May 29, 1962 R. W. MAAS ET AL 3,037,100

BALLOON FLIGHT CONTROL SWITCH

Original Filed Nov. 27, 1957 2 Sheets-Sheet 1

Fig. 1.

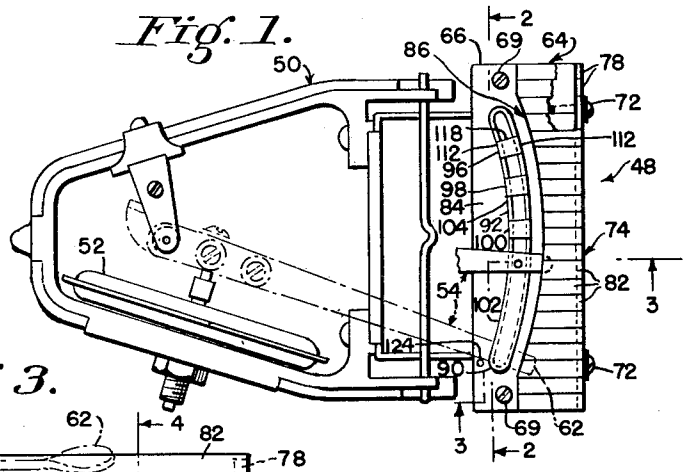

Fig. 3.

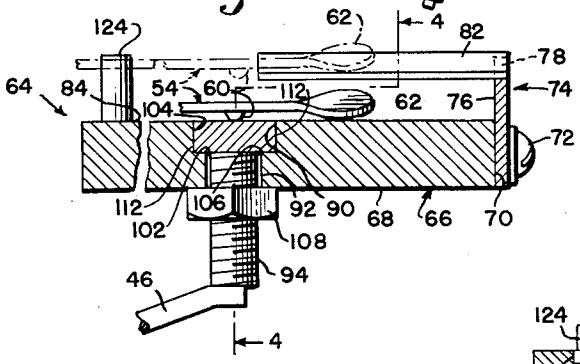

Fig. 2.

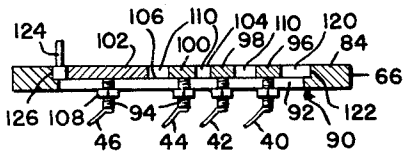

Fig. 4.

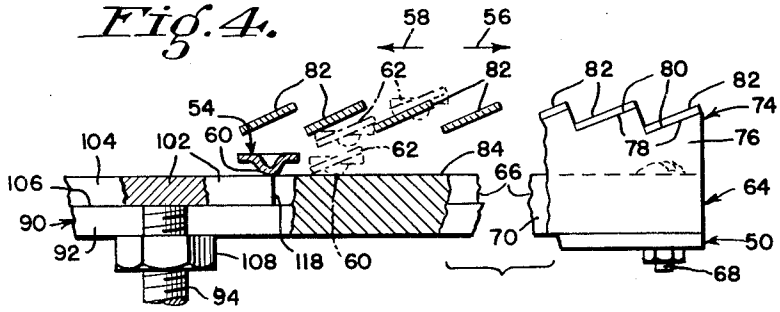

Fig. 5.

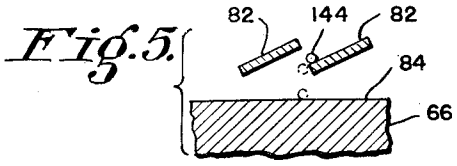

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Fig. 7.

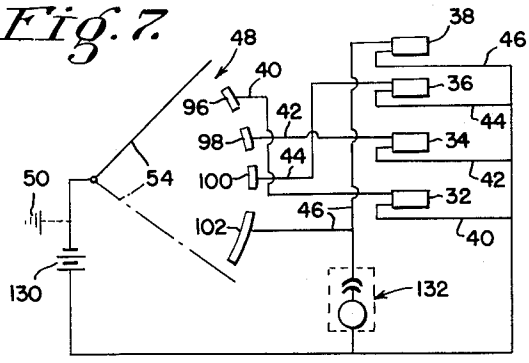


Fig. 8.

