April 4, 1961 O. M. BUNDY ET AL 2,978,553

ROTARY CAM SWITCHES

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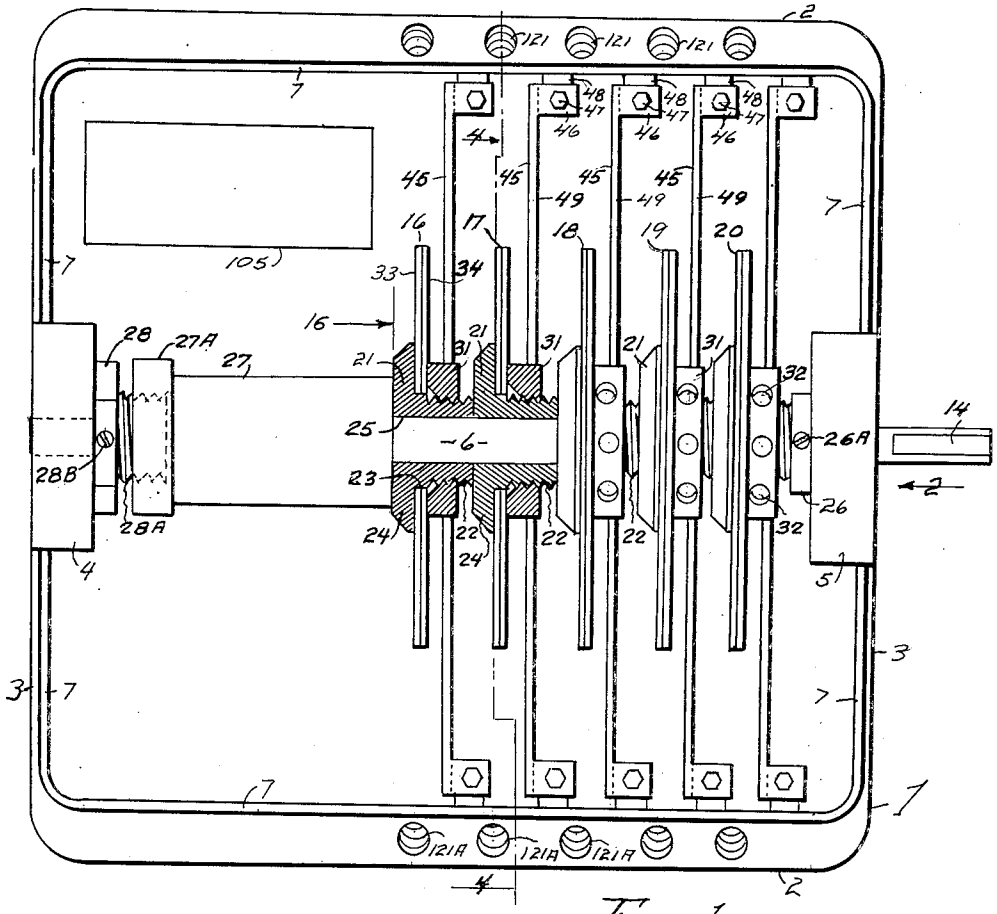


Fig. 1

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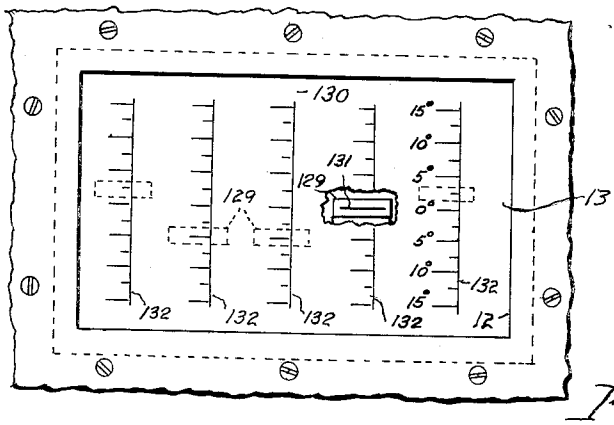


