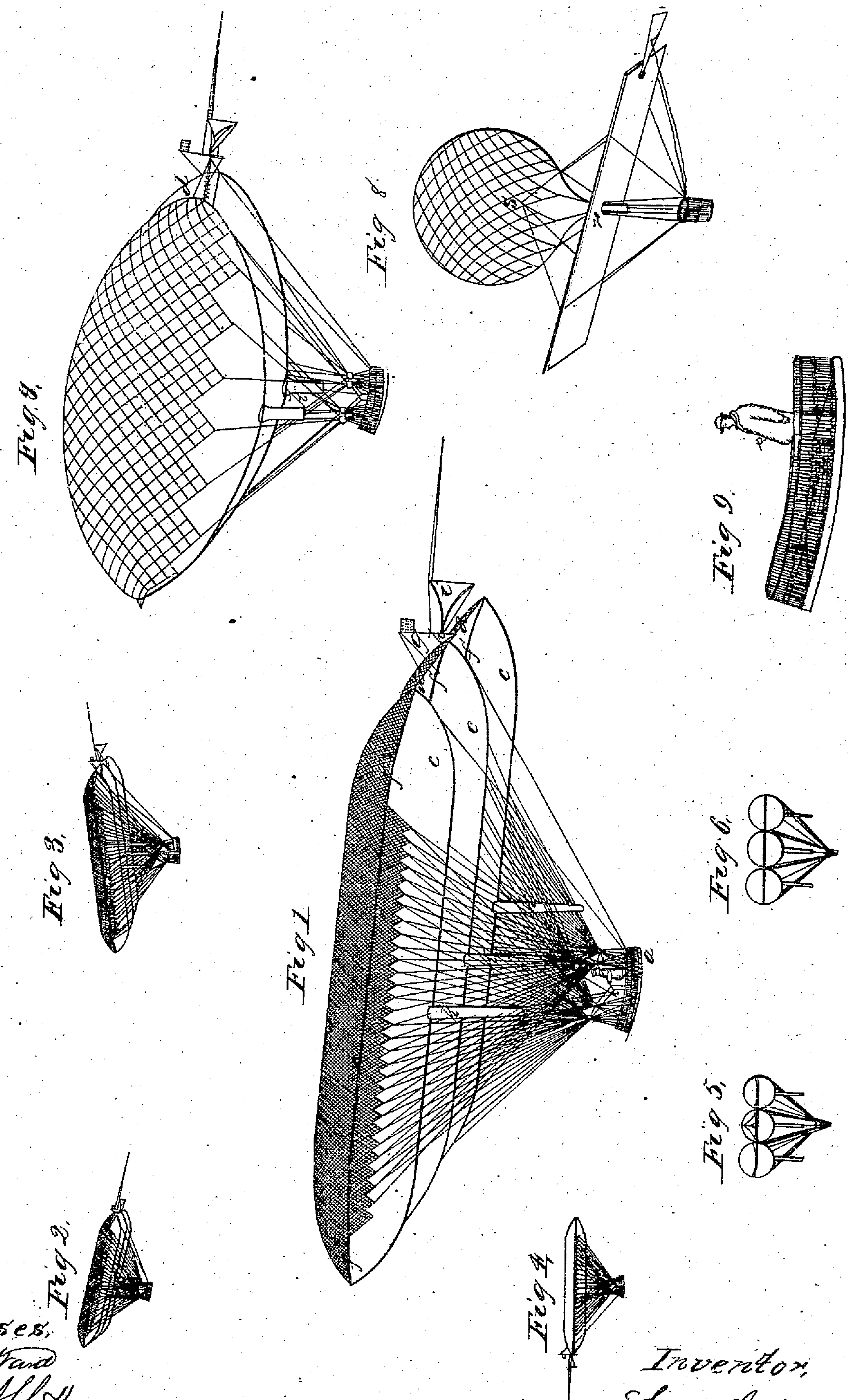
S. ANDREWS.

AEROSTAT.

No. 43,449. Patented July 5, 1864.



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IMPROVEMENT IN AEROSTATS.

Specification forming part of Letters Patent No. **43,449**, dated July 5, 1864.

