May 12, 1959

J. R. COSBY ET AL

2,886,667

MULTICIRCUIT BAROSWITCH

Filed Oct. 22, 1957

2 Sheets-Sheet 1

FIG. 1.

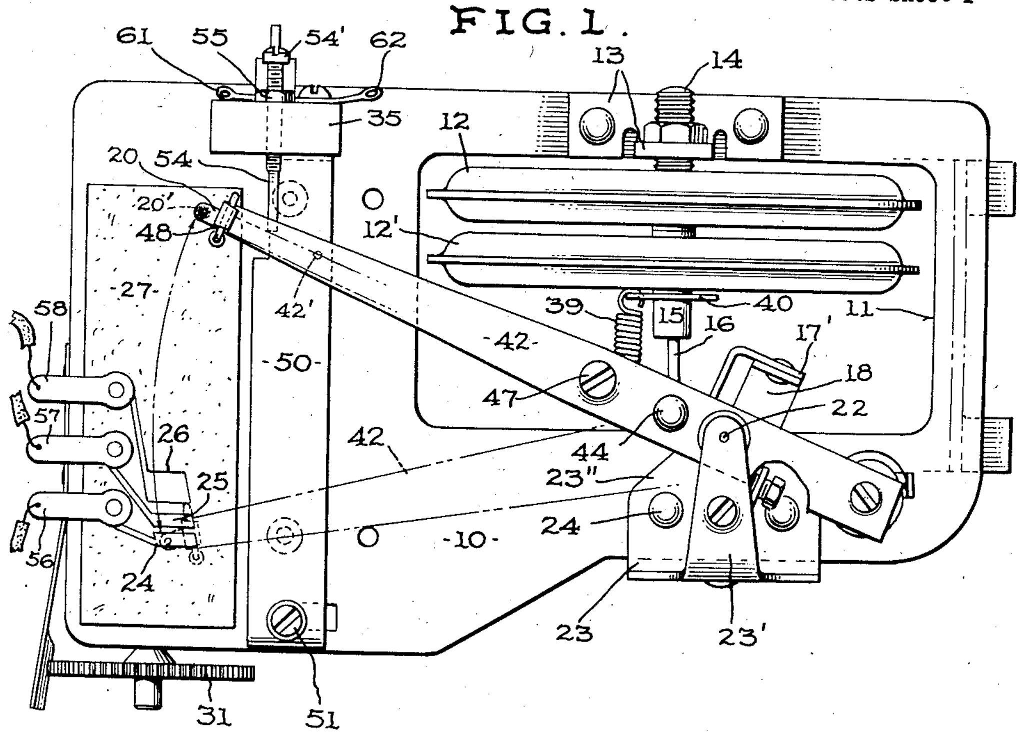

FIG. 2.

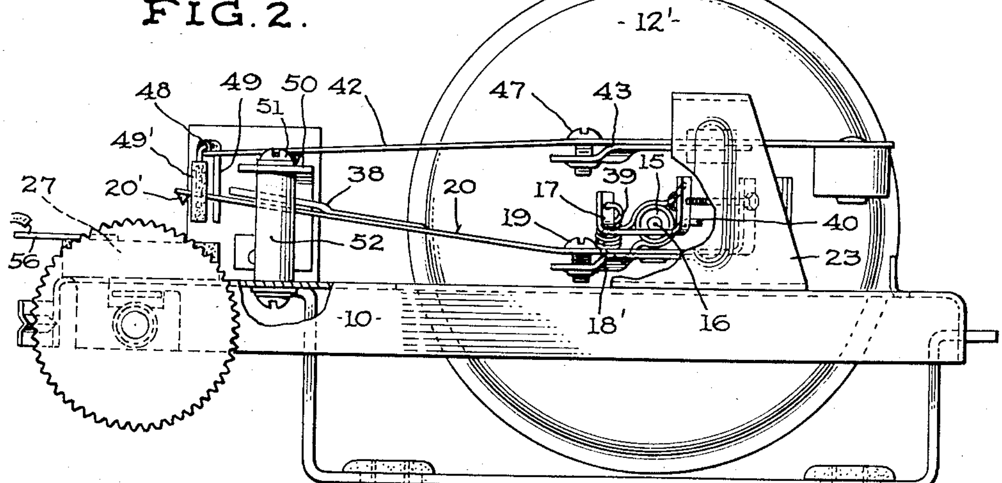

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FIG. 3.