Fig. 3

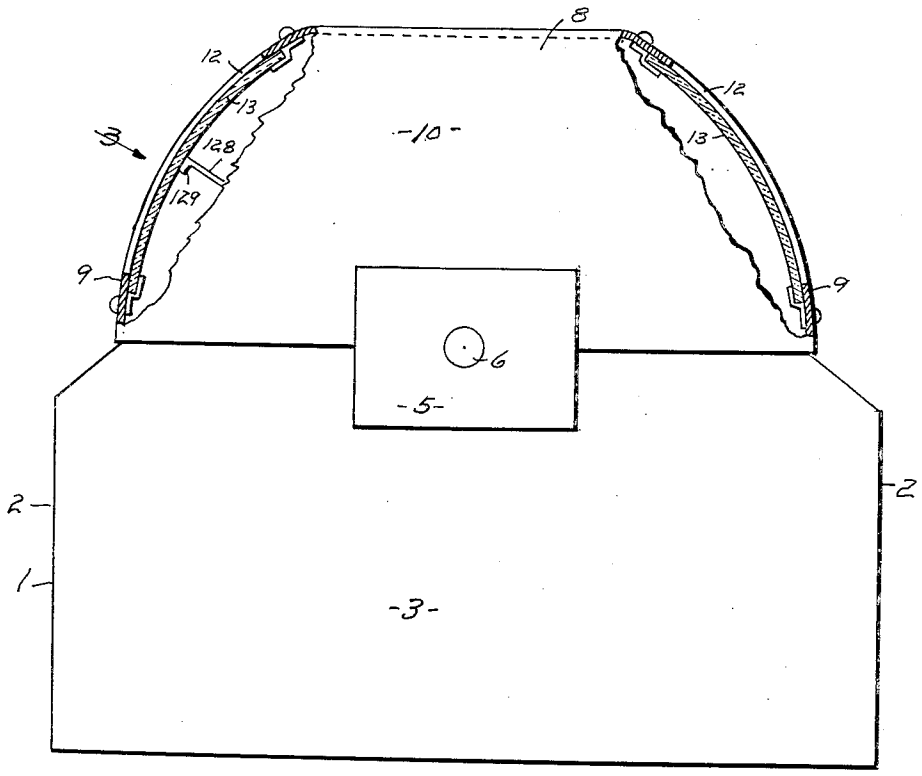


Fig. 2

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ROTARY CAM SWITCHES

Filed Sept. 6, 1956 5 Sheets-Sheet 3

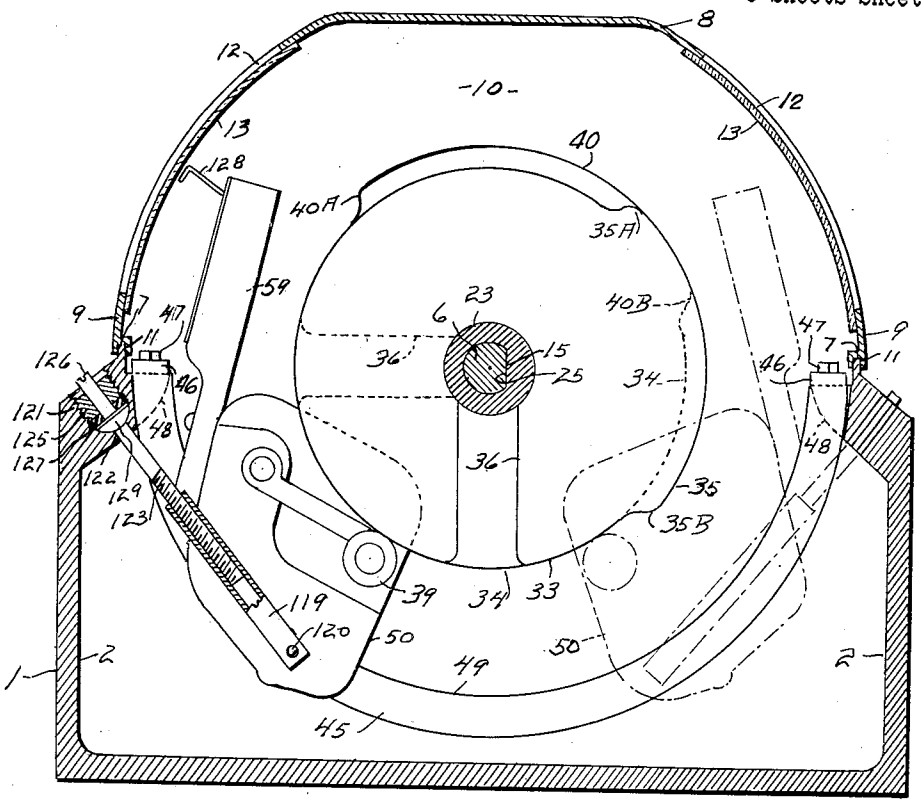


Fig. 4

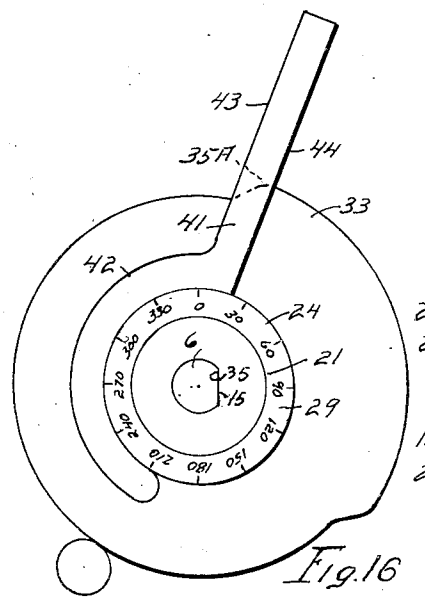


Fig. 16

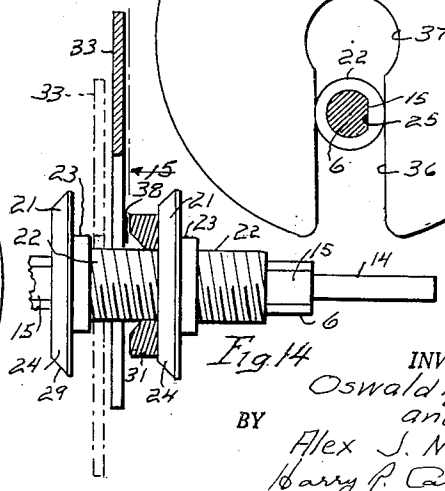


Fig. 14

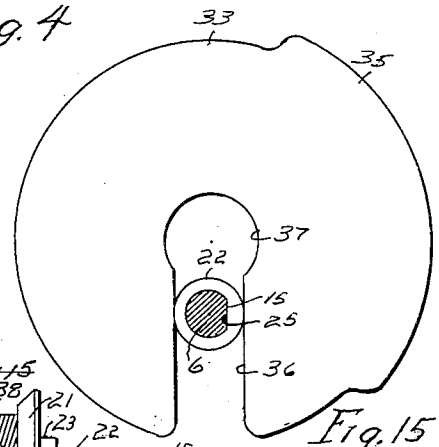


Fig. 15

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ROTARY CAM SWITCHES

Filed Sept. 6, 1956

5 Sheets-Sheet 4

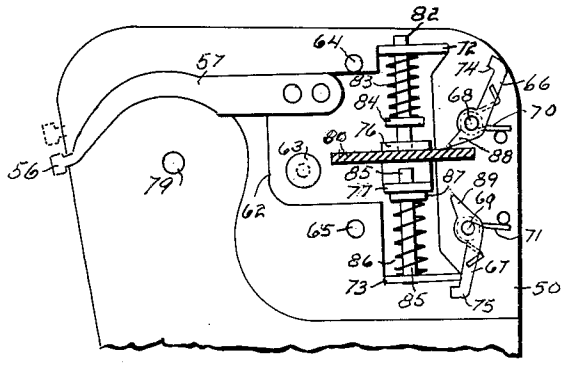


Fig. 6

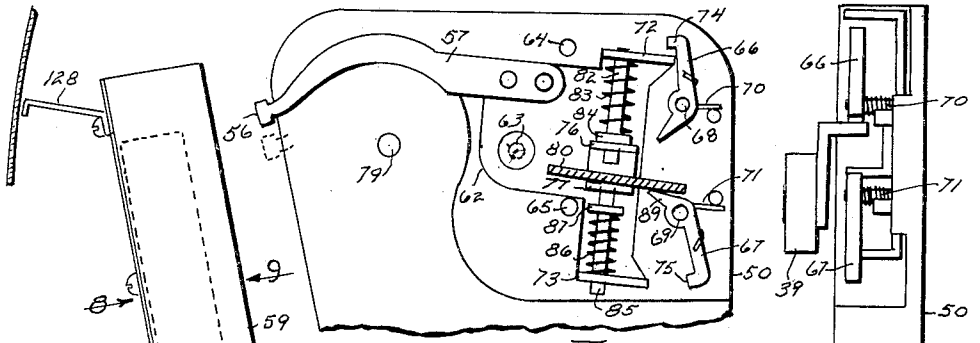


Fig. 7

Fig. 17

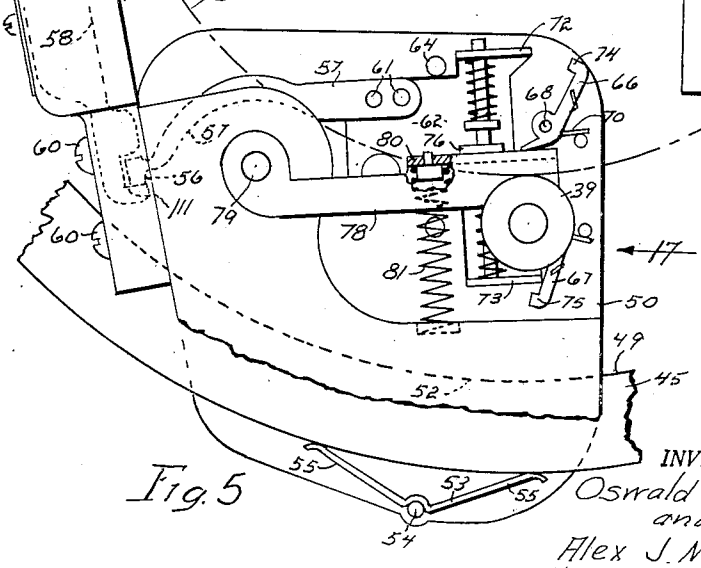


Fig. 5

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ROTARY CAM SWITCHES

Filed Sept. 6, 1956

5 Sheets-Sheet 5