To all whom it may concern:

Be it known that I, SOLOMON ANDREWS, of Perth Amboy, in the county of Middlesex, in the State of New Jersey, have invented a mode by which the air may be navigated, and a new and useful machine by which it may be done, which machine I call an "Aereon;" and I do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being had to the annexed drawings, making a part of this specification.

In Figure 1 there are three aerostats of a cylindrical form pointed at each end, joined together by a membrane or diaphragm at their longitudinal equators, covered by a net from which four rows of cords extend to a long and narrow car suspended below the center, the ballast and aeronaut in the car. It ascends and descends on inclined planes in the atmosphere, because of its form or construction, whenever it is poised obliquely. The angles of inclination are produced by the position of the aeronaut in the car or the removal of other weights, and it is steered by a common rudder.

To navigate the air with this vessel, it is only necessary to step to the rear end of the car, thus elevating the bow five to ten degrees, and by throwing out a little ballast she will go ahead on the ascending plane. When she has ascended as high as the aeronaut wishes to go, he opens one of the valves and discharges some gas, at the same time stepping toward the forward end of the car, which will depress the bow, elevate the stern, and so change the angle of inclination, when she will go ahead on the descending plane. On a near approach to the earth he has only to step to the middle or rear end of the car, and thus elevate the bow. To stop her momentum at any rate of velocity, sail horizontally for a short distance, or throw out more ballast and go ahead again on the ascending plane. Having forward motion, she is turned by the rudder just like a boat on the water. Stern way may also be had if desired. Before the ballast is exhausted come down to a depot, replenish the wasted gas and ballast, and go on again.

One pound of ascending or descending power will give to this vessel a forward movement of one mile per hour, and each additional pound will increase her speed in about the same ratio, so that by ascending or descending with a power of two hundred pounds a speed of two hundred miles per hour may be attained, and common varnished linen is strong enough to resist the pressure on the bow at that rapid rate, if brought to a point and held so by some inflexible frame-work.

The foregoing I consider a full and comprehensive description of my invention; but as aerial vessels have never before been directed in their course by the will of man, I shall go more into detail, even at the risk of being verbose.

I effect locomotion in the atmosphere in any given direction by means of the form or construction of the aerostat, the motive power being the attraction of gravitation.

To be more explicit, the difference between the specific gravity of the aerostat and that of the atmosphere in which it floats I use to propel the aerostat over the surface of the earth, by ascending and descending on inclined planes in the atmosphere by means of the shape or form of the aerostat itself, or a disk thereto attached.

A balloon or spherical body lighter than an equal bulk of the atmosphere will ascend perpendicularly to the horizon, as was demonstrated by the Messrs. Montgolfier, of France. If currents prevail in the atmosphere, the balloon will of course move in the same direction at the same rate of speed. If heavier than the same bulk of air it displaces, it will descend in the same way. But if made in any other shape and kept suspended by the center of gravity in any oblique position it will ascend or descend, as the case may be, on the line of least resistance. Thus, if made in a flattened and elongated form and kept in an oblique position, it will ascend or descend in the plane of its longest axis, because it meets with less resistance in that direction, and this produces a forward movement. If such an aerostat be held perfectly horizontal, it will move only perpendicularly, (supposing no current in the air,) because it finds no opposing force to the direction of gravitation, and gravitation always acts perpendicularly to the horizon. It is, then, by an opposing force or resistance to gravitation on one portion of the aerostat by which I compel the aerostat to move forward on a semi-horizontal line. The resistance on the top or bottom of the aerostat produced by the air on a surface much larger than the end of it prevents so rapid a movement in a perpendicular direction, and so it slides along on the atmosphere just as a sled slides down the side of a hill by the force of gravitation, or as a board rises obliquely out of the water by the force of gravitation indirectly applied. When two cylindroids are placed horizontally side by side, there is formed between them a longitudinal cavity both above and below. This concave surface offers more resistance to the air than a convex or plane surface, consequently rapid ascent and descent perpendicularly is prevented, and the power of ascent or descent is expended by forcing the body to move obliquely upward or downward in the line of least resistance, the cylindroids sliding, as it were, on an atmospheric railway, the rail being formed of atmospheric air partially condensed by pressure into this longitudinal cavity. When three cylindroids are placed side by side, two such cavities are formed. One cylindroid, being convex, is not sufficient to produce as much effect. There should be two or more. The single cylindroid may be improved, however, by the addition of a flange or membrane, extending along the sides like a bird's wings or the guard of a steamboat, so as to produce more resisting-surface to the atmosphere. The addition of every cylindroid after the first one of equal dimensions adds one cavity, and a resisting surface equal to its length multiplied by its diameter. So, after the first one, there is no loss of resisting-surface from the convexity of the cylindroids.