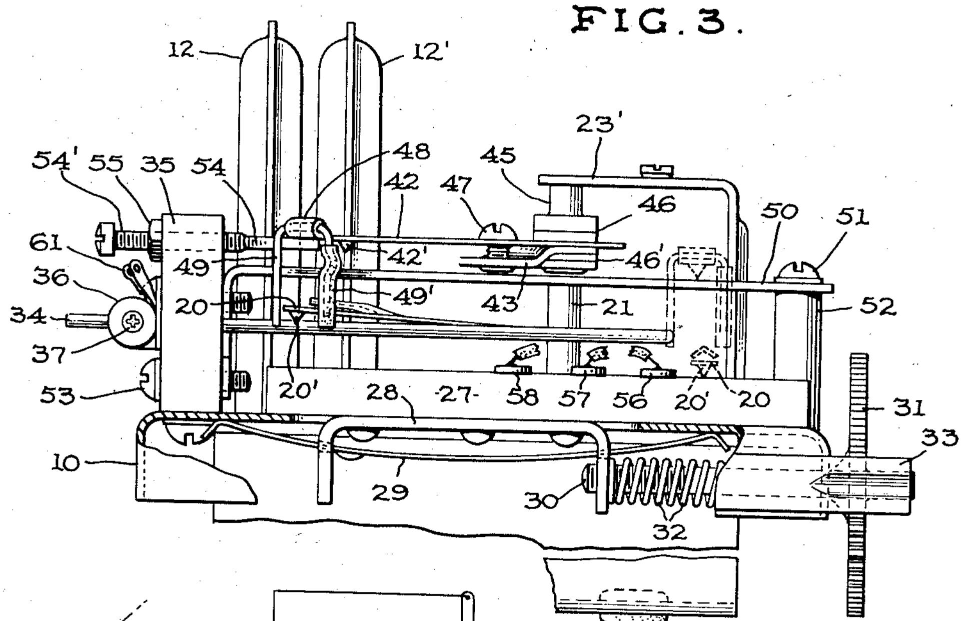


FIG. 4.

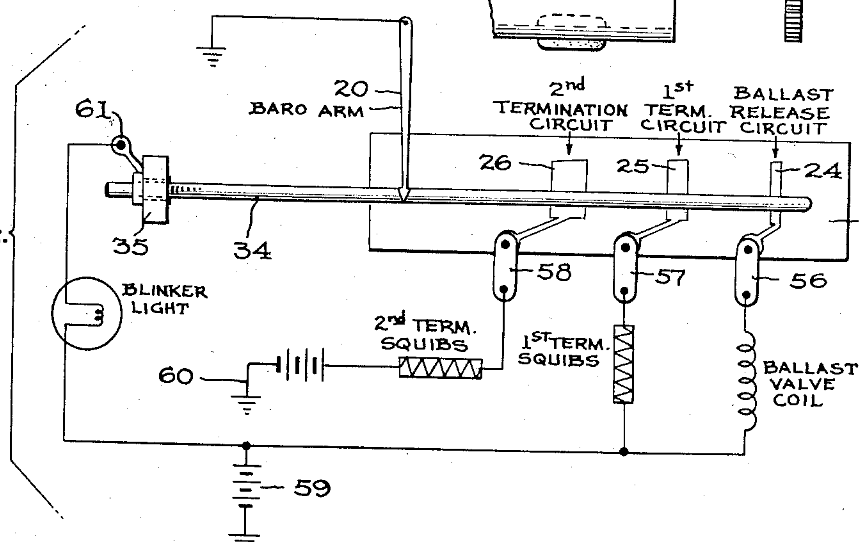
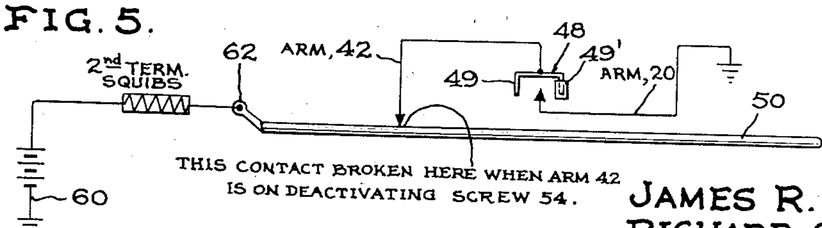