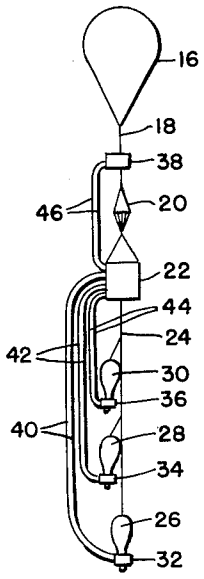


Fig. 9.

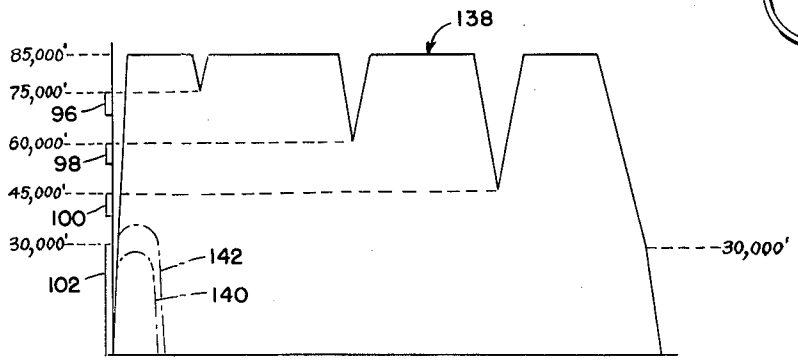
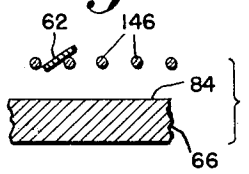


Fig. 6.



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BALLOON FLIGHT CONTROL SWITCH

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Original application Nov. 27, 1957, Ser. No. 699,431, now Patent No. 3,018,069, dated Jan. 23, 1962. Divided and this application Jan. 31, 1961, Ser. No. 86,273

13 Claims. (Cl. 200—83)

This is a division of our copending application entitled Balloon Flight Control, Serial No. 699,431, filed November 27, 1957, which issued as Patent No. 3,018,069 on January 23, 1962.

This invention relates to apparatus for programming high altitude balloon flights and to switch mechanism therefor.

It is an object of the invention to provide a novel ballast-release and blowdown switch mechanism for automatically programming a balloon flight.

Another object is to provide a simple control which is readily variable to afford the desired program of a balloon flight or other operation.

An additional object is to provide a novel ratchet switch mechanism.

Further objects and advantages of the invention will appear as the description proceeds.

The invention will be better understood on reference to the following description and accompanying drawing, wherein:

FIG. 1 is an elevational view of a switch mechanism embodying features of the invention.

FIG. 2 is a sectional view taken at 2—2 in FIG. 1 and turned 90°.

FIG. 3 is a magnified view, partly in section and partly in elevation, taken at 3—3 in FIG. 1.

FIG. 4 is a broken view, partly in section and partly in elevation, taken at 4—4 in FIG. 3.

FIG. 5 is similar to a part of FIG. 4 but shows a modified switch arm tip.

FIG. 6 is similar to FIG. 5 but shows a modified ratchet tooth construction.

FIG. 7 is a circuit diagram embodying features of the invention.

FIG. 8 is a diagram of a balloon assembly in flight in accordance with the invention.

FIG. 9 is a diagram showing graphically a normal flight and two failing flights.

