Aug. 25, 1953 H. P. SPARKES 2,650,276

CIRCUIT BREAKER

Filed May 12, 1950 4 Sheets-Sheet 1

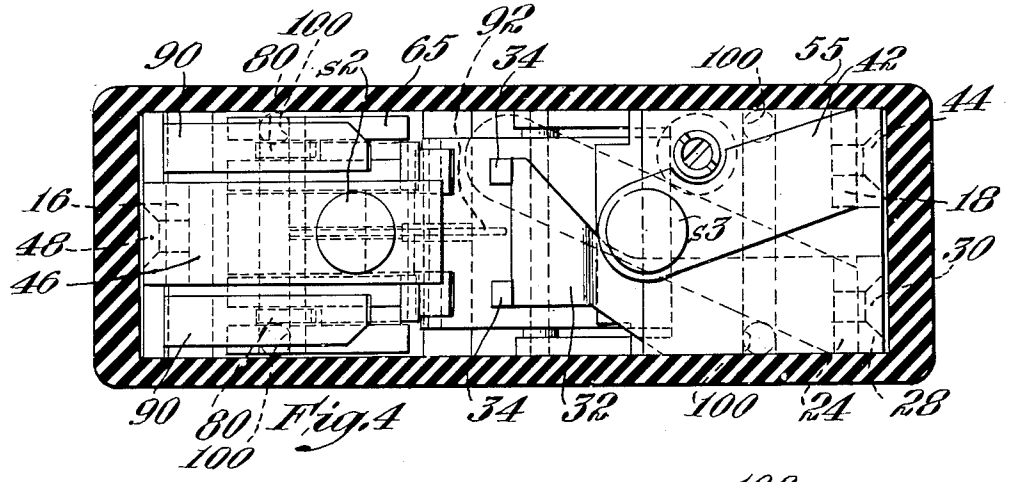


Fig. 4

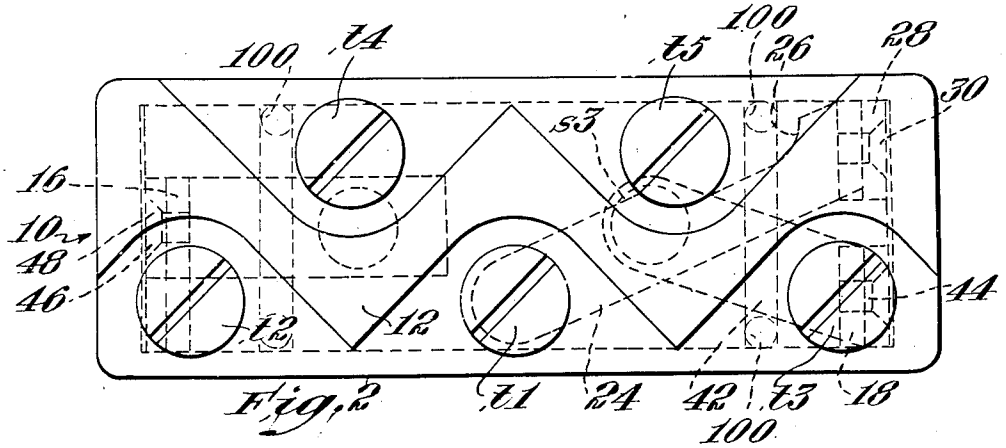


Fig. 2

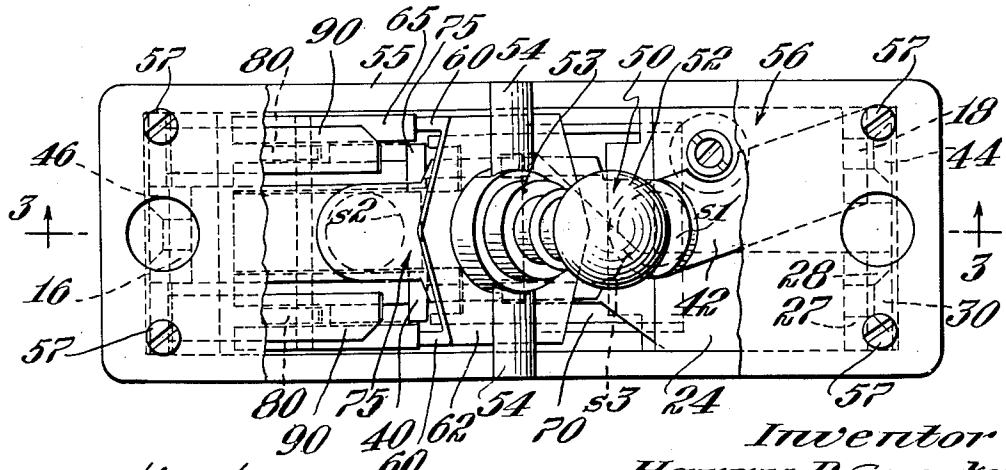


Fig. 1

Inventor
Harry P. Sparkes
by Roberts, Cushman & Groves
Attys.