FIG. 5.



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MULTICIRCUIT BAROSWITCH

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Application October 22, 1957, Serial No. 691,735

11 Claims. (Cl. 200—81.4)

This invention relates to baroswitches for controlling a plurality of electric circuits; it was originally devised for use in an airborne telemetering device carried by a balloon provided with ballast-control means operating to maintain the device aloft at a given altitude for a relatively long period of time, during which signals relating to atmospheric conditions such as temperature, humidity, pressure and other data are transmitted to a ground station. In telemetering devices of this nature, there are a multiplicity of functions to be controlled in addition to the actual transmission of data, for example, release of ballast through actuation of ballast control valves or the like, energization of flight termination control circuitry should the unit descend an increment of say 1500 feet while it is ascending to its flight altitude or should it descend a given distance below its flight altitude following a successful launching, energization of signal light circuitry during the ascent and descent periods, and other functions; and an object of the present invention is to provide a baroswitch which will control a plurality of circuits for carrying out the foregoing and other functions without utilizing cams or like motor-driven parts, the switch being easy to calibrate, light in weight, compact and yet at the same time capable of resisting premature switch operation or disturbance of its calibration due to shocks and jars which tend to close contacts independently of pressure changes.

Another object is to provide a multicircuit baroswitch which may be made as a unitary structure ready for wiring into the circuitry it is adapted to control.

The foregoing and other objects and advantages will become apparent in view of the following description taken in conjunction with the drawings wherein:

Fig. 1 is a plan view of a multicircuit baroswitch in accordance with the invention, certain parts being shown in alternate positions in dotted lines;

Fig. 2 is a view in side elevation of Fig. 1, with the main switch arm mounting bracket broken away to expose parts in the rear thereof;

Fig. 3 is a view in broken end elevation of the baroswitch of Fig. 1; and

Figs. 4 and 5 are circuit diagrams, illustrating a type of circuitry which may be controlled by the improved baroswitch.

Referring to the drawings, the baroswitch components are mounted on a frame member generally indicated at **10**, which is preferably in the form of a light gauge sheet metal stamping having therein an opening **11**, adapted to receive a condition-responsive device in the form of a stack of evacuated aneroid capsules **12, 12'**. The outer left-hand wall or diaphragm of the capsule **12**, as viewed in Figs. 1 and 3, is adjustably anchored to the adjacent frame structure by means of a bracket **13** and threaded stud **14**; the two inner walls or diaphragms are connected to one another, while the outer right-hand wall or diaphragm has connected thereto a boss **15**, which at its outer free end is recessed or formed with a cavity to receive the pointed end of a drive link **16**, the opposite

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end of which is pivotally connected to the base portion of a ranging bracket **17** (compare Figs. 1 and 2), formed with an arm **17'**, having an inturned end connected to an angle bracket **18**, the latter having a horizontally-extending arm **18'**, which is offset at its outer end and connected by means of a tension-adjusting screw **19** with a movably-mounted switch member in the form of a baro arm **20**, carrying on its outer end a contact **20'**. The brackets **17, 18** and arm **20** are rigidly connected to one another and also to a tubular bearing and spacer member **21**, Fig. 3, which is rotatably journaled on a pin **22**, fixed at its upper and lower ends in the horizontally extending portions **23'** and **23''** of a main mounting bracket **23**, the latter being fixed to the adjacent frame structure as by rivets **24**. When the capsules **12, 12'** expand (decreasing atmospheric pressure) link **16**, which is pivotally connected to switch arm **20** through ranging bracket **17**, exerts a driving thrust on said arm and swings it in a counter-clockwise direction against the return force of a spring **39**.