Referring now more particularly to the drawing, disclosing illustrative embodiments of the invention, there is shown diagrammatically (FIG. 8) at 16 a balloon envelope from which hangs a load line 18 supporting a parachute 20 suspending a gondola 22 housing telemetering and/or other instrumentation. An auxiliary line 24 hanging from the gondola 22 suspends inverted closed bags containing respectively first, second, and third ballasts 26, 28, and 30, the necks of the bags respectively passing through the barrels of explosive (squib) cutters 32, 34, and 36. The load line 18 passes through the barrel of a similar cutter 38. Wiring 40, 42, 44, and 46 from the respective cutters 32, 34, 36, and 38 extends into the gondola 22 and is suitably connected to switch mechanism 48 (FIG. 1) adapted to control the ballon flight by controlling the sequential firing of the cutters in accordance with the desired program.

The switch mechanism 48 comprises a frame 50 supporting an aneroid bellows 52 actuating a switch contact arm 54 to swing in the direction of the arrow 56 with ascent of the balloon and in the opposite direction 58 with descent of the balloon. The arm 54 is grounded to the frame 50 and has near its outer end a contact dent 60 beyond which the arm is preferably twisted to provide an inclined paddle or tip 62 which serves as a ratchet pawl. The frame 50 also supports a contact unit 64 cooperating with the arm 54, as will appear.

The contact unit 64 comprises an insulation block 66 secured at 68 to the frame 50. To one longitudinal side 70 of the block 66 is secured as at 72 a louver-like comb 74 comprising a strip 76 having a ratchet-like row of teeth 78 to whose risers 80 is soldered a series of cantilever slats 82 spaced from the upper face 84 of the block a distance exceeding the combined height of the dent 60 and tip 62 measured normal to the face (FIGS. 3 and 4). The free ends of the slats 82 are preferably arranged to provide an arcuate pattern as indicated at 86 conforming to the sweep of the tip 62. The arm 54 is preferably resiliently biased toward the block 66, and the tip 62 is sufficiently thin to be capable of sliding up and down any slat 82 without interference from the adjacent slat.

The block 66 is formed with a T-slot 90 (FIGS. 1 to 4) curved in conformity with the sweep of the dent 60. The narrow part 92 of the slot 90 is adapted to freely receive the shanks 94 of screw contacts 96, 98, 100, and 102 whose heads are received in the wide part 104 of the slot and clamped to the slot ledge 106 by nuts 108, with the tops of the heads preferably flush with the block face 84. The contacts 96, 98, 100, and 102 are spaced apart as at 110, their positions being determined by calibration, and are employed for control of the respective cutters 32, 34, 36, and 38. The radially spaced edges 112 of each contact head are preferably curved in conformity with the curvatures of and are adapted to slide along the sides of the wide part 104 of the slot 90 for adjustment along the slot. The block 66 may bear atmospheric pressure indicia (not shown), as at an edge of the slot 90. The low pressure end 118 of each contact head is preferably radial. A substantial space 120 separates the low pressure end contact 96 from the low pressure end 122 of the slot 90. The block 66 has a stop 124 at the ground pressure end 126 of the slot 90.

With the cutters 32, 34, 36, and 38, switch arm 54, and contacts 96, 98, 100, and 102 connected with a battery 130 (FIG. 7), and a flasher unit 132 in parallel with the cutter 38 preferably included, the switch mechanism 48 is assembled and installed for the balloon flight as shown in FIG. 1, with the tip 62 resting on a slat 82 adjacent the stop 124 as shown in dot-dash lines, the stop preventing the tip from moving down the slat and thereby preventing premature engagement of the dent 60 with the high pressure (blowdown) end contact 102 before the balloon is launched.

