to open or disconnect the switch from the closed position shown in Fig. 1. This is done by rotating the insulator stack **6** as by cranking action on the downwardly projecting end **13** (Fig. 1), As mentioned above, it is usual to operate three disconnecting switches at the same time so that there will usually be three insulator stacks corresponding to stack **6** which are rotated at the same time. Rotation of each stack **6** produces a clockwise rotation of the arm **20** as viewed in Fig. 2. As mentioned above the extent of rotation of this arm **20** is approximately 110°, starting at approximately 5° over the center line of the switch as viewed in Fig. 2. It will be seen that rotation of the arm **20** exerts a leftward pulling action on the link **46**, through the universal joint construction interconnecting the adjacent ends thereof. Upon being pulled to the left as viewed in Fig. 3, the link **46** exerts a counterclockwise movement on the upper end of the crank arm **56**. At this point in the operation, the crank arm **56** is in the position shown in Fig. 3 and the cam roller **77** is located at the upper right hand extremity of the cam tract **80**.

The rotating action applied to the upper end of the arm **56** tends to produce two different rotations. First, it tends to rotate the interconnected unit comprising the crank arm **56**, the shaft **67** and the cam arm **74** about the axis of the shaft **67**. Second, it tends to swing the cylindrical socket housing **70** upwardly and rotate therewith the housing **71** integrally connected thereto.

The right hand portion of the cam track **80**, and particularly the surface designated at A in Fig. 7 is so located and shaped that at this point in the operation only the first type of rotation is permitted, the second being prevented or blocked by the cam follower **77** engaging against the cam surface A having an arcuate length of approximately 30°. As the crank arm rotates on with the shaft **67** while the housing **71** and the cylindrical housing **70** remain stationary, it will be seen that the projection **62** on the crank arm **56** delivers an upward pull on the linkage interconnected with the clamping member **121**. This produces a clockwise rotation of the switch blade **15** and the sleeve **110** as viewed in Fig. 17. The extent of this coaxial rotation of the blade **15** is sufficient to turn the male contact **158** from its horizontal locked position shown in Fig. 13 to the unlocked position shown in Fig. 13 to the unlocked position shown in Fig. 14.

When the cam roller **77** reaches the end of the first portion of the cam track and the end of the cam surface A as shown in Fig. 7, it enters the left hand portion and the cam roller **77** and now presses against and runs over a cam surface designated as B. This surface B is so shaped that it does not permit any further rotation of the unit comprising the crank arm **56**, the shaft **67** and the cam arm **74** relative to the housing **71**. Accordingly, there can be no more rotation of the switch blade **15** when the cam roller leaves the surface A and engages to the surface B. However, the cam surface B is so shaped that it allows the second type of rotation to occur. That is, the rotation of the housing **71** and the lifting of the cylindrical socket housing **70** on its pivot support in the frame casting **14**. Accordingly, the switch blade **15** lifts to the vertical position as shown in Fig. 8, with the aid of the counterbalance **128**.

From the foregoing, it will be seen that the rotation of the switch blade **15** about its longitudinal axis which produces the unlocking of the other contacts is isolated, separated and entirely independent from the lifting action of the switch blade. Conversely, during the lifting of the switch blade **15** no rotation of the blade about its longitudinal axis can take place.

When it is desired to close the disconnecting switch then the insulator stack **6** is rotated in the opposite direction so as to rotate the arm **20** in the counterclockwise direction as viewed in Fig. 2. It will be seen that during the closing of the switch the reverse action takes place from that described above. That is, the cam roller **77** engages the cam surface B' which permits only swinging or lowering movement of the blade **15** but no coaxial rotation. When the cam roller **77** reaches the junction between the two cam tract sections A and B the switch blade **15** will have reached its horizontal position engaging the stop **190** and further lowering action will be prevented by the stop **190** as well as the cam track portion A'. The pushing of the link **46** toward the right after the mechanism has reached the condition shown in Fig. 7 permits only the rotation of the crank arm **56** which acting through the linkage interconnected with the sleeve **110** produces rotation of the blade **15** about its longitudinal axis back into the locked position shown in Fig. 13.

The cam slot **80** is of such length that when the roller or follower **77** is at either extremity of its path it will be spaced from the ends of the slot as shown in Figs. 3 and 8.

It will be appreciated that the switch, instead of being horizontally mounted as shown in Fig. 1 could be vertically mounted in which case the switch blade **15** would be in the horizontal position when open.

