RADIOSONDE WITH PROJECTILE MEANS TO CARRY IT ALOFT

Fig. 1.

Generator Casing 1
Clutch 10
Radio Sonde 6
Counter-Rotation Vanes 8
Impeller 11

Fig. 2.

Radio Sonde 6
Parachute 20
Impeller 11
Generator 21
Clutch 10
Radio Sonde 6
Commutator 4

Fig. 3.

Rose Casing 1

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RADIOSONDE WITH PROJECTILE MEANS TO CARRY IT ALOFT

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to meteorological apparatus, known as radiosondes, utilizing projectile means to carry the apparatus into the upper atmosphere. This application is a continuation-in-part of my application having Serial No. 579,131, filed February 21, 1945, which has been abandoned in favor of the present application.

Conventionally, radiosonde apparatus is carried aloft by means of balloons. This limits the altitudes obtainable to a range of from 40,000 to 60,000 feet, or, in other words, to altitudes considerably below those at which it is now necessary to obtain data. Furthermore, winds cause serious drifting of the balloon and it may move in various lateral directions from time to time during the ascent. This not only increases the time required for the ascent but also affects the relationship and the pertinency of the various data being recorded. Furthermore, even if a balloon ascended vertically, it would move upward at the comparatively low rate of from 600 to 1000 feet per minute. The use of a balloon for supporting the radiosonde during its upward movement thus introduces a serious departure from the ideal system which is to record all of the meteorological data instantaneously on a vertical track at all altitudes. In addition, if the track is substantially vertical, it will usually be possible to recover the apparatus for reuse.

It is therefore an object of this invention to make it possible for a radiosonde to be carried in a substantially vertical direction to very much higher altitudes and at very much higher speeds than are possible with the conventional balloon means for elevating the radiosonde.

It is a further object of the invention to replace the conventional batteries used in a radiosonde, with an air-driven electrical generator. These results are accomplished by a device which may be described broadly as consisting of a projectile, such as a rocket, for carrying the radiosonde into the upper atmosphere and parachute means for lowering the radiosonde from the upper atmosphere. It also includes air-driven vane means which are operated by passage of the radiosonde through the air during the descent, these vane means serving to operate the rotary commutator which sequentially connects each of the meteorological instruments in the radiosonde to the radio transmitter which is also in the radiosonde. In addition, the vane means operate an electrical generator which supplies power to operate the instruments and the transmitter.

Fig. 1 is an elevational view of the device as assembled for firing, a portion of the outer casing being cut away to show the internal arrangement. Fig. 2 is an elevational view of that part of the device which includes the radiosonde, as it appears during the descent from the upper atmosphere, with portions of some of the elements cut away to show the construction more clearly.

Fig. 3 shows an arrangement for releasably holding two portions of the device together during the ascent. Fig. 4 shows a different arrangement for releasably holding the two portions of the device together during the ascent.

Fig. 5 illustrates the way in which the air-driven vane means are used to provide electrical energy for operating a conventional radiosonde transmitter, as well as mechanical energy for operating the commutator.

This device consists essentially of a projectile having two main parts, the nose casing 1 and the projectile means 2. Projectile means 2 contain the propelling charge and may be constructed in the form of a rocket having propellant tubes 3, and guiding and stabilizing fins 4. Other means for guiding and stabilizing the device may, of course, be employed. These include end sticks, vanes, inertia controls, or ejection of gases from the interior of the projectile in such a way as to control the flight.

In the interior of the projectile is the radiosonde 5, connecting wire 6, generator casing 7 having counter-rotation vanes 8, shaft 9 having mounted on it an overriding clutch 10, impeller 11, radiosonde-parachute-ejecting spring 12, connecting wire 13, radiosonde parachute 14, projectile-means-parachute-ejecting spring 15, projectile-means-parachute-ejecting spring 17, and connecting wire 18. Projectile means 2 are releasably connected to nose casing 1. The releasable connecting means are diagrammatically represented in Fig. 1 by pins 16. These releasable connecting means are described in more detail later.

In firing the projectile, it is preferably so aimed, taking into account the rotation of the earth and the prevailing winds, that its track will be substantially vertical. The projectile may be carried all the way to the upper atmosphere by means of a rocket, or, as an alternative, it could be fired from an anti-aircraft gun. In the latter case, after the propulsion provided by the gun has been dissipated, a rocket could then be used to carry the projectile the rest of the way to its maximum altitude.

Even with the rocket propulsion means alone, altitudes of the order of 700,000 or 900,000 feet are attainable. It is possible to omit completely any means actually connecting nose casing 1 and projectile means 2 and to rely merely on the stepped construction of the inner end of projectile means 2 to press nose casing 1 during the ascent and thus to cause these two portions to remain adjacent to each other during the ascent. When the projectile reaches the top of its flight and attains a substantially horizontal attitude, the two portions would separate from each other under the action of gravity.