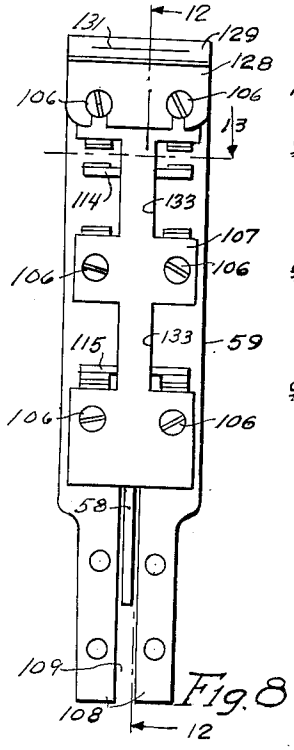


Fig. 8

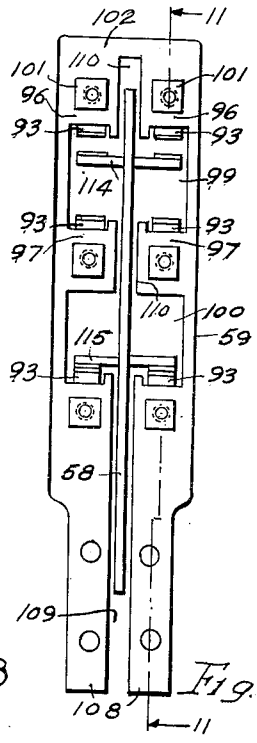


Fig. 10

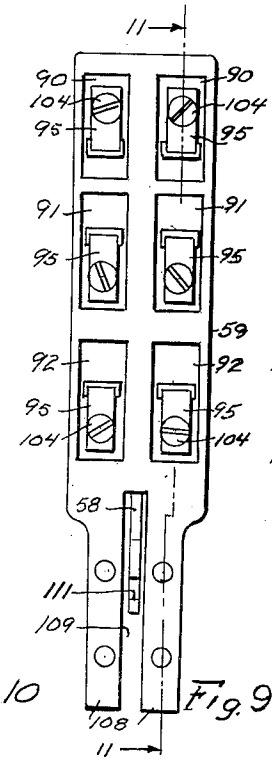


Fig. 9

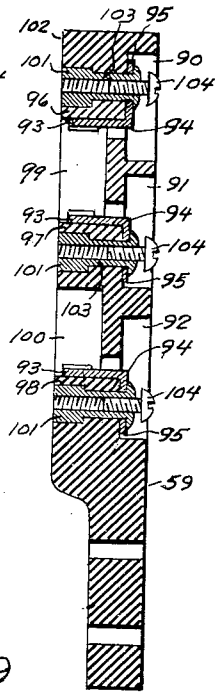


Fig. 11

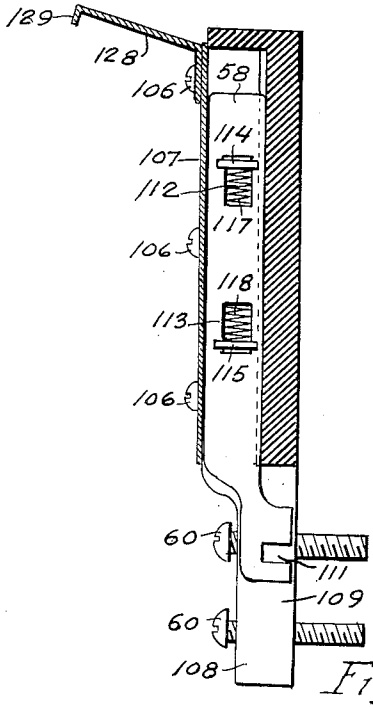


Fig. 12

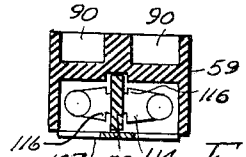


Fig. 13

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Patented Apr. 4, 1961

2,978,553

ROTARY CAM SWITCHES

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Filed Sept. 6, 1956, Ser. No. 608,264

11 Claims. (Cl. 200—38)

This invention relates to electric circuit making and breaking devices, of the general class sometimes referred to as rotary-cam-switches, comprising electric contacts operated to make and break circuits by rotary cams.