Since numerous changes of a detail nature may be made in the disconnecting switch construction described above and shown in the accompanying drawings, while still retaining the principles of operation and without departing from the spirit and scope of the invention, it is intended that the foregoing disclosure of a presently preferred embodiment of the invention shall be interpreted as illustrative and not in a limiting sense.

What is claimed as new is:

1. In a disconnecting switch of the type described having an elongated switch blade which in operation of said switch first rotates about a longitudinal axis and then swings around a transverse axis adjacent its rear end during opening and first swings around said transverse axis and then rotates about said longitudinal axis during closing, a switch blade operating mechanism comprising, in combination, receiver means for receiving and supporting the rear end of said blade for rotation about a longitudinal axis, support means for said receiver means whereby it is swingable around said transverse axis, linkage means interconnected with said receiver means and said switch blade and operable both to rotate said blade about said longitudinal axis and to swing said support means and blade about said transverse axis, cam means operably connected with said linkage means whereby rotation about said longitudinal axis is segregated from swinging about said transverse axis, said linkage means being under tension as it produces said rotation and swinging of said blade in one direction of operation and being under compression as it produces said rotation and swinging of said blade in the other direction of operation.

2. In a disconnecting switch of the type described having an elongated switch blade which in operation of said switch first rotates about its longitudinal axis and then swings in a vertical plane around a transverse axis adjacent its rear end during opening and which reverses these movements in closing, a switch blade operating mechanism comprising, in combination, a swingable socket having bearing means for receiving and supporting the rear end of said switch blade for rotation about its longitudinal axis, frame means having bearing means for supporting said socket whereby it is swingable around said transverse axis, linkage means operably interconnected with said socket and the rear end of said blade operable under tension to rotate said blade about its longitudinal axis and swing said socket and blade around said transverse axis during opening and then under compression as these movements are reversed during closing, cam means comprising a cam and cam follower one of which is stationary and the other movable, means for operably connecting the movable cam member to said linkage means, said cam having two sections one of which permits rotation of said blade about its longitudinal axis and prevents it from swinging about said transverse axis, and the other of which permits swinging of said blade about said transverse axis and prevents it from rotating about its longitudinal axis.

3. In a disconnecting switch of the type described having an elongated switch blade which in operation of said switch rotates about its longitudinal axis and swings in a vertical plane around a transverse axis adjacent its rear end, a switch blade operating mechanism comprising, in combination, a swingable socket having bearing means for receiving and supporting the rear end of said switch blade for rotation about its longitudinal axis, frame means having bearing means for supporting said socket whereby it is swingable around said transverse axis, a rotary housing connected to said socket on one side thereof and rotatable on a support shaft the axis of which coincides with said transverse axis, a cam track providing member stationarily mounted on said shaft within said housing, a crank shaft parallel to said support shaft and extending into said rotary housing, a crank arm fixed to said crank shaft on the outside of said housing, a cam follower arm fixed on said crank shaft within said housing, a cam follower mounted on said arm for operative engagement with said cam track, linkage means operatively interconnecting said crank arm with said switch blade whereby rotation of said crank arm rotates said shaft about its longitudinal axis, said cam track having one section followed by said cam follower which permits said crank shaft, cam follower arm and crank arm to rotate while preventing said rotary housing and socket from moving, and said cam track having a second section followed by said cam follower which permits said rotary housing to rotate and said socket to swing on said transverse axis while preventing rotation of said crank shaft.

4. In a switch blade operating mechanism called for in claim 3, said cam track providing member comprising a plate having a slot which constitutes the cam track, and said cam follower being a roller operable in said slot.

5. In the switch blade operating mechanism called for in claim 3, said linkage means comprising, an arm clamped to said switch blade and projecting to one side thereof, and a universal joint one member of which is connected to said crank arm and the other member of which is connected to said arm clamped to the switch blade.

6. In the switch blade operating mechanism called for in claim 3, said bearing means for receiving and supporting the rear end of said switch blade comprising, a sleeve member co-axially disposed within said socket which receives the switch blade, and bearings at opposite ends of said socket in which said sleeve is rotatably supported in said socket.