Preferably, other means are utilized for accomplishing the separation of nose casing 1 and projectile means 2. One form of these means is illustrated in Figure 3. Here the two main portions of the projectile are held together by pin 27 which is inserted into slot 29 which passes through both of these portions. In a recess 57 in the side of nose casing 1 and under the inner end of pin 27 are gas-filled bellows 28. When the projectile reaches a predetermined altitude at which the barometric pressure is substantially less than that at the launching point, the bellows will have expanded sufficiently to force the pin out of that part of slot 29 which extends into projectile means 2. In recess 55 which also extends into both nose casing 1 and projectile means 2 is positioned a spring 26 which is under compression and which tends to cause these two main portions of the projectile to disengage from each other. (Instead of using a spring under compression to accomplish the disengagement, it is possible to use a spring under tension.) This disengagement can not take place, however, until pin 27 has been moved out of that part of slot 29 which lies in projectile means 2. Similar releasable connecting means are employed at other points around the circumference of the projectile.
Figure 4 illustrates another type of releasable connecting means. In this construction, an impeller 30 is mounted on a supporting plate 33 and attached to nose casing 1 near the latter's point end. An air intake 31 and air outlets 32 are provided in connection with impeller 30. As the projectile moves upward, the vanes 59 of impeller 30 are rotated due to the passage of air through the impeller. As these vanes rotate, they cause lead screw 33 to rotate and nut 35 to be moved in an upward direction. Rod 36 is fixed to supporting plate 33 and passes radially through a hole in nut 35. Nut 35 is thus prevented from rotating. Nut 35 is also fixedly attached by means of rods 37 to an equalizing bar 38. As nut 35 moves upward, it thus rotates equalizing bar 38, which is cables 39 which pass through openings 41 in cable guides 40. The lower ends of cables 39 are attached to bell cranks 43 rotatably supported by projections 42 attached to nose casing 1. The lower ends of bell cranks 43 are arcuate-shaped members 44 which pass through arcuate-shaped slots 55 in nose casing 1 and projectile means 2, thus serving to hold these two main portions of the device together. The arcs of members 44 and slots 55 are drawn about the center of rotation of bell cranks 43. As equalizing bar 38 moves upward, cables 39 are replaced under stress, causing bell cranks 43 to rotate and withdraw members 44 from slots 55. With the assistance of spring means such as 26 already described in connection with Figure 3, nose casing 1 and projectile means 2 will be caused to separate from each other.

Still other methods of separating the two portions of the projectile could be used. These other methods include burning fuses which detonate a bursting charge at a predetermined point in the flight, inertia-operated arrangement, or clockwork mechanism which cause the two portions to separate at such predetermined point.

Whatever means are employed, when the predetermined point in the flight is reached, the two portions are disengaged. Spring 17 causes a parachute to emerge from casing 15 and this parachute which is attached to projectile means 2 supports the latter during the descent. Similarly, spring 12 causes parachute 20 to emerge and connecting wire 13 to become taut. Connecting wire 13 is attached to impeller 11 having vanes 19 of conventional design. Vanes 19 are attached to shaft 9 which is also attached to self-excited generator 21 and radiosonde commutator 22. Cable 23 contains electrical leads running from generator 21 to radiosonde 5. If preferred, commutator 22 could be mounted adjacent to generator 21, and could be connected by electrical leads to radiosonde 5.

As the assemblage of apparatus supported by parachute 20 descends, air is caused to pass through openings in radiosonde 5, thus permitting the conventional meteorological instruments located within the radiosonde to register properly. Air also passes through openings in impeller 11 causing vanes 19 to rotate shaft 9, thus causing generator 21 to develop electrical energy, and commutator 22 to be rotated.

Overriding clutch 10 serves to hold the speed of rotation of generator 21 and of commutator 22 to a predetermined maximum. While other means than speed control may be employed to control the voltage output of the generator 21, it is preferable to have such a control for the commutator 22. It is not necessary, of course, to have shaft 9 drive commutator 22 directly. This drive could be accomplished through reduction gearing.

The amount of power required to operate a radiosonde is in the order of 2 watts or about 0.0003 H. P. Thus, velocities of descent as low as 50 feet per minute could produce an adequate current to drive the impeller 11 to the necessary speed of rotation. However, this rate of descent could be and preferably would be considerably increased, up to the limit of the ability of the meteorological instruments to record the changing conditions sufficiently rapidly. This in turn permits the size of the parachute to be decreased. The size of the projected to used here is already smaller than one used in the conventional radiosonde equipment due to the fact that part of the retarding action during descent is provided by the rotation of the vanes of impeller 10 as the apparatus moves through the air. The small size of the parachute utilized in this invention makes the apparatus much less subject to lateral drifting under the action of the wind and thus makes possible a much closer approach to the ideal of vertical descent than is possible with conventional radiosonde apparatus.

To remove any tendency of the casing of impeller 11, generator casing 7, or radiosonde 5, to follow the rotation of vanes 19, counter-rotation shafts 8 are provided on casing 7. These shafts 8 are of conventional design and are preferably permanently mounted on casing 7 in their extended position. However, if desired, these shafts 8 could be folded flat and thus caused to be extended during the descent, e.g., by the action of the air, by wires connected to the parachute, by linkages operated by rotation of vanes 19, by inertia-operated means, or by springs which are permitted to act on vanes 8 upon disengagement of nose casing 1 and projectile means 2.