Aug. 25, 1953 H. P. SPARKES 2,650,276

CIRCUIT BREAKER

Filed May 12, 1950 4 Sheets-Sheet 2

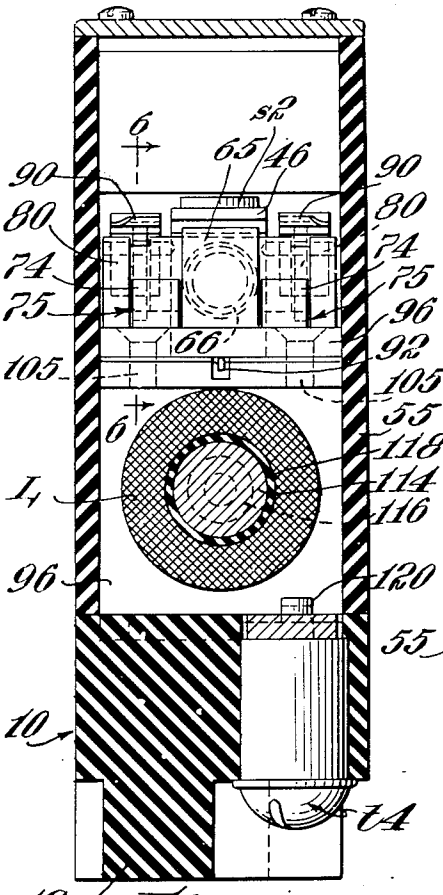


Fig. 5

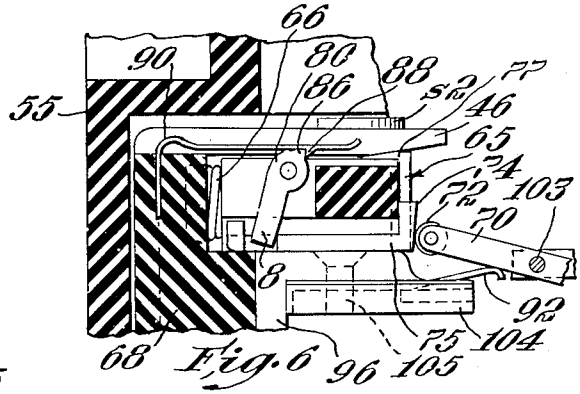


Fig. 6

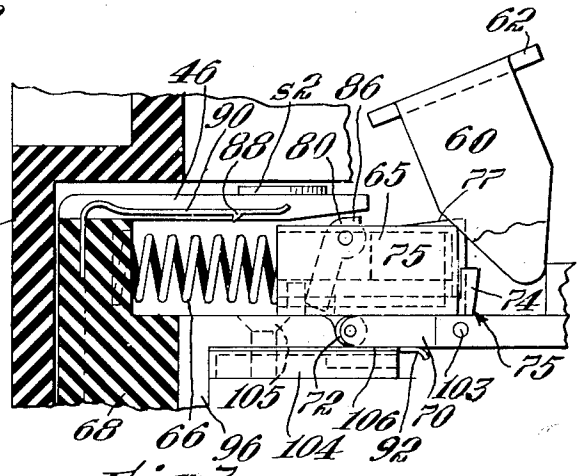


Fig. 7

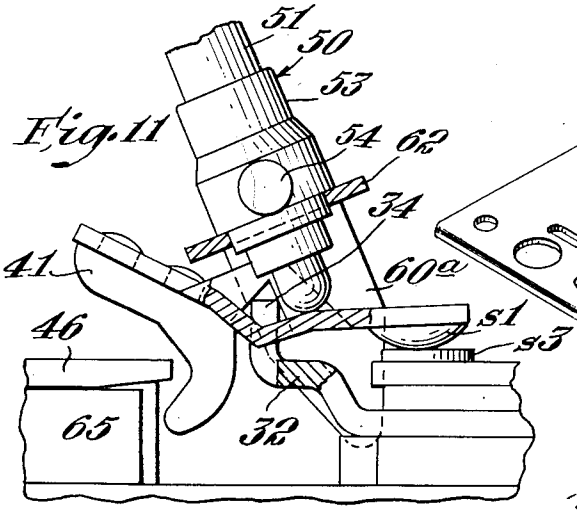


Fig. 11

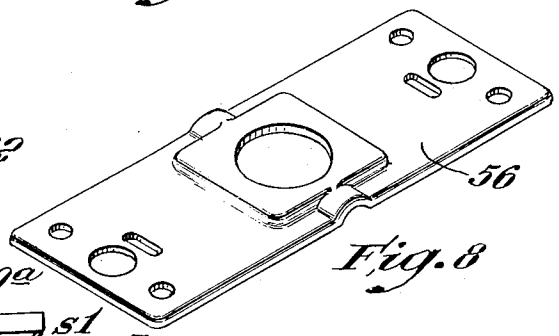


Fig. 8

Inventor
Harry P. Sparkes
by Roberts, Cushman & Grover
Attys.

Aug. 25, 1953 H. P. SPARKES 2,650,276

CIRCUIT BREAKER

Filed May 12, 1950 4 Sheets-Sheet 3

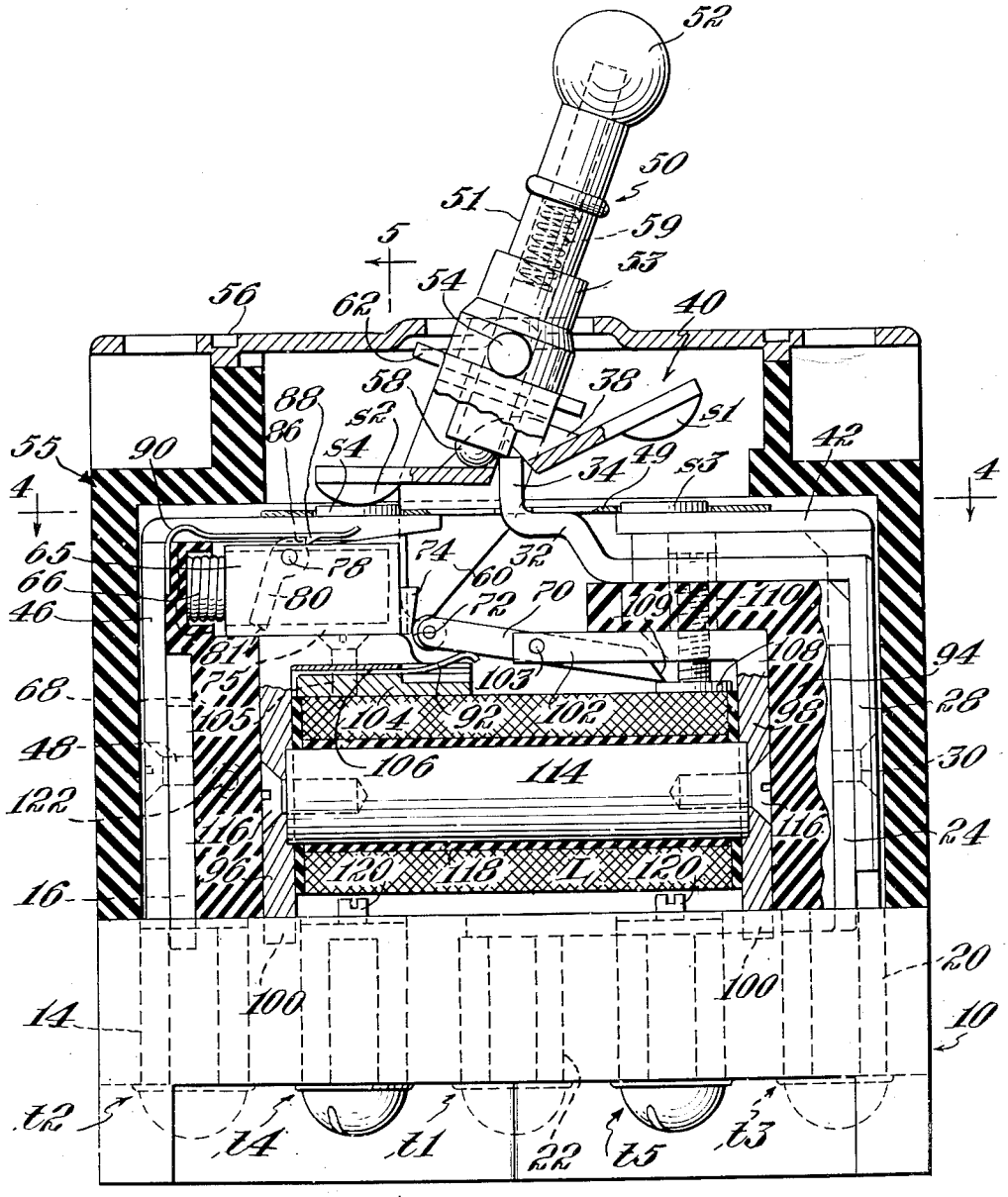


Fig. 3

Inventor
Harry P. Sparkes
by Roberts, Cushman & Grover
Att'ys.