Fig. 1 is a perspective view of my air-ship or aereon as she appeared on the 4th of September, 1863, on the ascending plane, having over two hundred pounds' ascending-power, and describing a spiral circle upward not less than one and a half mile in circumference. She made twenty revolutions in fourteen and a half minutes, when she was lost to view in the upper strata of clouds. The first eleven revolutions were made in seven minutes, the last three revolutions in three and a half minutes. The weight in the car was about one hundred and thirty pounds; the weight of the cars, fifty-eight pounds. Fig. 2 is also a view of the ascending plane. Fig. 3 is a view on the descending plane; Fig. 4, a side or horizontal view; Fig. 5, a rear view on the plane of the axis; Fig. 6, a front view on the plane of the axis; Fig. 7, a view of a wax aerostat on the ascending plane; Fig. 8, a view of a common balloon with an oblong plane or sail attached below, on the ascending plane; Fig. 9, the car or basket with the smaller or inner car to hold the ballast, such as was used in the aereon, Fig. 1. Figs. 3, 5, and 6 represent the front and rear elevations, or the sectional views, as perfectly as can be done.

The outlines are all that can be shown, as nothing visible is contained within but the three valve-cords passing through from the top to the bottom of each cylindroid. The main car *a*, Fig. 1, was twelve feet long, the bottom a curved line or arc of a circle of thirty degrees, and its width fifteen inches; the upper part, made of willow-work, spreading a little toward the top. An inner car, *b*, on runners, like a sled, of the same curve as the bottom of the main car, three feet long and just wide enough to slide inside the main car, was secured in its place by a threefold tackle at each end, the single rope passing over the top of the inner car, thus connecting both tackles and holding the inner car in any position or place in the main car. The ballast was placed in the inner car, which also served for a seat. The object of placing the ballast in the inner car was to move it, if necessary, toward either end of the main car, in order to change the inclination of the aerostat by changing its center of gravity. In ordinary cases the weight of the aeronaut alone will be sufficient to produce this effect. He has only to change his place fore or aft for the purpose. By moving a less or greater distance from the center of the car he can give the aerostat an inclination of five, ten, or fifteen degrees, the latter being quite sufficient for all ordinary purposes and seldom required. I found but one occasion to move the inner car with the ballast from its central position, and that was when she made her spiral flight, when I was not in the car. The angles of inclination may also be changed by hauling in the cords from the bow end and slacking those on the stern end of the aerostat, and vice versa; also, by hauling a weight out from the car toward the bow or stern by means of a tackle or running rigging.

In all the figures the car is shown in its proper position, sixteen feet below the center of the aerostat; but whether that is the best distance of suspension can only be known by further experiment.

Fig. 9 shows the cars on a larger scale; *b*, the inner car. Short cleats are fastened on the bottom of the car, the runners of the inner car straddling them. They are to give the aeronaut foot-hold, to walk to the upper end to change the angle of inclination of the aereon.