The contact **20'** on the outer end of the baro arm **20** is adapted to coact with a series of commutator segments **24, 25, 26** when the telemetering device reaches its preset flight altitude. In the example shown, the segment **24** is connected into a ballast control circuit, the segment **25** is connected into a first flight termination control circuit, and the segment **26** is connected into a second flight termination control circuit. Schematics of such circuitry are shown in Figs. 4 and 5 simply for the purposes of illustration, since it will be understood that any selected number of circuits of different types and for performing various other functions could be utilized. These segments are etched or otherwise embedded in or carried by a commutator bar or block **27**, adjustably mounted on the flat base portion of the frame **10**. To accommodate such mounting, a bracket **28** (Fig. 3), having a pair of downwardly projecting legs, is secured to the under side of the commutator block through an opening formed in said base portion of the frame, and a leaf spring **29** is projected through registering slots formed in said legs, the opposite ends of the spring being flexed upwardly and engaging the under side of the frame. By this means the commutator block is permitted limited lateral adjustment on the top surface of the frame. To facilitate such adjustment, a screw **30** is threaded through the right-hand leg of the bracket **28** and has its outer end projected through the adjacent frame flange and carries on said outer end a detent wheel **31**. The spring **32** which encircles the screw **30** takes up any looseness or play in the parts. A leaf-type detent spring **33** is secured to the end flange of the frame and is formed with an elongated rib which engages in the notches of the detent wheel **31** to hold the latter in adjusted position.

The specific details of the baroswitch as above described form no part of the present invention, this part of the switch mechanism being in general similar to the switch assembly shown in the patent to E. M. Talbott, Jr., No. 2,738,392, issued March 13, 1956.

A ballast control delay member in the form of an electric conductor drop-off rod **34** has its left-hand end, as viewed in Fig. 3, projecting through and rigidly carried by an insulating and supporting block **35**, which is anchored to the frame **10**. A bushing **36**, provided with an adjusting and set screw **37**, is inserted over the outer end of the rod and holds the latter fixed in its preset position. Adjustment of this rod determines the altitude to which the balloon-borne telemetering device will rise before ballast is released to maintain it at its flight level, as will be hereinafter more fully described. When the baro arm or movable switch member **20** swings to the right or counterclockwise, as viewed in Figs. 1 and 3, it rides on this drop-off rod **34** until it reaches the end of the latter, whereupon it drops down and the contact 20' engages the ballast control segment 24; and when the arm 20 moves back or clockwise upon descent of the device at the termination of the flight, the said arm moves beneath the rod 34 but it will again be in conducting engagement with said rod due to the action of a leaf spring 38, which is secured at its one end to the upper surface of the arm 20 and at its free end is sprung upwardly so that it will engage rod 34 from beneath the latter.

The baro arm return spring 39 has its one end connected to a clip 40, having spring legs which straddle and firmly grip the boss 15, and at its opposite end said spring is connected to an upstanding leg on the ranging bracket 17; it pulls the arm 20 in a clockwise direction when the aneroid capsules 12, 12' collapse due to increasing pressure when the unit moves from a higher to a lower altitude. By adjusting screw 19, the arm 20 may be stressed downwardly so as to ensure engagement of the contact 20' with the commutator when the arm drops off of the end of the rod 34.