Aug. 25, 1953 H. P. SPARKES 2,650,276

CIRCUIT BREAKER

Filed May 12, 1950 4 Sheets-Sheet 4

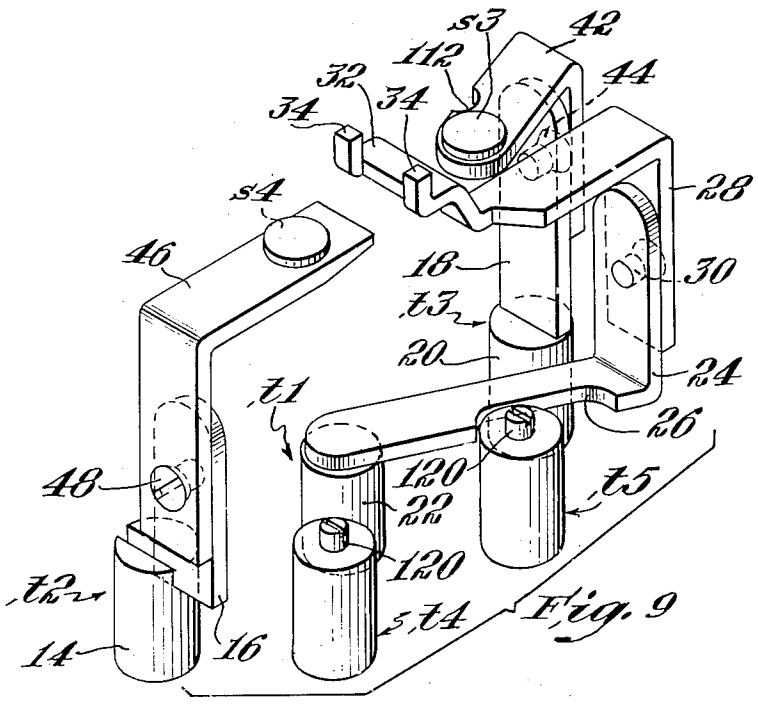


Fig. 9

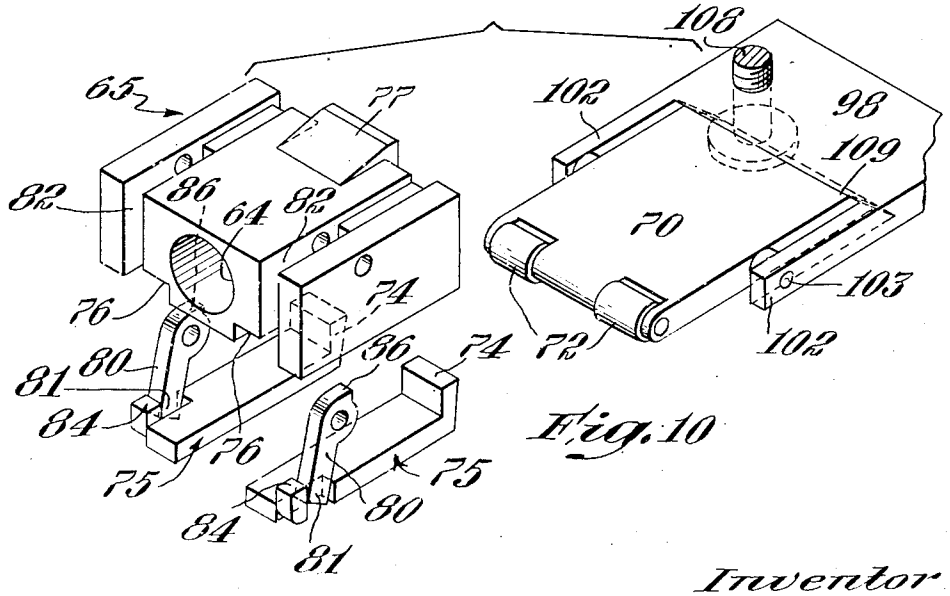


Fig. 10

Inventor
Harry P. Sparkes
by Roberts, Cushman & Groves
Att'ys.

Patented Aug. 25, 1953

2,650,276

UNITED STATES PATENT OFFICE

2,650,276

CIRCUIT BREAKER

Harry P. Sparkes, Orange, N. J., assignor to Anchor Manufacturing Company, Boston, Mass., a corporation of Massachusetts

Application May 12, 1950, Serial No. 161,493

16 Claims. (Cl. 200—89)

1

This invention relates to circuit breakers and more particularly to circuit breakers of the type used in vehicles such as airplanes or in other applications which require that the weight and size of the circuit breaker be kept to a minimum.

With the rapid increase in size and complexity of military and commercial airplanes, there has been a corresponding increase in size and complexity of their electrical supply systems. The electrical loads and number of distribution circuits have greatly increased in number in such modern aircraft requiring control equipment for switching and overload protection which is small in size and light in weight, but which must also be rugged and positive in operation under extreme conditions of temperature and the large forces resulting from acceleration and gravity.

Accordingly the principal objects of this invention are to provide a circuit breaker or solenoid operated switch which is very small and compact in size, which is light in weight, which is dependable and positive in operation, which requires a very low tripping current, which reduces heating and temperature rise to a minimum, which can be mounted adjacent similar circuit breakers without overheating, which has provision for both normally open and normally closed electrical load contacts, which can be tripped and reset manually, which meets the Army and Navy specifications for such type of apparatus, which can be produced by mass production techniques, and which advances the switch art generally.