Such rotary-cam-switches in general are known. In one type, a plurality of cams are mounted in axially spaced relation on a common rotary shaft; and all rotate in unison with the shaft; and individual switches are mounted in position to be operated by camming portions of the respective cams; and the camming portions are disposed so that certain ones of the switches are operated at different times from others during a revolution of the shaft; whereby circuits connected to the switches are energized and de-energized in a desired sequence or program, and at a frequency determined by the velocity of rotation of the shaft.

The present invention relates more particularly to cam-operated-switches of this type. There are uses for such rotary-cam-switches in the various arts; and as the arts have developed, they have, severally, required that the cam-operated-switches have certain features of construction and mode of operation, etc., correlated with the particular arts.

The problem therefore has arisen of devising a rotary-cam-switch that can be produced in quantities, all alike, but adaptable to the particular art in which it is to be used, either at the time of initial assembly, or in the field where installed.

The present invention solves this problem and comprises in general a rotary-cam-switch having among others the following features; the actual invention being that set forth in the appended claims.

The individual switches for the respective cams have one set of contacts that is readily manipulatable to be either normally open, or normally closed, and one set of normally closed contacts.

Each cam is readily mountable on or demountable from the main shaft, so that any desired number of cams, from one up may be utilized; or any one interchanged with another, without disturbing the mounting of the others.

The camming portions of the rotating cams operate and restore the individual switches, and are each readily manipulatable to change or select the period of time elapsing between operating and restoring.

The camming portion of each cam is readily manipulatable to dispose it at a selected position around the axis of the shaft, to determine the point in a revolution of the shaft at which the individual switch is operated or restored.

Reference index means is provided on the shaft, alike for each of the cams, from which the selected positions of the cam portions of each cam around the shaft, may be measured and indicated, so that the selected points in the revolution of the shaft, at which each switch is operated, may have a desired angular relation to the said points of the other cams.

Each individual switch comprises, in unitary construction, a cam follower snap mechanism operated by the rotating camming portion of the cam, and a switch proper snap-operated by the mechanism; and the mechanism and switch is bodily adjustably positionable on a circular arc around the axis of the shaft, with micrometer increments of movement by a manually operated micrometer adjustment; whereby the switch operating point in the revolution of the shaft, first determined by manipulation of the cam, as aforesaid, may be refined by the micrometer adjustment to a high degree of precision, to meet particular requirements of the apparatus energized by current through the switch.

The cams and switches are enclosed in a box like walled housing having a removable cover, and a transparent window of the cover is cylindrical around the axis of the shaft; and when, as aforesaid, the unitary switch and cam follower mechanism are propelled with micrometer adjusting movement on an arc concentric with the shaft, an indicating finger thereon, inside the window, moves over a scale on the window, to indicate the adjusted position.

The micrometer movement is produced by rotating a screw-threaded adjusting element extending outwardly through a wall of the housing at a threaded connection therewith; and the adjusting element is accessible for turning it without removing the housing cover.

The objects of the invention are to provide a cam-operated-switch having, among others, the above mentioned features, singly or in combination.

An embodiment of the invention is fully disclosed in the following description, taken in connection with the accompanying drawing, in which:

Fig. 1 is a top view of the embodiment with the cover thereof removed, and with the said individual switches and switch operating mechanisms omitted for simplification;

Fig. 2 is an end elevational view of the embodiment from the direction of the arrow **2** of Fig. 1, with the cover added;

Fig. 3 is a side elevational view of a fragment of the cover of Fig. 2 from the direction of the arrow **3** of Fig. 2;

Fig. 4 is a cross sectional view from the plane **4—4** of Fig. 1 including the cover omitted from Fig. 1, and with some details omitted;

Fig. 5 is a view of a part of Fig. 4 to larger scale and in more detail;

Figs. 6 and 7 are views similar to Fig. 5 with parts thereof broken away and in section and illustrating different positions of the parts in operation;

Figs. 8 through 13 are views illustrating a switch device of Fig. 5 and of which:

Figs. 8 and 9 are views in the direction of the arrows **8** and **9** of Fig. 5;

Fig. 10 is a view like Fig. 8 but with a cover of Fig. 8, removed;

Fig. 11 is a sectional view from the plane **11—11** of Fig. 9, or Fig. 10;

Fig. 12 is a sectional view from the plane **12** of Fig. 8;

Fig. 13 is a sectional view from the plane **13** of Fig. 8;

Fig. 14 is a view of a part of Fig. 1 illustrating the assembly operation;

Fig. 15 is a sectional view from the plane **15** of Fig. 14;

Fig. 16 is a fragmentary view from the plane **16** of Fig. 1, with an adjustment indicating tool added.

Fig. 17 is an elevational view in the direction of the arrow **17** of Fig. 5.

Referring to the drawing, Figs. 1 and 4, there is shown

a rectangular, upwardly open, box-like housing or base 1, having upright side walls 2—2 and end walls 3—3.

Bearing blocks 4 and 5 are seated in the end walls.

A main shaft 6 is rotatably supported at its ends in bearings in the blocks 4—5.

The side and end walls at the top thereof are provided with a continuous upstanding bead 7.

A cover 8 for the base is provided having side and end walls 9 and 10 provided with a continuous groove 11 embracing the bead 7 to position the cover on the base.

The opposite side walls 9—9 of the cover are curved, generally cylindrically, and have window openings 12—12 therein covered by cylindrically curved window panes 13 of transparent material; and when the cover is in place on the base, the window panes are coaxial with the main shaft 6 for a purpose to be described.

The base 1 and cover 8 are preferably provided with rubber or like sealing material at the groove 11 and bead 7 and the window panes 13 are sealed at the window openings 12 in the cover 8, to render the housing as a whole dust proof; but this, not constituting a part of the invention, is not shown in detail.

It is contemplated that the shaft 6 will be rotated by outside power, and for this purpose one end of the shaft projects beyond the bearing as at 14 for connection with a source of driving power which may be for example a motor provided especially for the purpose, and driving the shaft through speed reduction gearing; or may be a rotary part of a machine for example the main shaft of a power operated press whose cylical operations are to be controlled by the rotary cam switch.

The intermediate part of the shaft is of larger diameter than the end portions that rotate in the bearings, as indicated at 6 and 14 respectively in Fig. 14 and the intermediate portion is cut off to provide a flat face 15.

In the embodiment of the invention described herein, the housing 1 and shaft 6 have been shown in Fig. 1 as shorter, axially of the shaft, than will usually be the case, to shorten the figure for purposes of illustration, and five cams are shown at 16 through 20; but it is to be understood that fewer or more cams can be accommodated in the housing as illustrated, and that the housing can be longer, to accommodate a greater number of cams.