Figure 5 shows this invention as utilized to provide electrical current to conventional radiosonde equipment. Conventional radiosonde transmitter including modulating oscillator 54, carrier modulator 55 and antenna 56. (Connecting wires 6 and 13 may be utilized as antenna 56.) The electrical energy is provided by generator 21. Commutator 22 includes a conducting segment 46 and a non-conducting segment 45. Brush 47 which rides on conducting segment 46 is electrically connected to modulating oscillator 54. Riding on the circumference of commutator 22 are three brushes 48, 49 and 50, which are electrically connected to conventional temperature element 51, humidity element 52 and pressure element 53, respectively. As each of these three brushes 48, 49 and 50 contacts the conducting segment 46, a circuit is closed from the corresponding element 51, 52 or 53, to modulating oscillator 54, and a modulating signal is thus impressed in conventional fashion on the modulating oscillator. These conventional meteorological elements 51, 52 and 53, each include features which cause the characteristics, e.g., resistance, of the corresponding circuit to be varied as the condition, e.g., temperature, which the particular element is intended to record, varies. To illustrate this feature, these elements 51, 52 and 53 have been shown in such variable resistances, 61, 62 and 63, respectively. Various methods of varying these resistances may be used. The temperature-responsive element itself may, e.g., be of such a nature that its resistance changes with temperature. The humidity-responsive element may, e.g., be so arranged that the amount of moisture on its surface varies its resistance. The pressure-responsive element may, e.g., include a bellows to which a contact arm is attached, this contact arm passing over a resistance and varying the amount of resistance introduced into the circuit leading to the modulating oscillator. However, other arrangements for varying the resistance could be used. In this way, the modulating signal is caused to change with the change in the condition being recorded, thus affecting the signal being transmitted by the radiosonde and permitting this signal to be interpreted at the ground station as an indication of such condition.

If desired, impeller 10 could be made to operate radiosondes such as those described in U. S. Patent No. 2,347,160 issued to Wallace and U. S. Patent No. 2,216,161 issued to Curtiss. Shaft 9 of the present apparatus could be mechanically connected to Curtiss' temperature sensitive mechanism 45 in place of the electrical or mechanical means which Curtiss uses for this purpose, and could be mechanically connected to Wallace's shaft 125 in place of the latter's motor 30. In either case, the necessary sequential switching operations could be performed. If desired, instead of providing a mechanical connection by means of shaft 9, generator 21 could be made to supply
2,717,809

5 electrical power to Curtis' time-operated mechanism 45 or to Wallace's motor 30 and thus provide the sequential switching. As far as the power supply for the meteorological elements and the radio transmitter is concerned, all that would be necessary would be to substitute generator 21 for Curtis' batteries 12 and 25, or Wallace's battery 200.

What is claimed is:

1. Apparatus for indicating meteorological characteristics of the upper atmosphere, comprising: a casing within which is placed a radiosonde, the radiosonde including a plurality of meteorological instruments and a radio transmitter for transmitting to a receiving station the indications of such instruments, switching means also in the radiosonde for sequentially connecting each of the instruments to the transmitter; projectile means for carrying the casing to the upper atmosphere; means attached to the casing for limiting its rate of descent during its return from the upper atmosphere, the last-named means including a parachute which is initially unopened; means associated with the casing for causing the parachute to open at a predetermined stage of the flight; and rotary-vane means included within the means for limiting the rate of descent of the casing, these rotary-vane means being operated by the passage of the latter through the air during the descent and serving also to actuate the switching means and to supply energy for operating the transmitter.

2. Apparatus of the type described in claim 1, in which the casing also includes counter-vane means for minimizing any rotation of the casing resulting from operation of the rotary-vane means.

3. Apparatus for indicating meteorological characteristics of the upper atmosphere, comprising: a casing within which is placed a radiosonde, the radiosonde including a plurality of meteorological instruments and a radio transmitter for transmitting to a receiving station the indications of such instruments, switching means also in the radiosonde for sequentially connecting each of the instruments to the transmitter; projectile means for carrying the casing to the upper atmosphere, these projectile means being initially attached to the casing and detached from the casing during descent of the latter; means attached to the casing for limiting its rate of descent during its return from the upper atmosphere, the last-named means including a parachute which is initially unopened and which is opened in response to detachment of the projectile means; and rotary-vane means included within the means for limiting the rate of descent of the casing, these rotary-vane means being operated by the passage of the casing through the air during the descent, and serving also to actuate the switching means and to supply energy for operating the transmitter.

4. Apparatus of the type described in claim 3, in which the casing also includes counter-vane means for minimizing any rotation of the casing resulting from operation of the rotary-vane means.

5. Apparatus of the type described in claim 3, which include connecting means releasably attaching the projectile means to the casing; and means for releasing the connecting means at a predetermined stage of the flight and thus causing the projectile means to be detached from the casing.

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