In a principal aspect the invention contemplates a circuit breaker comprising one or more pairs of electrical load contacts biased in a set or normal position, for example, by a spring. Tripping means for automatically transferring the contacts are provided which include one or more latch pieces carried with or in a block urged by a spring along a path of travel from a latched position to a released position. The block and latch piece or pieces are restrained in their latched position by the open position of detent means which is moved to a closed position by means including actuating means such as a solenoid or bimetallic strip to release the block and latch pieces when the electric current through the actuating means exceeds a predetermined value. Preferably the detent means is an armature which is moved from its open position to a closed position wherein it releases the block and latch piece by the magnetic flux induced in a magnetic circuit by a solenoid when the current therethrough exceeds a predetermined value. Lever means interposed in the path of the block are arranged to transfer the contacts from their set position by the travel of the block upon its release by the actuating means. Resetting means are provided for manually returning the block and latch pieces to their latched position and conjointly transferring the contacts.

2

In a more specific aspect the slidable block is carried by two latch pieces, the block and pieces being arranged to slide in parallel relationship upon a portion of the magnetic circuit adjacent the armature. The end of the armature is provided with rollers which contact the ends of the latch pieces respectively when the armature is in the open position thereby to restrain the block and latch pieces in their latched positions. The configuration of the magnetic circuit is made substantially rectangular and the solenoid is wound upon the side or leg thereof opposite the side wherein the armature is hinged or otherwise movably arranged. The energization of the solenoid induces a magnetic flux in the magnetic circuit of sufficient magnitude to move the armature to its closed position when the solenoid current exceeds a predetermined value. The magnitude of such current as is required to move the armature to its closed position is determined by the position of an adjustable stop, for example, a threaded pin or screw, which limits the air gap between the armature and the adjacent portions of the magnetic circuit. To reduce to a minimum the force exerted upon the armature by the spring actuating the block, the mechanical advantage gained by the use of one or more levers is employed. For example, respective levers are pivotally attached at an intermediate point on opposite sides of the block so that one end of each lever bears against a respective latch piece. The opposite end of each lever is maintained stationary with respect to the block, for example by pivotally contacting a leaf spring or other member extending from the supporting structure. Greater effective leverage is obtained by employing a lever, bent for example, at the point of pivotal connection to the block so that the component of restraining force exerted by the armature upon the latch pieces (and therefore upon the block) parallel to the path of travel of the block is relatively effectively greater with respect to the total force exerted by the armature than the parallel component of the force exerted by the spring interposed between

the block and the casing is with respect to the total spring force.

In another aspect a rocking toggle member is bent at its midpoint so that the ends thereof, one or both of which are provided with movable contacts, form an obtuse angle. The rocking member is pivotally supported at its midpoint preferably being provided with notches which engage the bifurcated end of a strap which being made of conducting material provides an electrical path to the moving contacts. A toggle arrangement including a biasing spring is provided for maintaining the rocking member at either end of its path of travel so that the movable contacts upon the ends thereof are alternatively maintained in either an open position or in engagement with corresponding stationary contacts carried by the support. The toggle arrangement comprises a hollow actuator which also acts as a manual reset lever for returning the block and latch pieces to their latched position which actuator is pivotally attached to the casing or cover therefor immediately above the pivot point of the rocking member and has telescoping therein a member such as a pin. The rounded lower end of the pin is held against the rocking member by a spring thereby to maintain the rocking member at either end of its path of travel so that the contacts are biased in either an open or closed position as the case may be. The actuator is also provided with one or more extensions interposed in the path of the block so that the movement of the block upon its release by the armature transfers the contacts from the set or "on" position.

These and other objects and aspects will be apparent from the following description of an illustrative specific embodiment of the invention referring to drawings in which:

Fig. 1 is a top view of one embodiment of the invention with cover partially broken away;

Fig. 2 is a bottom view showing the terminal block;

Fig. 3 is a sectional view on line 3—3 of Fig. 1;

Fig. 4 is a sectional view on line 4—4 of Fig. 3;

Fig. 5 is a sectional view on line 5—5 of Fig. 3;

Fig. 6 is a fragmentary sectional view on line 6—6 of Fig. 5 showing the movable block and latch pieces in the latched position;

Fig. 7 is a similar view to that shown in Fig. 6 with the movable block in elevation moved to the released position;

Fig. 8 is an isometric view showing the details of the cover plate;

Fig. 9 is an isometric view of the conducting straps comprising the electrical circuit;

Fig. 10 is an isometric view of the armature and block and latch assembly; and

Fig. 11 is a partial elevation view in section showing a second configuration wherein the contacts are free tripping.

Referring particularly to Figs. 2 and 3 of the drawings, the circuit breaker illustrated comprises a terminal block 10, preferably molded of an insulating plastic material, upon which block are supported the magnetic and electric circuits and the tripping mechanism as will be described in detail hereinafter. The bottom of the block 10 is provided with a serrated barrier 12 (Fig. 2) molded integrally therewith to form a plurality of recesses wherein are located the heads of screws for terminals *t1*—*t5* which are used to connect the circuit breaker with the leads from its external load and control circuits (not shown). Each of the terminals *t1*—*t5* consists of an insert having a threaded axial recess to receive the correlated screw for securing the lug (not shown) of a connecting conductor. The outer surface of the inserts are preferably knurled so that they can be securely molded into the block 10.

The upper end of the insert 14 (Fig. 9) for the terminal *t2* is slotted to accommodate a strap 16 of a conducting material, the strap being silver soldered or otherwise secured in the slot in the insert in an offset position so that the strap is located centrically with respect to the width of the block 10. A second conducting strap 18 extends directly upwardly at one corner of the block 10 from the insert 20 of the terminal *t3*, the strap preferably being formed as an integral part of the insert. The insert 22 of the terminal *t1* has silver soldered thereto a conducting strap 24 which laterally extends to the opposite corner of the block 10 being cut away as at 26 so that it avoids the terminal *t5*.

To complete the electrical circuit from terminal *t1* to the movable contacts, the strap 24 has attached to its upwardly projecting end the lower end of a conducting strap 28. The ends of the straps 24 and 28 are lapped and fastened together by means of a flat headed screw 30. The strap 28 is bent at a right angle at an intermediate point so that a lateral portion thereof extends obliquely inwardly to a central position as is best shown in Fig. 4. The centrically located end 32 of the strap 28 is stepped upwardly and bifurcated, as is shown in Fig. 9, having two upwardly projecting fingers 34 which respectively engage notches in the upturned lips 38 (Fig. 3) located at the midposition of a bent rocking toggle member or arm 40 carrying the movable contacts *s1* and *s2* at its respective ends.