In any case, a plurality of cam mounting devices 21, one for each cam, are provided on the shaft, as in Fig. 1, two of which are shown separately in Fig. 14.

These cam mounting devices 21 each comprise a threaded portion 22, a thin cylinder 23 of larger diameter than the threads, and a circular flange 24 of still larger diameter; and a coaxial bore 25 therethrough of the same cross sectional contour as the intermediate portion 6 of the shaft, whereby they can be telescoped upon the intermediate portion of the shaft and locked against rotation thereon by the flat face 15 on the shaft.

These cam mounting devices are also telescoped on the intermediate portion of the shaft in an axially extending tier, with the threaded portion 22 of each abutting the flange 24 of another as shown in Fig. 1 and Fig. 14.

One end of the tier abuts upon a collar 26 fixed to the shaft by a set screw 26A; and the other end abuts upon one end of a tubular spacer 27, telescoped on the shaft, the other end of the spacer abutting upon a nut 27A. The nut 27A is threaded on a tubular extension 28A of a collar 28 fixed to the shaft by a set screw 28B.

By this construction it will be apparent that on turning the nut 27A with a wrench, the tier may be clamped against the collar 26 and between the collars 26 and 28, and become in effect integral with the shaft. The collar 28 preferably has flats on it by which it and the shaft may be held against turning while turning the nut 27A.

As shown in Figs. 14 and 16 the periphery of the flange 24 is circular and is bevelled as at 29 and has a scale thereon comprising twelve index marks on the bevel, 30 degrees apart, designated by degree numerals from zero degrees to 330 degrees inclusive; for a purpose to be described.

The zero marks on the several flanges 24 all have homologous positions around the shaft; this being effected by making all of the devices 21 alike and by keying them to the shaft by its flat face 15.

To this end the devices 21 are preferably die castings, with the degree marks and numerals die cast thereon.

As shown in Fig. 1 there is a clamp nut 31 on the threads of each device 21 provided with radial sockets 32 to receive the end of a rod or like tool by which it may be rotated, and these nuts are put on the threads 22 before the devices are telescoped on the shaft.

The cams 16 to 20 of Fig. 1 are made from sheet metal stampings, with generally circular peripheries, but with a camming portion of the periphery of larger radius. A single stamping may be used as the cam, but in most cases two are used, superimposed on each other as indicated at 33—34 in Fig. 1 whereby adjustment can be made as will be described.

In either case the stampings are mounted on respective mounting devices 21 as follows with reference to Figs. 14 and 15.

The cam stamping, say the stamping 33 of Fig. 1 having a camming portion 35, has a wide radial slot 36 therein, which at the center of the cam is circular as at 37 and of larger diameter than the width of the slot 36.

To mount the cam, the nut 31 of the device is retracted to provide a space 38 between it and the device cylinder 23. The slot 36 of the cam is straddled over the threads 22 of the device in the space 38, the width of the slot 36 being predetermined to just clear the threads. The cam is moved downwardly as shown in broken line in Fig. 14 until the enlarged circular part 37 of the slot is axially opposite to the cylinder 23 on the device, the diameter of the circular part 37 being predetermined to fit the cylinder 23 with clearance.

The cam is then moved axially to telescope the circular part 37 of the slot upon the cylinder 23 until it lies against the flange 24 as in Fig. 1. The nut 31 is then screwed inwardly and clamps the cam against the flange 24.

When the cam is in two parts 33—34 as referred to, both parts are mounted in this manner, see Fig. 1.

By this means, the cams are rigidly mounted on the devices 21 and therefore on the shaft 6. Upon loosening the nut 31 enough to loosen the cam, the cam can be rotated on the cylinder 23 to adjust it on the shaft as will be described, but cannot become displaced radially of the shaft when loosened and rotated, and cannot come off, because of the interlock of the circular part 37 of the cam slot with the cylinder 23.

The purpose of providing cams of two superimposed pieces 33—34, as referred to, is illustrated in Fig. 4, wherein the circular peripheries of both pieces are shown engaged with a roller 39 constituting part of the switch operating mechanism to be described later.

One piece 33 of the cam is identified by its radial slot 36 in solid line and its circular periphery has a peripheral camming portion 35 extending from 35A to 35B. The other cam piece 34 is identified by its radial slot 36 in dotted line and is also circular but has a camming portion 40 extending from 40A to 40B.

The camming portions 35 and 40 thus overlap and provide jointly a camming portion extending from 35B to 40A.

As the cam rotates, the joint camming portion 35B–40A first depresses the roller 39 and then allows it to restore, to operate and restore the switch proper as will be described.

Upon loosening the cam pieces 33—34 as described, they can be rotated on the shaft, one relative to the other to chosen positions, and again clamped to the shaft to adjustably vary the circumferential extent of the joint

camming portion 35B—40A and therefore vary the interval of time between operating and restoring the switch.

It is a part of the invention that the "point" in a revolution of the shaft 6 at which the roller 39 is depressed or released to operate or restore the switch can also be preselected by rotating and adjustably positioning the cam pieces; and that this point can be preselected, for each of the cams in the series along the shaft, independently of the others, so that as the shaft rotates, the several individual switches will be operated successively according to any desired sequence or program. This selection is made as follows with reference to Fig. 16.

A tool 41 is provided comprising a circularly shaped portion 42 that fits around the circular periphery of the mounting device flange 24, and a handle 43 having an edge 44 extending therealong, radially of the shaft 6.

The tool 41 is rotated around the device periphery until the edge 44 indicates a selected degree position on the device.

The cam 33 is then loosened and rotated until the end of the camming portion 35A coincides with the edge 44 of the tool, and is then clamped in this position.

Given a single cam, for example the cam 33 of Fig. 4, it may be used alone and provide a peripheral camming portion extending from 35A to 35B.

Two such cams, and assuming that they are alike, may be superimposed upon each other and provide a joint camming portion, the extent of which may be manipulated as described to be any amount in the gradual range from 35A–35B to substantially twice that amount, 40A to 35B.

By providing cams of seven different designs, that is, having camming portions of seven different peripheral extents measured in degrees of the circular periphery in the range from 15 degrees to 175 degrees, and using them singly, or in manipulated superimposed pairs as described, a peripheral camming portion may be provided covering a continuous gradual range from 15 degrees to 345 degrees.