A movably-mounted idler switch member functioning as an initial flight termination baro arm 42, provided with a pointed grounding contact 42', is secured at its rear extremity to a stiffening arm or bracket 43 by means of a rivet 44, these two parts then being swiveled or pivotally mounted on the pin or shaft 22 by means of a bushing 45, through which said pin projects. For reasons which will hereinafter become apparent, it is necessary that the arm 42 be insulated from the frame 10 at this point. Accordingly, the arm 42 and its stiffening bracket 43 are clamped on the necked lower end of the bushing between insulating washers 46 and 46' and around a short tubular insulator (not visible) which is sleeved over said necked end. At its outer end the arm-like bracket 43 is offset and connected to the arm 42 by means of a tension screw 47, to facilitate adjustment of the flexing force of the arm in a contact-engaging direction. The outer end of the arm 42 has secured thereon a combined contact and connecting member 48 in the form of an inverted U or fork having an uninsulated leg 49 and an insulated leg 49', the purpose of which will be hereinafter explained.

The contact 42' on the outer extremity of the arm 42 is adapted to engage a grounding shelf or bar 50, which has its upper surface roughened to impose a certain degree of friction to free movement of the arm 42. The shelf or bar 50 has its one end secured to the adjacent frame structure by means of a screw 51 and spacer 52 and at its opposite end is bent downwardly and secured to the block 35 by means of screws 53.

When the arm 42 is in its extreme left-hand position, it rides on a disarming rod 54, which is projected through the block 35 and terminates at its outer end in a screw head 54', by means of which its longitudinal position may be readily adjusted. A lock nut 55 holds the rod 54 in its adjusted position.

Wiring diagram of Figs. 4 and 5

The wiring diagrams shown in Figs. 4 and 5 are purely for illustrative purposes. In these figures, parts which represent like parts in Figs. 1, 2 and 3 are given corresponding reference numerals. Fig. 4 is a schematic of the circuit controlled by the arm 42. The segments 24, 25, 26 of the commutator block 27 are provided with terminals 56, 57, 58, which when a circuit is completed across said segments and then to ground or the return side of the circuit by way of the baro arm 20 and baro frame 10, energize the ballast control circuit and the first and second flight termination circuits. The ballast control circuit has therein one or more electrically-actuated ballast control valves, which when opened release ballast from the unit and permit the balloon to ascend to a higher altitude, while the first and second termination flight circuits have therein firing squibs which when fired

separate the cable which connects the telemetering unit proper from the balloon. The left-hand end of the rod 34 beyond the anchor block 35 has connected thereto a terminal 61, from which a blinker light circuit is connected to the positive side of the battery 59, and when the baro arm 20 rides on the rod 34, the blinker light circuit is completed across the baro arm and thence by way of the baro frame back to the return side of the battery. Likewise the shelf 50 is provided with a terminal 62 at its left-hand end, from which the second termination circuit is also connected to the battery 60. This means that there are two sources of energization of the second termination circuit, one by way of the commutator segment 26 and the other across the shelf 50, arm 42, baro arm 20 and baro frame 10. The reasons for the circuitry above briefly described will become apparent in the light of the description of operation, which follows:

Operation

Carrying on the example of use heretofore noted, it will be assumed that the multicircuit baroswitch has been installed in an airborne telemetering device carried by a balloon designed to fly at high altitudes for a period of several days, and during its flight the transmitters (not shown) carried by the unit transmit meteorological data to various ground stations. The baroswitch which forms the subject matter of the present invention is not connected in circuit with the transmitters; its function is fourfold: (*a*) it terminates the flight of the device if for some reason while it is being launched and moving to flight altitude it should descend an increment of say 1500 feet; (*b*) it provides a coarse ballast control, the function of which it to keep the instrument at its flight altitude; (*c*) it terminates the flight should the unit descend a given distance below its line of flight following a successful launching; and (*d*) it energizes a blinker light circuit during the ascent and descent periods.

The baro arm 20 coacts with the arm 42 during ascent. Thus by means of the combined connecting and contact member or fork 48, the arm 42 will follow the arm 20 as long as the fork 48 straddles the end of arm 20, and this straddling action will be maintained as long as the arm 20 rides on the rod 34. The primary function of the idler arm 42 is to terminate the flight should the unit descend a given distance during the ascent period.