The toggle arm 40 is pivoted on the fingers 34 with a rocking motion by means which will be described hereinafter so that the movable contacts *s1* and *s2* at the ends thereof are alternatively brought into electrical engagement with stationary contacts *s3* and *s4* respectively. The stationary contact *s3* is secured to one end of a conducting strap 42 (Fig. 9) which is bent normally at an intermediate point so that the opposite end thereof lies adjacent the upwardly extending end of the strap 18, the straps being fastened together by means of a flat headed screw 44. The stationary contact *s4* is similarly carried by a strap 46 which connects with the strap 16 extending from the terminal insert 14 as has been described heretofore, by means of the flat headed screw 48. A mica arc shield 49 having apertures for the stationary contacts *s3* and *s4* is laid upon the top of the conducting straps 42 and 46 thereby to separate the contacts from the remaining elements of the circuit breaker as is shown in Fig. 3.

From the foregoing, it will be evident that upon the positioning of the toggle arm 40, as is shown in Fig. 3 so that the contacts *s2* and *s4* are in engagement, completes an electrical circuit from terminal *t1* to terminal *t2*; and conversely the positioning of the toggle arm so that the contacts *s1* and *s3* are in engagement completes an electrical circuit from terminal *t1* to terminal *t3*. The above-mentioned positioning of the toggle arm 40 may be accomplished manually by means of an actuator 50 which actuator also carries the spring means for biasing the toggle arm in either of its extreme positions as will be described below. As is best shown in Fig. 3, the actuator 50 comprises a hollow member or tube 51 at one end of which is formed an integral ball 52 which acts as a knob or handle for moving the actuator.

Surrounding the opposite end of the tube 51 is a sleeve 53 having a pair of oppositely disposed trunnions 54 (see also Fig. 1), journaled in recesses in the top of a casing 55 which mounts on top of the terminal block 10 to enclose the remaining elements of the circuit breaker. The trunnions 54 are held in the casing recesses by a cover 56 which is attached to the casing by means of screws 57 engaging inserts in the top of the casing 55. Telescopingly arranged within the tube 51 is a member such as the pin 58 the upper end of which is contacted by a spring 59 compressed within the tube recess. The lower end of the pin 58 is spherically shaped and bears against the toggle member 40 thereby biasing such member in either of its extreme limits of travel.

Provision is also made for tripping the contacts of the circuit breaker automatically. To this end, the actuator 50 has extending from the lower end thereof two arms 60 which are formed integrally and bent at right angles to a central portion 62 having an aperture so that it can be pressed over the tube 51 beneath the trunnion sleeve 53. With the actuator in a first position as shown in Fig. 3, the arms 60 bear against the end of a slidable trigger block 65. As is best shown in Fig. 10, the central portion of the block 65 is provided with a circular aperture 64 wherein is enclosed a trigger spring 66 (Fig. 3) one end of which bears against the bottom of the recess. The other end of the spring 66 seats in a recess in a separator or insert 68 which separates the conducting straps 46 and 18 from the low reluctance elements of a magnetic circuit as will be described in detail below.

The block 65 is restrained by a detent member so that it cannot move the actuator arms 60 and thus rock the toggle arm 40. The detent member is also the armature 70 of the above mentioned magnetic circuit. The end of the armature 70 is provided with two rollers 72 which bear against the respective upturned ends 74 of two latch pieces 75 to restrain the trigger block 65 in its latched position shown in Fig. 3. As is best shown in Fig. 10, the bottom of the trigger block 65 has two longitudinally disposed grooves 76 whose depth is slightly more than the thickness of the latch pieces 75 so that the pieces extend slightly below the block. Similar grooves are provided in the front face of the block 65 to accommodate the upturned ends 74. The top of the block 65 is provided with a protruding boss 77 whose upper wedge-shaped portion, when the block is in the latched position shown in Fig. 6, engages the beveled under surface of the strap 46 thereby to insure that all elements are in exact position so that an accurate calibration can be secured which will permit the circuit breaker to repeat at temperatures varying over a very wide range and without requiring close manufacturing limits.

To reduce the restraining force exerted by the armature 70 to a minimum, two bent levers such as the angular displaced dogs 80 are pivotally attached to the block 65 by means of pins 78 (Fig. 3) so that the dogs can rotate in deep slots 82 (Fig. 10) in the rear of the block. The lower end or tail 81 of each dog 80 engages a rectangular notch cut in the side of the corresponding latch piece 75, the tails being prevented from leaving the notches by the upturned projections 84 respectively. A finger 86 at the opposite end of each dog 80 engages a mating finger 88 (Fig. 3) extending downwardly from a respective cantilever spring 90 one end of which is inserted in a slot in the plastic insert 68 so that the tip of the finger 86 acts as a fulcrum for the dog 80 whereby a mechanical advantage of as great a value as 8 may be readily obtained. An additional mechanical advantage is obtained by angularly displacing the dog 80 at the pin 78 so that a ratio of approximately 2:1 exists between the cosine of the angle formed by the vector of the force exerted by the trigger spring 66 and a line normal to the lever arm extending from the point of contact between the fingers 86 and 88 and the center of the pin 78 and the cosine of the angle formed by the vector of the restraining force exerted upon the end 81 of the dog by the associated latch piece 75 and a line normal to the lever arm extending from the point of contact between the fingers 86 and 88 and the point of contact of the dog end 81 and the associated latch piece 75, that is, the component of the restraining force acting parallel to the path of travel of the block 65 exerted by the rollers 72 of the armature 70 upon the upturned ends 74 of the latch pieces 75 and the front face of the block 65 is relatively approximately twice as effective with respect to the total force exerted by the armature as the parallel component of the force exerted by the spring 66 is to the total force exerted by such spring. The total mechanical advantage gained is therefore 8 x 2 resulting in a reduction by 16 of the force which must be exerted by the armature 70, and a corresponding diminution of the magnetic force required to move the armature to its closed position against the force exerted by a biasing spring 92. When tripping occurs the above described relation between the vectors of the forces reverses and the ratio is reduced from 2:1 to 1:1 by a slight forward motion of the block, a feature which decreases the trip time and aids in positive action of the device.

The required magnetic force for closing the armature is further reduced by beveling the front face of the latch piece ends 74 against which the rollers 72 bear so that a slight movement of the armature 70 brings it past the "dead center" point whereupon the force of the trigger spring 66 aids rather than hinders the closing thereof.

Upon the closing of the armature 70 by magnetic flux induced in the magnetic circuit as will be described in detail below, the latch pieces 75 are no longer restrained so that they are slid along the top of a portion of the magnetic circuit adjacent the armature to the position shown in Fig. 7. The tripping spring 66 also moves the block 65 and the actuator arms 60 until the side of the arms opposite the block come into contact with the top portion of a second plastic separator or insert 94 for separating the components of the magnetic and electrical circuits.