A survey of the requirements of apparatus in the various arts to which the invention may be applied, as referred to in the premises, shows that the requirements will be met, by providing only the seven kinds of cams described above.

Coming now to the switch operating mechanism and the individual switch for each cam, there is shown in Figs. 1, 4 and 15, for each cam, a bar 45 of rectangular cross section, bent edgewise, upwardly concave, with horizontal ears 46 at its ends secured by screws 47 to lugs 48 on the housing side walls 2—2. The bar 45 is formed so that, when thus mounted, its inner concave edge 49 is circular and coaxial with the shaft 6.

The switch operating mechanism comprises in general a main base 50, preferably formed as a die casting, having a deep groove 51 in its lower side straddling the bar 45, the bottom 52 of the groove being coaxial with the shaft and supported on the bar and slidable thereon, but held down and in yieldable frictional contact therewith by a spring 53, Fig. 5, mounted on a pin 54 on the base 50 below the bar and having oppositely extending legs 55—55 resiliently engaging the underside of the bar 45.

The parts of the mechanism are mounted on the base 50, and will be described in full later; but in general they include the roller 39 hereinbefore referred to, reciprocated down and up by cam action, and such reciprocations cause the end 56 of a finger 57, Figs. 5–6–7, to reciprocate up and down, and the finger end reciprocates a contact bar 58 carrying switch contacts. All of the parts of the switch including the contact bar 58 are enclosed in a switch housing 59 molded from insulating material mounted rigidly upon the mechanism base 50 by screws 60—60 Fig. 5.

The mechanism is best shown in Figs. 5–6–7. The said finger 57 is riveted at 61 to an oscillator 62 pivoted on the base at 63 and stopped in up and down oscillated positions by stops 64—65 on the base 50.

Latches 66—67 with hook ends 74—74 are pivoted on the base 50 at 68—69, the upper latch 66 being biased counterclockwise by a spring 70 and the lower one biased clockwise by a spring 71 in a well known manner.

The oscillator 62 has upper and lower wings 72—73 projecting forwardly, over which the hook ends 74—75 of the latches can engage; and has upper and lower forwardly projecting lugs 76—77.

A main arm 78 pivoted at 79 on the base 50 carries the said roller 39; the periphery of the cam engaging it being indicated in broken line at 33, Fig. 5; and the arm 78 has a flange 80 extending toward the base between the lugs 76—77; and the arm 78 and flange 80 and the base 50.

An upper pin 82 slides reciprocably in aligned holes in the upper wing 72 and lug 76 and a spring 83 surrounding the pin 52 abuts between the wing 72 and a collar 84 on the pin 82; and the lower end of the pin 82 can be projected downwardly beyond the lug 76, by the spring 83 and stopped by the collar 84.

A like lower pin 85 slides reciprocably in holes in the lower wing 73 and lug 77, and a lower spring 86 abuts between the wing 73 and a collar 87 on the pin; and the pin can be projected upwardly beyond the lug 77 and stopped by the collar 87.

When the arm 78 and flange 80 have gone to the normal upper position, Figs. 5 and 6, the flange 80 has pushed the upper pin 82 up and raised the collar 84 and compressed the upper spring 83; and the flange 80 has engaged a finger 88 on the upper latch 66 and has rocked the hook 74 of the latch 66 away from the upper wing 72 and the spring 83 is holding the oscillator 62 against the upper stop 64.

In this position of the oscillator, the lower latch 67 has hooked over the lower wing 73 and the lower spring 86 has expanded and projected the upper end of the lower pin 85 upwardly beyond the lower lug 77.

The finger end 56 on the oscillator is, as viewed, in Fig. 6 in the lower solid line position.

When the arm 78 and flange 80 are moved downwardly by the cam as described, the flange 80 first engages the projected end of the pin 85 and moves the collar 87 down compressing the lower spring 86 and then engages a finger 89 on the lower latch 67 and rocks its hook 75 away from the lower wing 73 and the compressed spring then snaps the oscillator 62 downwards against the lower stop 65, whereupon the upper latch 66 rocks inwardly and hooks over the upper wing 72, Fig. 7, and the finger end 56 is snapped to the solid line position of Fig. 7.

When the flange 80 again moves upwardly, it raises the pin 82 to compress the upper spring 83 and engages the finger 88 of the upper latch 66 to unhook the latch from the upper wing 72 and the spring 83 snaps the oscillator back again against the stop 64.

The snap movements of the finger end 56 from the solid line position of Fig. 6 to that of Fig. 7 actuate the switch as follows.

The switch comprises said elongated housing 59 moulded from insulating material, which when mounted in position on the mechanism base as described is longitudinally upright.

As viewed from the rear as in Fig. 9, the switch has six rear pockets in horizontally spaced pairs, 90—90, 91—91, 92—92 through the bottoms of each of which is projected a horizontal leg 93 of an L-shaped terminal element 94, and the other or vertical leg 95 lies on the pocket bottom.

There are thus three pairs of terminal legs 93, upper, middle and lower pairs, projecting through the rear pocket bottom toward the front of the housing; the upper and middle legs lying respectively on upper and lower walls 96—97 of an upper front pocket 99 and the lower legs lying on the lower wall 98 of a lower front pocket 100.

The L-shaped terminal elements 94 are mounted by bolts 101, having heads flush with a front surface 102

of the housing and having tubular shanks **103** going through the vertical terminal legs **95** and spun over at their ends. The bolts **101** are interiorly threaded from end to end, the threads on the rear side of the housing being adapted to take threaded terminal screws **104** by which circuit wires on the rear side of the housing may be attached to the terminals.

The circuit wires (not shown) are preferably all brought downward along the rear side of the switch housing to a terminal block in the main base indicated at **105**, Fig. 1, and wires from the terminal block go to the apparatus to be controlled.

The threads on the front side of the bolts **101** are adapted to take screws **106** for mounting a front cover **107** on the housing.

The lower end of the housing has downwardly projecting legs **108—108** spaced apart providing a space **109** therebetween, and the space is continued upwardly through the walls of the front pockets **99** and **100** by slots **110** therein.

The aforesaid contact bar **58**, made from insulating sheet material, is disposed in the groove thus provided, and fits loosely therein for free up and down reciprocation.