As the balloon soars, the expanding bellows 52 swings the switch arm 54 in the direction of the arrow 56, causing the switch arm tip 62 to ride up the ramp of the slat 82 then supporting the tip. On completion of its upward traverse of that slat, the tip 62 will snap down off the top of that slat and onto the next slat, and so on as the ascent continues. Whenever the balloon descends, the tip 62 will ride down the nether slat, and, if any descent is sustained to such an extent that the tip drops down off a slat, the switch arm 54 will snap the tip onto the block face 84 if at such time the dent 60 is in a space 110 or 120, or will snap the dent onto a contact, as the case may be. Once the tip 62 snaps off of the bottom of a slat 82, the bias on the arm 54 will keep the arm free of the slats for the remainder of the flight. While the dent 60 is in the space 120 or any space 110, the tip 62 will be stationary on the block face 84 or will ride on the face, in one direction 56 or the other 58, depending on whether the altitude is maintained, increasing, or decreasing. When the dent 60 while moving in the direction 58 touches the edge 118 of a contact, a circuit is closed, firing the corresponding cutter. A cutter will of course be fired if, pursuant to

descent of the balloon, the switch arm 54 snaps the dent 60 into touch with a contact.

A balloon launched early enough in the day will normally proceed to ceiling altitude without the necessity for releasing ballast. At sunset and as night sets in, the consequent cooling and thus the reduction in volume of the lift gas will cause the balloon to descend. It is to prevent undesired complete descent and enable the balloon to reascend to ceiling altitude that ballasting is provided.

In the illustrative example of the invention, the balloon is designed to reach and remain for considerable periods at a predetermined ceiling altitude, and provision is made for a flight to terminate after the fourth day. On the first night the tip 62, pursuant to the descent of the balloon, will ride down and snap off the bottom of the nether slat and move in the direction of the arrow 58 until the dent 60 touches the low pressure end 118 of the first contact 96, closing the circuit for and firing the first cutter 32, which cuts the neck of the bag of and dumps the first ballast 26, whereupon the balloon will reascend to ceiling altitude, and the tip 62 during such reascent will ride along the block 66 in the direction 56. With the second night's descent, the arm 54 will retrogress in the direction 58 far enough to bring the dent 60 into touch with the low pressure end 118 of the second contact 98 (the first contact 96 then being "dead" inasmuch as its circuit is open at the fired cutter 32), closing the circuit for and firing the second cutter 34 to cut the neck of the bag of and dump the second ballast 28, whereupon the balloon again will rise to ceiling altitude. Similarly, engagement of the dent 60 with the low pressure end 118 of the third contact 100 (the first and second contacts 96 and 98 then being "dead") will fire the cutter 36, resulting in the dumping of the third ballast 30, whereupon the balloon will again proceed to ceiling altitude. The device is designed so that descent (on the fourth night) to a level somewhat above the upper altitude limit of aircraft airlanes will bring the dent 60 into touch with the low pressure end 118 of the fourth contact 102, closing the circuit for and firing the fourth (blowdown) cutter 38, which severs the load line 18, whereupon the gondola 22 is parachuted to earth to minimize hazard to aircraft.

Should the balloon for any reason fail initially to ascend sufficiently to enable any of the ballasts to be dumped, the dent 60 during the ensuing descent will touch the contact 102 to fire the blowdown cutter 38 and thus bring about complete descent of the gondola 22, as indicated in the two examples in dot-dash lines at 140 and 142 in FIG. 9.

If desired, a radio control (not shown) may be provided, operated from the ground, to fire the blowdown cutter 38 at will.

At and following the firing of the blowdown cutter 38 the flasher 132 will operate to warn aircraft pilots of the falling load and aid in tracking the load for recovery.

FIG. 9 shows diagrammatically at 138 a plot of balloon altitude against time for a typical normal flight and at 140 and 142 similar plots for faulty flights. The ceiling altitude is here assumed to be 85,000 feet, the ballast dumping altitudes to be respectively 75,000, 60,000, and 45,000 feet, and the blowdown altitude 30,000 feet. For different flights of the same duration, the calibrated adjustments of the contacts will vary, depending on, among possibly other things, the ceiling altitude for which the balloon is designed, and climatic conditions. The weights of the ballasts and the number of ballasts and associated cutters and contacts will depend on, among other things, the number of nights during which the balloon is to remain aloft.