7. In a disconnecting switch of the type described having a rotatable insulator stack, a rear stationary insulator stack adjacent said rotatable insulator stack, a front stationary insulator stack in line with said other two insulator stacks and spaced from said rear stationary stack on the same side of said rotary insulator stack, a frame member jointly supported on said rotary insulator stack and said rear stationary insulator stack, a switch blade operating mechanism mounted on said frame member, an operating arm mounted on said rotary insulator stack for operating said switch blade operating mechanism, a switch blade the rear end of which is operably supported by said operating mechanism and which in operation rotates about its longitudinal axis and swings in a vertical plane around a transverse axis adjacent its rear end, a flat male contact on the front end of said switch blade, front female contact means mounted on said front stationary insulator stack for lockably receiving said male contact, rear female contact means mounted on said frame member so as to receive therein in closed circuit conducting relationship said switch blade at a place adjacent its rear end, and counter balance means for assisting in the raising and lowering of said switch blade: said switch blade operating mechanism comprising, a swingable socket, a sleeve member co-axially disposed within said socket and over the rear end of said switch blade, bearings rotatably supporting said sleeve in said socket, bearing means for supporting said socket on said frame member whereby said socket is swingable about said transverse axis, a rotary housing connected to said socket on one side thereof and rotatable on a support shaft the axis of which coincides with said transverse axis, a cam plate having a cam track in the form of a two section slot stationarily mounted on said support shaft within said housing, a crank shaft parallel to said support shaft and extending into said rotary housing, a crank arm fixed to said crank shaft on the outside of said housing, a cam follower arm fixed on said crank shaft within said housing, a cam follower mounted on said arm for guided travel within said cam slot, an arm clamped to said switch blade and projecting to the side thereof, and a universal joint one member of which is connected to said crank arm and the other member of which is connected to said projecting arm, one section of said

cam slot permitting said crank shaft, cam follower arm and crank arm to turn and rotate said switch blade while preventing said rotary housing and socket from swinging, and the other section of said cam slot permitting said rotary housing and said socket to rotate and swing on said transverse axis thereby swinging said switch blade while preventing turning of said crank shaft; said female contact means comprising a casting providing a mounting base, a pair of spaced side portions having inwardly turned horizontal ledges formed on the tops for supporting therebetween from the top a pair of depending female contacts, a platform on the front at least as low as said male contact, a web portion at the rear interconnecting said side members adjacent the bottoms thereof and serving as a stop for limiting downward motion of said switch blade, and spaced upstanding guides for guiding the front end of said blade formed at the rear of said casting including outwardly turned horns at the top projecting above said ledges, with one of said guides having a guiding edge which slopes downwardly and inwardly to an overhang which is level with the top of said male contact when in its horizontal locked position and serving as an upper stop therefor, and with the guiding edges of both of said guides being bowed inwardly inside of the upper inner surfaces of said female contact for protecting the same and being disposed outwardly beyond the lower inner surfaces of said female contacts below said overhang so as not to interfere with engagement of said contacts by said flat male contact; linkage means interconnecting said operating arm mounted on said rotary insulator stack with said crank arm comprising a link member, and universal joints secured to each end thereof the outer end of one universal joint being connected to said operating arm and the outer end of the other universal joint being connected to said crank arm; said operating arm being in an over-toggle or over-center position when said switch blade is down and rotated to its closed position, and stop means limiting said over-center or over-toggle position.

8. In a disconnecting switch of the type described having a front insulator stack, an elongated switch blade which in operation of said switch rotates about its lon-

gitudinal axis and swings around a transverse axis adjacent its rear end, said rotation and swinging movements not being simultaneous and not overlapping, said switch blade having a flat male contact on the front end thereof, female contact means mounted on said front insulator stack for lockably receiving said male contact in closed current conducting relationship, comprising a mounting base, a pair of side members having inwardly turned parallel ledges formed on the tops thereof, a pair of female contacts having out-turned mounting flanges formed on the tops thereof by which each may be downwardly hung from one of said parallel ledges on the inner side of the adjacent side member, and a platform for terminal connections supported from the fronts of said side members at a level below said ledges whereby current flowing between said male contact and said platform follows a path generally in the form of an inverted loop, said mounting base, side members, ledges and platform being provided by an integral casting, having at the rear a web portion interconnecting said side members adjacent the bottoms thereof and serving as a stop for limiting downward motion of said switch blade, and having spaced guides for the outer end of said blade formed at the rear including outwardly turned horns at the top projecting above said ledges, with one of said guides having a guiding edge which slopes downwardly and inwardly to an overhang the underside of which constitutes a stop for said male contact, and with the guiding edges of both of said guides bowed inwardly inside of the upper inner surfaces of said female contacts for protecting the same and being disposed outwardly beyond the lower inner surfaces of said female contacts so as not to interfere with engagement of said contacts by said flat male contact.

References Cited in the file of this patent

UNITED STATES PATENTS

2,554,824	Graybill	May 29, 1951
2,697,144	Owens	Dec. 14, 1954
2,818,474	Gussow	Dec. 31, 1957