The three cylindroids, Fig. 1, *c*, composing this air-vessel or aereon, were made of varnished linen, each one eighty feet long and thirteen feet in diameter. Forty-eight feet of their central portions were perfectly cylindrical. At the distance of sixteen feet from each end they began to taper to a point. They were secured together at their longitudinal equators by membranous portions of the linen of which they were made. These membranous portions were left on the outer edge of the linen, overlapping about two inches one of the longitudinal seams of the two outside cylindroids; also on two opposite seams of the middle cylindroid. When the cylindroids began to diverge from each other, membranes or diaphragms *d*, Fig. 1, of cambric muslin, cut to fit the curved lines formed by the sixteen feet points, were sewed fast to the two-inch membranes, and filled up with a flat surface, the otherwise open spaces between them. A net of cotton twine (plainly seen in the figure) was thrown over the whole, extending from end to end, and below the equators on the outside cylindrical portions, where it terminated in thirty points on each side for the attachment of cords. Between the cylindroids the net was brought down to the membranes by long strips of light wood, two and a half inches wide in their central portions by three-eighths of an inch in thickness, and diminishing in width to one inch at their ends. These strips of wood were placed edgewise on the net and rested on it and on the linen membrane connecting the cylindroids. Where these strips of wood came in contact with each other (forty-eight feet of their length) they were fastened together by screws. The ends of these strips were bent to the curved sides of the sixteen-feet points of the cylindroids, and two meeting each other at the front and rear ends of the middle cylindroid were fastened together at their ends by a brass plate bent over their ends and screwed on. Two similar strips, *e*, were placed on the outside equators of the two outer cylindroids, and were kept there by being passed through the meshes of the net. These joined the inside strips of wood at the front and rear ends of the outside cylindroids the same as the middle one before stated. To these strips of wood or frame-work the net was secured on each side of the sixteen-feet points of the cylindroids, as seen at *f*, Fig. 1. In each of the six pointed ends of the three cylindroids were conical pieces of cork, five inches diameter at their base, and the linen was tied tightly over them. Through these corks strong cord passed out to secure the pointed ends of the cylindroids to the frame-work. Thirty cords passed down from the net on the outside of each outside cylindroid to the car below, one cord from each point of the net, as shown in the figure. Thirty cords were also passed up through each of the two inch membranes between the cylindroids twenty inches apart. They also passed through the net and were fastened to the longitudinal strips of wood or frame above it. Thus there were four rows of cords of thirty each, or a total number of one hundred and twenty cords, passing down from the net to secure the car below. These cords are shown in all the figures of this machine. When the strips of wood or frame joined on the near end of the middle cylindroid, they were allowed to extend past each other four inches, and were locked together at their crossing. Here was screwed on a top and bottom plate of brass, with suitable holes through them to support the rudder post *g* on this four-inch extension of the frame. The rudder-post rested by a shoulder on the top plate, *h*, and the upper and lower ends were stayed by cords fastened to the frame on the rear end of the middle cylindroid, about eight feet from the point. Where the cords connected with the rudder-post, they were fastened to stiff pieces of leather, having suitable holes in them for the rudder-post to turn in.

The rudder *i* was made of cambric muslin, triangular in form, kept extended by reeds or bamboo projecting from the rudder-post. It contained only seventeen square feet of surface, and was abundantly large. It was controlled by cords or rudder-ropes passing through pulleys attached to the frame near the ends of the outside cylindroids, and thence down to the rear end of the car, where they passed through other pulleys, one on each side, and were extended along the border of the car to the forward end, where they were secured, leaving sufficient slack for the motion of the rudder. The object of this was that the rudder-ropes could be always reached by the aeronaut without changing his place in the car. The car was suspended on four rings or hoops, (shown in the figure,) made of strong wood five inches in diameter and surrounded by rope. From these rings twenty-four cords passed down underneath the car, twelve at each end. They were much stronger than the cords from the net. These cords were woven through the upper rim of the basket or willow-work and were secured also at the bottom of the car. The cords from the net were attached to these rings or hoops, thirty to each ring, and these rings constituted two, or rather four, foci for the suspension of the car. In the side view, Fig. 4, two foci can be seen, as also in the end views, Figs. 5 and 6; but in Figs. 1 and 3 the four are distinctly visible. The attachment of these cords to the rings was peculiar, and the result of experiments showed that the best plan was to cross them, as shown in the figure, every other cord on a side going to the most distant ring or focus on the same side. Thus if all the weight in the car were placed in the extreme end of the car it would bear equally on the whole length of the aerostat while it changed its center of gravity. In this case the whole weight would be suspended by half the number of cords. Each of the three cylindroids were open on the lower side or bottom, they having tubes *k*, eleven feet long and one foot diameter at their lower ends. These tubes were kept open by spiral steel hoops or coils. There were also three valves of ordinary construction for balloons, with openings five inches square in the upper part of the three cylindroids, one in each, with valve-cords passing down to the car. The cord of the center valve passed down through the center tube. Those of the two outside cylindroids were neither central nor vertical over the said tubes, but a little aft and on the outer side of the central line of the tops. Each of these valve-cords passed through the opposite side of the cylindroid in a direct line to the car, and where it passed out through the varnished linen thin pieces of light wood four inches square were screwed together, one on the inside, the other on the outside of the varnished linen of the cylindroid. Between these pieces wood, in their center, was a piece of india-rubber or caoutchouc one inch in diameter, in which was the hole for the valve-cord to pass through. These valve cords were covered with tallow where they operated in these holes.