In FIG. 5 a modified switch arm tip 144 is employed, and in FIG. 6 the slats are replaced by pins 146, the action being substantially the same as with the above described construction.

While preferred embodiments have been described, they should be regarded as examples of the invention and not as restrictions or limitations thereof as changes may be made in the construction and arrangement of the parts without departing from the spirit and scope of the invention.

We claim:

1. Switch mechanism, comprising an insulation block having a longitudinally arcuate slot therethrough, wider at the top than at the bottom, a series of contacts adjustably clamped in the slot with the heads of the contacts flush with the upper face of the block, a comb-like ratchet structure mounted on the block and comprising slats inclined to and overhanging and spaced from the face and arranged in a series along the slot, the series of slats being of substantially greater extent lengthwise of the slot than the series of contacts, and a switch contact arm pivoted about the axis of curvature of the slot and having a tip biased toward the face and formed to ride the upper sides of successive slats ratchet-wise when the arm sweeps initially in one direction and to pass between adjacent slats when the arm sweeps initially in the return direction, the tip being adapted, on the first predetermined magnitude of retrogression of the arm, to slide down and off the upper side of a slat and snap toward the face, and thereafter, irrespective of the direction of sweep, to extend between the face and the series of slats, the arm having a projection extending below the level of the bottom of the tip, the projection being disposed over the slot when the tip is on a slat, whereby, on snapping of the tip down off a slat, the tip will engage the face if the projection extends into an unoccupied part of the slot, but will be spaced above the face when the projection engages the top of one of the contacts.

2. Switch mechanism, comprising an insulation block, a series of teeth overhanging the block and having free ends arranged in an arcuate series spaced from the upper face of the block, the block having an arcuate series of spaced contacts at the face and radially inward of and adjacent the free ends of the teeth, a pivoted contact arm coaxial with the two arcuate series, and means for sweeping the arm transversely of the teeth in each direction, the free end portions of the teeth being inclined, with their bottoms closer than their tops to one end of sweep of the arm, the arm having a downward projection at a radius conforming to that of the series of contacts, the arm having a tip at a radius in conformity with the free end portions of the teeth and biased toward the bottom of the block, whereby the arm on initial movement from the above mentioned sweep end will traverse the series of slats, the tip being formed to pass down between and clear of the teeth on the first predetermined magnitude of retrogression of the arm, the free end portions of the teeth being spaced from the face a distance exceeding the corresponding overall dimension of the tip and projection so that the projection is spaced above the level of the contacts when the tip is supported by a tooth, but is engageable selectively with the contacts when the tip is free of and below the series of teeth.

3. Switch mechanism, comprising a stationary series of contacts, a stationary comb-like series of teeth, and a movable switch contact arm forming with the teeth a one-way ratchet, the arm being biased toward the level of the series of contacts and having a predetermined range of sweep, the series of teeth extending throughout the range, the series of contacts extending from a point adjacent one end of the range and being of substantially less extent than the range, the arm when engaged with any of the teeth being unengageable with any contact, the arm initially being engaged with the tooth at one end of the range and being adapted throughout the initial sweep of the arm to travel ratchetwise from tooth to tooth, the arm being biased to pass into the first intertooth space encountered by the arm on return sweep of the arm, the arm being engageable for the first time with one or another of the contacts only after such sustained retrogression of the arm as will enable the arm to snap clear of the series of teeth.

4. Switch mechanism, comprising an insulation block, a pivoted arm having an outer end portion overhanging and biased toward the block and having a predetermined range of sweep, a comb mounted on the block and comprising a series of louver-like slats over the block and extending from their secured ends generally toward the pivot axis, the free ends of the slats forming an arcuate pattern coaxial with the arm, the block having a slot extending in an arc coaxial with the pattern, the slot being wider at the face than remote from the face, and a series of contacts adjustably clamped in the slot with the upper ends of the contacts adjacent the face, the overhanging portion of the arm comprising a tip whose sweep conforms to the pattern and a downwardly extending projection whose sweep conforms to the slot, the distance of the free end portions of the slats from the block exceeding the overall dimension of the tip and projection in a direction normal to the upper face of the block, the projection being spaced above the level of the series of contacts when the tip is engaged with any of the slats, and being engageable for the first time with one or another of the contacts only after such sustained retrogression of the arm as will enable the tip to snap down off a slat.