The lower end of the contact bar **58** extends into the space **109** between the legs **108** and has a notch **111** in its rearward edge.

The housing is rididly mounted on the operating mechanism by the said screws **60**; and in such position that the aforesaid reciprocating finger end **56** of the mechanism projects into the notch **111** and thereby reciprocates the contact bar **58**, see Fig. 5.

The cover **107** made from insulating sheet material is mounted on the front of the housing by the screws **106** threaded into the heads of the bolts **101** and by overlapping the front edge of the contact bar **58** retains it in its groove.

The contact bar **58** has upper and lower generally rectilinear holes **112—113** therethrough. Upper and lower bridging contacts comprising respectively sheet metal bars **114—115** with contact tips on their ends extend through the holes **112—113** and each has edge notches **116** intermediate its ends loosely embracing the sides of the hole to retain it therein.

The upper bridging bar **114** is yieldingly held against the upper edge of its hole and the lower bridging bar **115** is yieldingly held against the lower edge of its hole, by respective upper and lower springs **117—118** disposed in the holes.

The holes **112—113** are spaced apart, up and down, in the bar **58** so that when the bar is in the normal downwardly reciprocated position, the lower bridging bar **115** connects contact tips on the lowermost terminal legs **93** providing "normally closed contact" thereat, and so that the upper bridging bar **114** is below tips on the uppermost terminal leg **93** providing "normally open contacts" thereat.

It will be noted that the connection to each terminal wire is insulated from the others by the surrounding walls of the rear pockets, **90–91–92**.

Also, that the making and breaking of current on the contact tips of each bridging bar **114—115** is caused to occur within surrounding pocket walls, provided by the forward pockets **99** and **100** and the body of the reciprocating contact carrier **58**; and that the contacts can be inspected from the front through recesses **133—133** in the cover **107**.

The bridging contact bar **114** can readily be manipulated as referred to, to change from normally open to normally closed condition etc., upon removing the cover **107** and lifting out the assembly of reciprocating contact carrier **58** and the contact bars.

The arrangement illustrated is only one of numerous other possible arrangements, of normally opening and normally closed contacts. The holes **112—113** can be located longitudinally of the bar **58** in other positions than those shown; and bar **114** can be put at the top or at the bottom of its hole **112** with the spring **117** placed on top of it. The bar **114** can readily be removed from its hole after removing its spring by rocking it on its axis to disengage its notches **116**, and then withdrawing it axially, and it can then be turned upside down to oppositely dispose its contact tips, and put back into the hole.

With the location of holes **112—113** as illustrated, the upper contact bar **114** can be turned over and put in the bottom of the hole **112** to provide another pair of normally closed contacts.

In Figs. 5, 6 and 7, the down and up movements of the finger end **56** is enough to first engage the tips of the contact bars **115** and **114** and then compress the springs **117** and **118**, to provide spring-pressed contact engagement.

Longitudinal reciprocation of the contact bar to close and open the contacts by the cams of the switch operating mechanism as the main shaft revolves has already been described.

It has been described hereinbefore, how the camming portions of the cams are readily manipulatable to change their circumferential extent; and to select the point in a revolution of the shaft at which operation of the operating mechanism occurs.

In some cases the operating point must be more accurately or precisely set than is practical by manipulation of the cams, and the following means is provided for this purpose, referring to Figs. 1 and 4.

An interiorly threaded tube **119** functioning as a tubular travelling nut, is hinged at one end on a post **120** on the mechanism base **50**.

The main housing **1** has an interiorly threaded pocket **121** having a reduced diameter hole **122** in the pocket bottom.

An adjusting rod **123** has one end portion threaded and projected through the pocket hole **122** and screwed into the tubular nut **119**. The rod **123** has a collar **124** thereon engaged with the pocket bottom. The rod extends through a tubular nut **125** screwed into the pocket and clamps the collar **124** against the pocket bottom. The outer end of the rod **123** has a screw driven slot **126** for turning it.

Upon turning the rod **123**, the mechanism housing **50** is adjustably propelled along the circular bar **45**, with micrometer increments of movements. The roller **39** accordingly moves with the mechanism housing in a circular path around the axis of the main shaft **6**, and this adjustably selects the said point of operation with high precision.

Preferably a rubber or like compressible washer **127** is provided in the pocket **121** between the nut **125** and the collar **124**, whereby, while the collar is clamped upon the pocket bottom to prevent accidental rotation of the adjusting rod **123**, and maintains the adjustment, the rod may be forcibly rotated to effect the adjustment without loosening the pocket nut **125**.

Such adjustment for each cam is preferably provided, as indicated by the row of pockets **121** Fig. 1.

As will be understood the aforesaid micrometer cam adjustment is made for any cam or each of the cams to cause the corresponding individual switch to operate or restore at precisely the exact instant in the revolution of the main shaft, required by the particular apparatus controlled by the switches. It is an important feature that this micrometer adjustment can be made from outside the housing while the cams are rotating and the switches operating.

The drawings, particularly Figs. 4 and 5 show one of the switches and one of the switch operating mechanisms, but it is to be understood that there is a like mechanism

and switch for each of the cams of Fig. 1 in a series adjacent to one side wall 2 of the main housing.

Similarly the same cams may be utilized to operate mechanisms and switches in a series adjacent to the other side wall 2 of the main housing. This has not been illustrated in full, to simplify the drawing, but it is believed that it will be understood from the showing in Fig. 4 wherein a switch housing 59 and a mechanism base 50 are shown in broken-line outline; and in Fig. 1 wherein the corresponding row of threaded pockets of the micrometer adjustment are shown at 121A—121A.

According to the foregoing description, it will be apparent that each individual switch will be first operated and then restored by the beginning and end of the camming portion of one cam, for example, to energize and de-energize a circuit; and that the point in the revolution of the shaft at which operating or restoring occurs can be selected with precision by micrometer adjustment.

In some cases, it may be desirable to select with micrometer precision, both the operating and restoring point, for example, the points at which a circuit is respectively energized and de-energized.

In such case, two switches may have their contacts interconnected to control the same circuit; and two cams may be utilized; and their camming portions manipulated to cause one cam to operate one switch to close the circuit, and the other to restore the other switch to open the circuit; and both adjusted with precision by the micrometer adjustments of the respective cams.

It is often desirable to have an indicator that will indicate the micrometer movement while the adjustment is being made, and the adjusted position of the operating mechanism after the adjustment is made.