When the device is ready to launch, the arm 42 will be in its extreme clockwise position, or to the left as viewed in Figs. 1 and 3, at which time the ends of the fork 48 will straddle the end of the arm 20, but the contact 48' on the underside of the arm 42 will be held clear of the shelf 50. The purpose of this is to prevent shocks and vibration during the launching period and up to a predetermined altitude from energizing the second flight termination circuit. Assuming both arms 20 and 42 to be in the left-hand position just noted, and that the unit has been launched and is moving to altitude; when a given altitude is attained, say for example 3,000 feet, the aneroids will have expanded sufficiently to move the arm 42 clear of the rod 54, whereupon the arm 42 will drop down on the friction shelf 50, with the fork 48 still straddling the end of the baro arm 20. When the contact 42' on the underside of the arm 42 engages the friction shelf 50, the termination circuit is armed. In other words, the termination circuit can now be completed to ground across the left-hand uninsulated leg 49 of the fork 48 should the arm 20 move in a counterclockwise direction a given distance due to a decrease in altitude. Thus if we assume that for some reason the device drops a distance of 1500 feet, for example, the arm 20 will have moved in a clockwise direction to a point where it engages the uninsulated leg 49, at which time the flight termination circuit is completed from the positive side of the battery to the friction shelf 50, thence to the arm 42, to the left-hand leg 49 of the fork 48, to the arm 20 and the return side of the circuit or to ground.

If it be assumed that the instrument keeps on rising or ascending to its predetermined flight altitude, then the arm **20** keeps moving in a counterclockwise direction with the end thereof engaging the insulating leg **49** of the fork **48**, causing the arm **42** to follow.

During the ascent period the signal lights will be flashing, or the blinker light circuit will be energized due to the fact that the arm **20** will be riding on the rod **34**, thereby grounding said circuit from the positive side of the battery **59**, through rod **34** to and across the arm **20** to the baro frame **10**.

When the flight altitude is attained, the arm **20** will ride off of the rod **34** (this point is adjustable by adjusting the longitudinal position of the rod **34**), and when this happens, the end of arm **20** is freed or moves clear of the fork **48** and falls onto the ballast control segment **24** of the commutator **27**. Since the desired altitude has now been attained, a certain amount of ballast will be dropped, causing the unit to rise, whereupon the contact **20'** is moved to the extreme right of the ballast segment clear of the latter; and as long as the balloon or unit remains within a given altitude range, the contact **20'** will remain clear of the ballast segment **24**. However, should the instrument drop below its flight altitude, the contact **20'** will engage the ballast segment **24** and cause the unit to again rise to its flight level.

The duration of the flight is governed by a suitable timing device, such as a time clock, not shown. If during the flight period, for some reason the unit should drop below a given altitude, say for example 2,000 feet below its flight altitude, the contact **20'** on the end of the arm **20** will engage the first termination segment **25** of the commutator **27**, whereupon ballast would be released by the ballast valves, not shown, the cable connecting the instrument to the ballast would be severed, a parachute opened and the instrument would descend to ground level. If for some reason the first or primary termination mechanism fails and the unit drops through another altitude range, the contact **20'** on the end of the arm **20** will engage the second termination segment **26**, which is of greater area than the first termination segment, thereby energizing the second termination circuit.

At the termination of the flight, which is governed by the clock mechanism above noted, the contact **20'** will engage, respectively, the first and second termination segments **25** and **26** and the flight will terminate either by the first or second termination routine as above noted.

During descent of the instrument, the spring contact **38** on top of the arm **20** engages the rod **34** and energizes the blinker light circuit so that the blinker lights are turned on when the instrument is dropping to ground level.