5. Switch mechanism, comprising an insulated block having a contact, a comb mounted on and comprising teeth overhanging and spaced from the block, and a movable switch contact arm biased toward the block, the outer end portion of the arm initially overhanging and resting on the free end portion of a tooth, the tip of the arm on its initial sweep traversing the comb ratchet-wise out of engagement with the contact but being slidable down and off a tooth on its first substantial retrogression, the arm being engageable with the contact when the arm is unsupported by the comb.

6. Switch mechanism, comprising an insulated block, a comb mounted on and comprising a series of louver-like slats overhanging and spaced from the block, a switch contact arm whose outer end portion is biased downward and rests on an end slat and is adapted in its initial sweep to traverse the series ratchet-wise, the block having contacts in a series over which the arm is adapted to sweep, the comb, while supporting the arm, spacing the arm from the contacts, the slats being unconnected to one another where they overlap the outer end portion of the arm, the arm being slidable down and off a slat and onto the block on the first substantial retrograde sweep in a position to selectively engage the contacts, and means enabling the length of the series of contacts and the positions of the contacts to be preselected.

7. Switch mechanism, comprising a ratchet including a stationary set of teeth and a cooperating movable switch contact pawl biased against the teeth, the teeth being openly spaced and the pawl, when engaged with any tooth, being passable entirely through the space between that tooth and the next trailing tooth in response to a predetermined degree of retrogression of the pawl, and a switch contact engageable by the pawl only pursuant to retrogression of the pawl.

8. In a switch mechanism, an insulation block having a T-slot therethrough, a T-shaped switch contact whose head is disposed in the wide part of the slot and whose shank extends in the narrow part of the slot, the contact being slidable along the slot to any desired position, and means engaged with the shank for clamping the contact in such position.

9. In a switch mechanism, an insulation block having a slot, a switch contact keyed in the slot and adjustable to any desired position therein, and means for clamping the contact in such position.

10. Switch mechanism, comprising a contact, and a ratchet including a stationary set of openly spaced teeth and a cooperating switch contact pawl engaging an upper face of a tooth and biased toward a level below the set of teeth, the pawl being out of touch with the contact while so engaged, the pawl, in response to the bias and a predetermined degree of retrogression of the pawl, traveling down between a pair of teeth to a position free of the set of teeth, the pawl, when free of the set of teeth, being biased against reengagement with any of the teeth, the contact being engageable by the pawl on a predetermined degree of retrogression of the pawl.

11. The structure of claim 10, together with means responsive to progressive change in a condition toward and from an optimum for sweeping the pawl toward and from a position adjacent one end of the set of teeth, and means responsive to engagement of the pawl with the contact for promoting resumption of the optimum condition.

12. The structure of claim 10, together with means responsive to progressive change in a condition toward and from an optimum for sweeping the pawl toward and from a position adjacent one end of the set of teeth, and means responsive to engagement of the pawl with the contact for preventing resumption of the optimum condition.

13. Switch mechanism comprising, in combination with an aneroid bellows actuated pivoted switch contact arm, an insulation block having an arcuate slot coaxial with the arm and over which the arm is adapted to sweep, the block having a row of pressure indicia along the slot for different positions of the arm, a contact slidably keyed in the slot so as to be adjustable therealong, the contact having a radial edge adjacent the row of indicia to facilitate location of the contact at the desired position for engagement with the arm when the pressure increases to a predetermined magnitude, means for clamping the contact in the desired position, and means for preventing engagement of the arm with the contact during initial decrease in pressure.

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