This is provided for as follows:

At the top of each switch housing 59 is a dial pointer 128 mounted by the uppermost screws 106, the end of which has a flange 129 thereon, adjacent to the said cylindrical window pane 13 of the cover, and which moves in a circular arc over a scale 130, Fig. 3, on the inside of the pane, as the switch housing is moved by the micrometer movement of the operating mechanism.

The flange 129 has an inscribed line 131 thereon parallel to the shaft axis.

The scale 130 comprises five vertical lines 132 corresponding to the respective switches, and the vertical lines each have index marks on them, for example, plus and minus degree marks above and below a zero degree center mark, as shown for one of them in Fig. 3.

The position of the inscribed lines 131 of the several dial pointers on the scale 130 indicates the micrometer adjustment positions of the several switches as will be understood. The wires leading from the six terminal screws 104 on the back of each switch to the said terminal block 105 have been omitted, as referred to. It will be understood by those skilled in the art that the terminal block will itself have terminals to which these wires will be connected and terminals from which wires will go out of the main housing to an apparatus to be controlled. Inasmuch as the construction as described provides for a great multiplicity of switches, and contacts in different condition as to normally open or normally closed, and possible interconnections among them in various arrangements as referred to for energizing and de-energizing external control apparatus of many kinds, the terminals of the terminal block have also been omitted to avoid great complexity of drawing and description.

What is claimed is:

1. In a rotary-cam-switch, a main frame; a shaft rotatably mounted on the frame; a stationary support mounted on the frame, and having a circularly arcuate guide surface thereon radially spaced from the shaft and coaxial therewith; a base carrying a mechanism; a switch mounted on the base; the base and switch being movable in unison on the arcuate guide surface and guided thereby for positionally adjusting the base and switch around the shaft axis; the mechanism comprising a cam follower reciprocable generally toward and from the shaft to operate and restore the switch; a cam comprising a body mounted on the shaft and having a camming portion extending radially therefrom and engageable with the cam follower and causing reciprocation thereof during a revolution of the shaft.

2. A rotary-cam-switch as described in claim 1 and in which the support is in the form of a bar of uniform polygonal cross-section bent into circular form and secured at its ends to the main frame at opposite sides of the shaft and coaxial with the shaft; and the mechanism base is provided with portions fitting the bar and slidable therealong.

3. A rotary-cam-switch as described in claim 1 and in which a nut element and a screw element with mutually meshed threads, are provided; one element connected to the mechanism base; the other element rotatably mounted on the main frame; and means is provided anchoring the said other element on the frame against axial shifting during rotation thereof; whereby the mechanism base is propelled along the arcuate guide surface with micrometer movement upon rotating the said other element.

4. A rotary-cam-switch as described in claim 3 and in which the said anchoring means comprises a threaded pocket provided on the main frame having a tubular nut therein and having a reduced diameter hole in the pocket bottom; and the said other element extends through the hole and tubular nut, and is rotatable therein, and has a collar thereon clampable between the tubular nut and the pocket bottom.

5. A rotary-cam-switch as described in claim 4 and in which a packing of yieldable material is compressed between the tubular nut and the collar, normally holding the said other element against accidental rotation but permitting forced rotation thereof.

6. A rotary-cam-switch as described in claim 1 and in which the switch is provided with a scale pointer movable therewith on a circular arc coaxial with the shaft upon said movements of the mechanism around the shaft axis; and a scale is provided, stationary with respect to the main frame over which the pointer moves to indicate positions of the mechanism.

7. A rotary-cam-switch as described in claim 1 and in which a removable cover is provided on the main frame to cover the mechanism and switch, and the cover has a sheet metal wall portion with a window therein and the window is covered by a pane of transparent material positioned and bent to be coaxial with the shaft and having a scale thereon; and a scale pointer is provided on the switch and moves over the pane as the mechanism and switch is moved arcuately around the shaft axis, to indicate positions thereof.

8. In a rotary-cam-switch, a main frame rotatably supporting a shaft carrying a generally circular cam having a peripheral camming portion; a stationary support mounted on the frame, and having a circularly arcuate guide surface thereon radially spaced from the shaft and coaxial therewith; a switch operating mechanism comprising a base; the base being movable on the arcuate guide surface and guided thereby for positionally adjusting the switch around the shaft axis; an arm pivoted on the base carrying a cam follower disposed in the path of the camming portion and effective to oscillate the arm, during rotation of the shaft; a snap mechanism comprising a finger snapped back and forth by oscillations of the arm; a switch mounted upon the base mechanism and comprising a contact carrier engaged by the finger, and reciprocable by snap movements of the finger.

9. A cam operated switch as described in claim 7 and in which the main frame is in the form of a housing having upstanding side and end walls and the shaft is dis-

posed between opposite walls; and the cover is in the form of a housing having downwardly extending side and end walls, a wall of the cover supporting the said window pane; and the cover is positioned on the main frame to dispose the pane coaxially of the shaft by intermeshed male and female portions of the walls of the main frame and cover.

10. In a cam operated switch, a rotatably supported shaft carrying a cam rotatable therewith; a mechanism comprising a cam follower engaged by the cam, and arranged to be reciprocated thereby during rotation of the shaft and cam; and comprising, a snap action mechanism operable by the reciprocable movement of the cam follower, a finger for transmitting the reciprocable snap movements of the snap action mechanism; a switch comprising a housing of insulating material having an elongated bar guided therein for longitudinal reciprocation and carrying contacts; the bar provided with a recess in which the finger engages and being reciprocated thereby with snap movements; and stationary contacts in the switch housing engaged and disengaged by the bar-carried contacts.

11. In a cam operated switch, a rotatably supported shaft carrying a cam rotatable therewith; a mechanism comprising a cam follower engaged by the cam, and arranged to be reciprocated thereby during rotation of the shaft and cam; and comprising a finger reciprocable with snap movements upon reciprocation of the cam follower; a switch comprising a housing of insulating material having open groove means; an elongated bar carrying contacts and guided in the groove means for longitudinal reciprocation; the bar provided with a recess in which the finger engages and being reciprocated thereby with snap movements; stationary contacts in the switch housing engaged and disengaged by the bar carried contacts; a removable plate for retaining the bar in the groove; and upon the removal of the plate, the bar and its contacts are free to be removed out of the housing and to concurrently disengage the recess and finger.

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