What is claimed is:

1. In switching mechanism for automatically controlling one or more electric circuits in response to changes in an atmospheric condition or conditions, a condition-responsive device, a first movably-mounted switch member operatively connnected to said device to be driven thereby proportionally to such changes, a second movably-mounted idler switch member coacting with said first switch member, said driven switch member having a limited range of travel in its driven plane independently of said idler switch member, a combined contact and connecting member secured to one of said switch members and having an insulated part and an uninsulated part loosely straddling the other switch member thus providing a driving connection between the driving switch member and the idler switch member, an electric circuit including said switch members and said uninsulated part of said connecting contact member, said driven switch member when moving in one direction in response to a change in a condition engaging said insulated part to maintain the circuit open and when moving in the opposite direction engaging said uninsulated part to maintain the circuit closed.

2. In a switching mechanism for automatically controlling one or more electric circuits in response to changes in an atmospheric condition or conditions, a condition-responsive device, a first movably-mounted switch member operatively connected to said device to be driven thereby proportionally to such changes, a second movably-mounted idler switch member coacting with said first switch member, said driven switch member having a limited range of travel in its driven plane independently of said idler switch member, a combined contact and connecting member secured to one of said switch members and having an insulated part and an uninsulated part loosely straddling the other switch member thus providing a driving connection between the driven switch member and the idler switch member, an electric circuit including said switch members and said uninsulated part of said connecting contact member, said driven switch member when moving in one direction in response to a change in a condition engaging said insulated part to maintain the circuit open and when moving in the opposite direction engaging said uninsulated part to maintain the circuit closed, and means whereby the driving connection between the driven and idler switch members by way of said combined contact and connecting member is automatically released after the driven switch member has moved a predetermined distance through its range of travel.

3. Switch mechanism as claimed in claim 2 wherein said combined contact and connecting member is secured to said idler switch member and has an insulated leg and an uninsulated leg overriding said driven switch member, the latter being urged in a direction such that it moves clear of said legs after it has moved a predetermined distance through its range of travel.

4. In switching mechanism for automatically controlling one or more electric circuits in response to changes in an atmospheric condition or conditions, a condition-responsive device, a first movably-mounted switch member operatively connected to said device to be driven thereby proportionally to such changes, a second movably-mounted idler switch member coacting with said first switch member, said driven switch member having a limited range of travel in its driven plane independently of said idler switch member, contacts carried by said switch members, a combined contact and connecting member secured to one of said switch members and having an insulated part and an uninsulated part loosely straddling the other switch member thus providing a driving connection between the driven switch member and the idler switch member, a plurality of electric circuits including said switch members and said uninsulated part of said connecting contact member, said driven switch member when moving in one direction in response to a change in a condition engaging said insulated part to maintain the circuit open and when moving in the opposite direction engaging said uninsulated part to maintain the circuit closed, an electric commutator having contact segments connected into said circuits, means for maintaining the driving connection between the driven switch member and the idler switch member by way of said combined contact and connecting member over a predetermined portion of the range of travel of the driven switch member and for releasing said drive connection during the remaining portion of its range of travel, said contact segments of the commutator being located to be engaged by the contact carried by the driven switch member when the drive connection is released.

5. Switch mechanism as claimed in claim 4 in which there is an elongated support on which said driven switch member rides through a predetermined portion of its travel range and is held by said support between the insulated and uninsulated parts of said connecting member, said support being of conducting material and wired into one of said circuits, said driven switch member upon

moving clear of said support being free to engage said commutator segments.

6. In a baroswitch for controlling one or more electric circuits in response to changes in atmospheric pressure, a pressure-responsive device, a pivotally mounted switch arm operatively connected to said device to be driven thereby, a second pivotally mounted idler switch arm coacting with said first switch arm, said driven switch arm having a limited range of angular travel independently of said idler switch arm, a combined contact and connecting member secured to one of said arms and having an insulated part and an uninsulated part loosely straddling the other arm thus providing a driving connection between the driven arm and the idler arm, an electric circuit in which said arms are connected in series relationship across said uninsulated part, said driven arm when moving in one direction in response to changes in ambient pressure engaging said insulated part to maintain the circuit open and when moving in the opposite direction engaging said uninsulated part to maintain the circuit closed.