The above mentioned magnetic circuit of which the armature 70 is one element also includes two inverted L-shaped straps 96 and 98 of a low magnetic reluctance material, for example mild steel. The lower end of the vertical leg of the strap 96 is provided with two projecting protuberances such as the fingers 100 which extend into respective recesses in the terminal block 10. Similar fingers are also provided upon the end of the corresponding leg of the strap 98. As is best shown in Fig. 10, the end lateral leg of the strap 98 is bifurcated having two fingers or tines 102 between which is pivotally supported the armature 70. The pivotal connection or hinge consists of a pin 103 which extends through

aligned apertures near the ends of the tines to engage a transverse aperture positioned near the longitudinal midpoint of the armature. The armature 70 is statically and dynamically balanced thereby substantially overcoming the effects of vibration, shock, gravity and acceleration.

The movement of the armature towards its "closed" position is limited by a stop piece 104 of a low reluctance material which is attached beneath the lateral leg of the strap 96 by means of two flat headed screws 105. The top and one end of the stop piece 104 are grooved to receive the armature biasing spring 92 mentioned above. A shim 106 of brass or other high reluctance material is interposed between the stop piece 104 and the strap 96 so that the armature does not "freeze" in the "closed" position when it is in contact with the stop piece as is shown in Fig. 7.

The movement of the armature 70 in the opposite direction to its "open" position is limited by a stop such as the head of an adjustment screw 108 (Figs. 3 and 10) which is contacted by the beveled end 109 of the armature opposite the rollers 72. The screw 108 threadingly engages an aperture in the magnetic circuit strap 98 and is locked in position by means of a circular checknut 110 (Fig. 3). From the above it will be evident that rotating of the screw 108 will either raise or lower the head of the screw with respect to the strap 98 and therefore with respect to the pivot point of the armature 70. It will be further evident that the raising of the screw 108, decreases the air gap between the stop piece 104 and end of the armature 70, so that the magnetic flux required to close the armature against the force of the biasing spring 92 is decreased; and conversely lowering the screw increases the air gap so that the magnetic flux required to close the armature is increased. To facilitate rotating the screw 108, both the end of the screw body and the corresponding end of the checknut 110 are provided with transverse slots for a screw driver or other adjusting tool. A circular aperture provided in the mica arc shield 49 and the conducting strap recessed as at 112 (Fig. 9) so that the screw driver can be inserted in the slots by removal of the cover plate 57.

The magnetic circuit is completed by a core piece 114 which extends between the vertical legs of the straps 96 and 98 being secured thereto by means of the screws 116. The core piece 114 is circular in cross section to accommodate a plastic spool 118 whereupon is wound the solenoid L for inducing the magnetic flux in the magnetic circuit. The solenoid L comprises a plurality of turns of an insulated conductor, the respective ends of which are connected by soldering to lugs 120 on the ends of the inserts of terminals *t4* and *t5*.

The circuit breaker is assembled by first mounting the elements of the magnetic circuit on the top of the terminal block 10 with the fingers 100 engaging the recesses in the block. The separators 68 and 94 are then inserted respectively between the magnetic circuit strap 96 and the conducting strap 16 and the magnetic strap 98 and the conducting straps 18 and 24. The tripping block 65 and associated parts are assembled on the top of the magnetic circuit strap 96 and secured in place by attaching the conducting strap 46 to the strap 16 by means of the screw 48 which also locks the spacer 68 in place. The other spacer 94 is secured in an analogous manner by attaching the straps 28 and 42 to the straps 24 and 18 respectively. The mica shield 49 is set in place over the stationary contacts *s3* and *s4* before the outer casing 55 is set in and slid over the parts assembled as described above. The casing 55 is secured in place by two opposed screws 122 which extend through clearance holes in the casing to engage threaded apertures in the opposite sides of the separator 68. The toggle arm 40 is placed on the fingers 34 at the end of the conducting strap 28 and the trunnions 54 of the actuator 50 placed in the journal recesses in the top of the casing 55. The trunnions 54 are held in place by the cover plate 57 which is secured by the screws 57. The above described relay is connected to its external circuits in the conventional manner, the terminals *t1*—*t3* connecting to the circuit to be controlled; the solenoid L being connected in the same or a separate control circuit by the terminals *t4* and *t5*. With the actuator handle 52 moved to the set position shown in Fig. 3, the contacts *s2* and *s4* are closed and the contacts *s1* and *s3* are in the open positions. The movement of the actuator 50 to the set position also causes the arms 60 to force the trigger block 65 into the position shown in Fig. 6, wherein the block is latched by the armature 70 as described heretofore. The contacts can be transferred so that contacts *s2* and *s4* are open and *s1* and *s3* are closed by rocking the toggle member 40 by movement of the actuator 50 to its opposite position from that shown in Fig. 3. Such movement may be accomplished manually by means of the handle 52 whereupon the trigger block is still restrained by the armature 70 as is shown in Fig. 6. The automatic movement of the actuator 50 results from the forcing of the block 65 against the arms 60 by the action of the spring 66, when the block is released by the armature 70 upon the flow of a current through the solenoid L of a sufficient magnitude so that the resulting flux in the magnetic circuit overcomes the biasing action of the spring 92. The position of the various tripping elements after being automatically tripped is shown in Fig. 7. The circuit breaker is reset by manual movement of the actuator 50 to the set position as described above.

The second embodiment of the circuit breaker shown in Fig. 11 is analogous in most respects to the above described embodiment, its similar parts being identified by the same indicia with the exception of its toggle member 40*a* and actuator arms 60*a* which are altered so that it "trips free." In the embodiment of Fig. 11 the contacts *s2* and *s4* are replaced by a finger 41 which is riveted to the underside of the right hand end of the toggle member 40*a* so that the hooked end of the finger is in the path of travel of the trigger block 65. The obtuse angle at which the toggle member 41 is bent is such that the actuator 50 is moved to a vertical position as the contacts *s1* and *s3* are opened by the finger as the actuator is contacted by the trigger block 65 upon the release thereof by the armature 70.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; means for biasing the movable one of said contacts in a set position; tripping means including a slidably arranged block, a spring for urging the block along a path of travel from

a latched position to a released position, and lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from their set position upon the movement of the block to its released position; detent means for restraining the block in its latched position including a lever arrangement pivotally attached to the block with one end bearing against a relatively stationary portion of the circuit breaker to act as a fulcrum whereby the force exerted by the detent means against the block to overcome the force of the spring is reduced; magnetic means including a solenoid for releasing the detent means so that the block is moved along its path of travel by the spring to transfer the contacts when the current through the solenoid exceeds a predetermined value; and resetting means for returning the block to its latched position and conjointly transferring the contacts to their set position.

2. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including a latch piece slidably arranged with respect to the magnetic circuit to move along a path of travel from a latched position wherein the latch piece is restrained by the armature in its open position to a released position, a block carried by said latch piece, and a spring bearing against said block to urge conjointly the block and latch piece to the released position; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the latch piece by the movement of the armature to its closed position; and resetting means for returning the block and latch piece to their latched position and conjointly transferring the contacts to their set position.

3. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including two latch pieces arranged to slide in parallel relationship on a portion of the magnetic circuit, a block carried by the latch pieces, a spring urging the block and latch pieces along a path of travel from a latched position wherein the block and latch pieces are retrained by the armature in its open position to a released position; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch pieces by the movement of the armature to its closed position; and resetting means for returning the block and latch pieces to their latched position and conjointly transferring the contacts to their set position.

4. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; an enclosing casing; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including a latch piece arranged to slide on a portion of the magnetic circuit, a block carried by the latch piece, a spring interposed between the casing and one end of the block for urging the block and latch piece along a path of travel from a latched position wherein the block and latch piece are restrained by the armature in its open position to a released position and a lever pivotally attached at an intermediate point to the block so that one end thereof bears against the latch piece, the opposite end of the lever being maintained stationary with respect to the block to act as a fulcrum thereby reducing the force exerted upon the armature by the action of the spring; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch piece by the movement of the armature to its closed position; and resetting means for returning the block and latch piece to their latched position and conjointly transferring the contacts to their set position.

5. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; an enclosing casing; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including two latch pieces arranged to slide in parallel relationship on a portion of the magnetic circuit, a block carried by the latch pieces, a spring interposed between the casing and one end of the block for urging the block and latch pieces along a path of travel from a latched position wherein the block and latch pieces are restrained by the armature in its open position to a released position, and two levers each pivotally attached at an intermediate point to a respective side of the block so that one end thereof bears against respective latch pieces, the opposite end of each lever being maintained stationary with respect to the block to act as a fulcrum thereby reducing the force exerted upon the armature by the action of the spring; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch pieces by the movement of the armature to its closed position; and resetting means for returning the block and latch pieces to their latched position and conjointly transferring the contacts to their set position.

6. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; an enclosing casing; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including a latch piece arranged to slide on a portion of the magnetic circuit, a block carried by the latch piece, a spring interposed between the casing and one end of the block for urging the block and latch piece along a path of travel from a latched position wherein the block and latch piece are restrained by the armature in its open position

to a released position, and a lever pivotally attached at an intermediate point to the block so that one end thereof bears against the latch piece, the opposite end of the lever being maintained stationary with respect to the block to act as a fulcrum thereby reducing the force exerted upon the armature by the action of the spring, the lever being bent at its point of attachment to the block so that the effective component of the restraining force exerted parallel to the path of travel of the block by the armature is relatively greater than the parallel effective component of the force exerted by the spring; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch piece by the movement of the armature to its closed position; and resetting means for returning the block and latch piece to their latched position and conjointly transferring the contacts to their set position.

7. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; an enclosing casing; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including two latch pieces arranged to slide in parallel relationship on a portion of the magnetic circuit, a block carried by the latch pieces, a spring interposed between the casing and one end of the block for urging the block and latch pieces along a path of travel from a latched position wherein the block and latch pieces are restrained by the armature in its open position to a released position, and two levers each pivotally attached at an intermediate point to a respective side of the block so that one end thereof bears against a respective latch piece, the opposite end of each lever being maintained stationary with respect to the block to act as a fulcrum thereby reducing the force exerted upon the armature by the action of the spring, the levers being bent at their point of attachment to the block so that the effective component of the restraining force exerted parallel to the path of travel of the block by the armature is relatively greater with respect to the total force exerted by the armature than the parallel effective component of the total force exerted by the springs; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch pieces by the movement of the armature to its closed position; and resetting means for returning the block and latch pieces to their latched position and conjointly transferring the contacts to their set position.

8. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; a magnetic circuit of low reluctance material formed into an essentially rectangular configuration, one of the sides thereof having a hinged portion acting as an armature, a spring biasing the armature in an open position, and a solenoid wound about a second side of the magnetic circuit for inducing a magnetic flux therein to move the armature from the open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including a latch piece slidably arranged with respect to the magnetic circuit, a block carried by the latch piece, a spring conjointly urging the block and latch piece along a path of travel from a latched position wherein the block and latch piece are restrained by the armature in its open position to a released position; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch piece by the movement of the armature to its closed position; and resetting means for returning the block and latch piece to their latched position and conjointly transferring the contacts to their set position.

9. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; a magnetic circuit of low reluctance material formed into an essentially rectangular configuration, one of the sides thereof having a hinged portion acting as an armature, a spring urging the armature so as to increase the air gap between the armature and the adjacent portions of the magnetic circuit, an adjustable stop for limiting the movement of the armature thereby determining its open position, and a solenoid wound about an opposed side of the magnetic circuit for inducing a magnetic flux therein to move the armature from the open to a closed position when the solenoid current exceeds a value determined by the adjustment of the stop; tripping means for the movable one of said contacts including a latch piece slidably arranged with respect to the magnetic circuit, a block carried by the latch piece, a spring conjointly urging the block and latch piece along a path of travel from a latched position wherein the block and latch piece are restrained by the armature in its open position to a released position; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch piece by the movement of the armature to its closed position; and resetting means for returning the block and latch piece to their latched position and conjointly transferring the contacts to their set position.

10. A circuit breaker comprising at least one pair of electrical contacts one of which is movable; means including a low reluctance magnetic circuit having a hinged portion forming an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including a latch piece slidably arranged with respect to the magnetic circuit, a block carried by the latch piece, a spring conjointly urging the block and latch piece along a path of travel from a latched position to a released position, a roller carried by the armature and contacting the latch piece in the open position of the armature thereby to restrain the block and latch piece in the latched position; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch piece by the movement of the armature to its closed position; and resetting means for returning the block and latch piece to their latched position and conjointly transferring the contacts to their set position.

11. A circuit breaker comprising at least one pair of electrical contacts one of which is mov-

able; means including a low reluctance magnetic circuit having a hinged portion forming an armature provided with rollers on one end thereof, and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including two latch pieces arranged to slide in parallel relationship on a portion of the magnetic circuit adjacent the end of the armature carrying the rollers, each of the latch pieces having a shoulder at one end thereof, a block carried by the latch pieces, a spring conjointly urging the block and latch piece along a path of travel from a latched position to a released position, the rollers carried by the armature contacting the respective shoulders of the latch pieces in the open position of the armature thereby to restrain the block and latch pieces in the latched position, the surfaces of shoulders being chamfered so that the force exerted by the spring assists the magnetic flux in moving the armature to its closed position; lever means interposed in the path of the block and connected with said movable contact to transfer the contacts from a set position upon the release of the block and latch pieces by the movement of the armature to its closed position; and resetting means for returning the block and latch pieces to their latched position and conjointly transferring the contacts to their set position.