7. In a baroswitch for controlling one or more electric circuits in response to changes in atmospheric pressure, a pressure-responsive device, a first switch arm pivotally mounted within the region of said device and operatively connected to the latter to be driven thereby, a second idler switch arm pivotally mounted in substantially axial alignment with said first arm, said driven switch arm having a limited range of angular travel independently of said idler switch arm, contacts carried by said arms, a combined contact and connecting member secured to one of said arms and having an insulated part and an uninsulated part loosely straddling the other arm thus providing a driving connection between the driven arm and the idler arm, an electric circuit, said arms being connected in series in said circuit across said uninsulated part of said connecting member, said driven arm when moving in one direction in response to a change in pressure engaging said insulated part to maintain the circuit open and when moving in the opposite direction engaging said uninsulated part to maintain the circuit closed, said combined contact and connecting member having an opening through which said driven member may pass to break the driving connection between said arms, said driven member being biased in a drive-breaking direction.

8. In a baroswitch for controlling one or more electric circuits in response to changes in atmospheric pressure, a supporting frame, a pressure-responsive device fixed to said frame, a pair of switch arms of conductive material pivotally mounted on said frame adjacent said device, one of said arms being drivably connected to said device to be driven thereby in response to changes in pressure and the other of said arms being free to swivel about its pivot independently of said driven arm, a generally yoke-shaped combined contact and connecting member secured to one of said arms and provided with a pair of legs straddling the other arm, one of said legs being insulated and the other of said legs being uninsulated and made of conducting material and providing a conducting path between said arms, a first electric circuit including said arms and said uninsulated leg, said driven arm when moving in one direction in response to changes in pressure engaging said insulated leg and maintaining the circuit open and when moving in the opposite direction engaging said uninsulated leg and closing the circuit, an elongated support of conducting material on which said driven arm rides during part of its arcuate travel, a second electric circuit including said support, said driven arm being spring-urged in a direction to release the drive connection provided by said combined contact and connecting member when the driven arm rides off said conducting support, and means for maintaining said switch arms in predetermined axially-spaced relation during the time the driven arm is traversing said elongated support.

9. In a baroswitch for controlling a plurality of electric circuits as a function of changes in atmospheric pressure, a supporting frame, a pressure-responsive device fixed to said frame, a driven arm and an idler arm of conducting material pivotally mounted on said frame adjacent said device, means providing a driving connection between said driven arm and said device, said idler arm being free to swivel about its pivot independently of said driven arm, a generally yoke-shaped combined contact and connecting member secured to said idler arm and provided with a pair of legs straddling the driven arm, one of said legs being insulated and the other being uninsulated and made of conducting material to provide a conducting path between said arms, a first electric circuit including said arms and said uninsulated leg, said driven arm when moving in a direction of decreasing pressure engaging said insulated leg and maintaining the circuit open and when moving in the opposite direction engaging said uninsulated leg and closing said circuit, an elongated substantially rigid conductor projecting adjacent the path of travel of said driven arm and a substantially parallel grounding shelf or support located adjacent the path of travel of said idler arm, said arms being spring-stressed in a direction to cause the arms to ride on said supports and be maintained in axially-spaced relation until the driven arm rides clear of its support, a second electric circuit including said driven arm and said conductor, an electric commutator having a plurality of commutating segments at least one of which is located beyond said conducting support to be engaged by said driven arm when it clears said support, and additional electric circuits including in series said segments and said driven arm.

10. In a baroswitch as claimed in claim 9 wherein said driven arm is provided with a spring contact strip adapted to engage said conducting support when said driven arm is moving in a direction of increasing atmospheric pressure.

11. In a baroswitch as claimed in claim 9 wherein there is provided an adjustable deactivating member which functions to hold the idler arm clear of said grounding support when the driven arm is at its maximum pressure position.

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