12. A circuit breaker comprising an enclosing casing having an open end, a terminal block closing said end, two pair of electrical contacts positioned at the opposite ends of the casing, each pair including a stationary contact and a movable contact, two conducting straps each carrying a stationary contact and extending respectively along the inner surfaces of opposed walls of the casing to the terminal block, a rocking member carrying the movable contacts at the respective ends thereof, a third conducting strap extending along one of the casing walls from the terminal block and having an end upon which is pivotally mounted the rocking member so that the movable contacts can be selectively transferred to make electrical contact with a corresponding stationary contact; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; spacers inserted between the conducting straps and the magnetic circuit so that the straps and magnetic circuit are held in position by the casing; tripping means for the movable one of said contacts including a latch piece arranged to slide along a portion of the magnetic circuit adjacent the armature, a movable block carried by the latch piece, a spring conjointly urging the movable block and latch piece along a path of travel from a latched position wherein the movable block and latch piece are restrained by the armature in its open position to a released position; lever means interposed in the path of the movable block and connected with said movable contact to transfer the contacts upon the release of the movable block and latch piece by the movement of the armature to its closed position; and resetting means for returning the movable block and latch piece to their latched position and conjointly retransferring the contacts.

13. A circuit breaker comprising an enclosing casing having an open end, a terminal block closing said end, two pair of electrical contacts positioned at the opposite ends of the casing, each pair including a stationary contact and a movable contact, two conducting straps each carrying a stationary contact at one end thereof respectively, the other end of each connecting with the terminal block, a rocking member carrying the movable contacts at the respective ends thereof, a third conducting strap connecting with the terminal block and having an end upon which is pivotally mounted the rocking member so that the movable contacts can be selectively transferred to make electrical contact with a corresponding stationary contact; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including a latch piece arranged to slide along a portion of the magnetic circuit adjacent the armature, a movable block carried by the latch piece, a spring conjointly urging the movable block and latch piece along a path of travel from a latched position wherein the movable block and latch piece are restrained by the armature in its open position to a released position, lever means interposed in the path of the movable block and connected with said movable contact to transfer the contacts upon the release of the movable block and latch piece by the movement of the armature to its closed position; and resetting means for returning the movable block and latch piece to their latched position and conjointly retransferring the contacts.

14. A circuit breaker comprising an enclosed casing having an open end, a terminal block closing said end, two pair of electrical contacts positioned at the opposite ends of the casing, each pair including a stationary contact and a movable contact, two conducting straps each carrying a stationary contact at one end thereof respectively, the other end of each connecting with the terminal block, a rocking member bent and notched at its midpoint so that the ends form an obtuse angle, each end carrying a movable contact, a third conducting strap connecting with the terminal block and having a bifurcated end which engages the notches of the rocking member so that the movable contacts can be selectively transferred to make electrical contact with a corresponding stationary contact; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; tripping means for the movable one of said contacts including a latch piece arranged to slide along a portion of the magnetic circuit adjacent the armature, a movable block carried by the latch piece, a spring conjointly urging the movable block and latch piece along a path of travel from a latched position wherein the movable block and latch piece are restrained by the armature in its open position to a released position, lever means interposed in the path of the movable block and connected with said movable contact to transfer the contacts upon the release of the movable block and latch piece by the movement of the armature to its closed position; and resetting means for returning the movable block and latch piece to their latched position and conjointly transferring the contacts.

15. A circuit breaker comprising a pair of electrical contacts including a stationary and a movable contact; a rocking member carrying the movable contact at one end thereof, said member being bent at its midpoint so that the ends form an obtuse angle, means for pivotally supporting the rocking member at its midpoint so that the movable contact can be selectively transferred to make contact with the stationary contact, a hollow actuator pivotally attached to the casing immediately above the point of attachment of the rocking member, a spring loaded telescoping member extending from the actuator to contact the rocking member forming a toggle whereby the contacts are biased in both the open and closed positions; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; automatic tripping means for the contacts including a latch piece slidably arranged with respect to the magnetic circuit, a block carried by the latch piece, a spring conjointly urging the block and latch piece along a path of travel from a latched position wherein the block and latch piece are restrained by the armature in its open position to a released position, a finger extending from said actuator so that it is interposed in the path of the block thus transferring the contacts upon the release of the block and latch piece by the movement of the armature to its closed position; said actuator having a handle portion for manually returning the block and latch piece to their latched position and conjointly transferring the contacts.

16. A circuit breaker comprising a pair of electrical contacts including a stationary and a movable contact; a rocking member carrying the movable contact at one end thereof, said member being bent at its midpoint so that the ends form an obtuse angle, means for pivotally supporting the rocking member at its midpoint so that the movable contact can be selectively transferred to make contact with the stationary contact, a hollow actuator pivotally attached to the casing immediately above the point of attachment of the rocking member, a spring loaded telescoping member extending from the actuator to contact the rocking member forming a toggle whereby the contacts can be biased in the closed position; means including a low reluctance magnetic circuit having an armature and a solenoid for inducing a magnetic flux therein to move the armature from an open to a closed position when the solenoid current exceeds a predetermined value; automatic tripping means for the contacts including a latch piece slidably arranged with respect to the magnetic circuit, a block carried by the latch piece, a spring conjointly urging the block and latch piece along a path of travel from a latched position wherein the block and latch piece are restrained by the armature in its open position to a released position, a finger attached to the opposite end of the rocking member from the movable contact and extending from said member so that it is interposed in the path of the block thus opening the contacts upon the release of the block and latch piece by the movement of the armature to its closed position; said actuator having a handle portion and two fingers which contact the end of the block as the handle portion is manually moved to return the block and latch piece to their latched position and conjointly to close the contacts.

HARRY P. SPARKES.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
997,759	Denny	July 11, 1911
1,950,225	Burton	Mar. 6, 1934
1,974,488	Geraghty	Sept. 25, 1934
2,027,538	Krieger	Jan. 14, 1936
2,091,108	Sengebusch	Aug. 24, 1937
2,171,267	Doty	Aug. 29, 1939
2,253,400	Shoemaker et al.	Aug. 1, 1941
2,502,537	Speck	Apr. 4, 1950

FOREIGN PATENTS

Number	Country	Date
315,121	Germany	Oct. 25, 1919