In the bottom of the car was an angulometer made as follows: Between the cleats on the bottom were longitudinal strips of wood placed three-quarters of an inch apart near the central line and as high as the top of the cleats. This constituted grooves between the cleats, in each one of which was placed a small ball or marble—such as boys play with—and as each of these several marbles rolled from their natural positions toward either end of the car it was indicated whether the car had an angle of inclination of five, ten, or fifteen degrees, the bottom of the car being a curved line or arc of a circle of thirty degrees, as before stated, and the angle of inclination of the aerostat being produced by the position of the aeronaut or the ballast in the elongated car. A common spherical balloon can be made to travel by its construction, though it is the worst possible shape for locomotion. By making an oblong disk or sail and suspending it below the balloon above the car, as shown at Fig. 8, it will, if sufficiently large, force the balloon even against the wind. Placed on the equator of the balloon it does not operate so well. The balloon takes off more than half the effect of its sliding motion, and also makes it very difficult to preserve its position, requiring much greater weight below to hold it steady. The disk, sail, or flat frame on the top will not answer the purpose, as it makes it top-heavy. All the weight of an aerostat must be kept as much as possible below.

Fig. 8 shows a twelve-feet-diameter balloon of this description which carried up seventeen pounds, including the weight of the disk or sail, and with three and one-half pounds' ascensive power resisted a two-mile current or breeze. Toy balloons of ten inches diameter are made to move across a room on this plan without any difficulty by using tissue-paper for the disk or oblong sail.

In the balloon Fig. 8, the disk or oblong sail is movable on an axis at the focal ring r. The cords which support it above pass through blocks suspended to the net, one of which is shown at S. The hauling-cords pass down from the lower side of the disk to the car. The car may be made like an ordinary basket, as the aeronaut is stationary. When elongated cylindroids are used, they should be filled with spheres or common balloons, making a compound aerostat, not only to divide the aerostat into compartments for safety, but to enable the aeronaut to control the balancing of the machine. When tilted, the gas in the simple aerostat will rush to the upper end and the atmospheric pressure on the outside will collapse the bottom and make it heavy, or, if it be admitted to the inside, below, to keep it full at all times, it will act as dead-weight just the same, for the air will not quickly and readily mix with the hydrogen gas and so become generally diffused. With carbureted hydrogen it may do better. I have not tried it. I had fifteen balloons of twelve feet diameter and six balloons of seven feet diameter made of cambric muslin to fill my three cylindroids, Fig. 1. When I tried my first experiment, fourteen of them were inflated in the two outside cylindroids. I afterward took them out and made my other experiments with the cylindroids alone, taking the risk and obtaining one hundred and eighty pounds' more ascensive power. From these experiments I come to the following conclusion, viz. The best shape or form for practical purposes for each simple aerostat will be that wherein the greatest elongation can be had and at the same time preserve the bottom nearest to a perpendicular line extending through the center of gravity in any angle of inclination which may be required. As these can never be made to coincide in all positions or angles of inclination which may obtain, except in a perfect sphere, and as in the greater elongation the bottom will necessarily be thrown farther from the said line, it is obvious that there will be found by experiment a happy medium for the comparative length and diameter of any simple aerostat.

In a compound aerostat, as before described, greater deviation may be allowed, and doubtless improved shapes will be made, to approximate the above rule. The best shape now known to me, and I know of nobody else who knows from experience anything about it, is that of Fig. 7, the diameter of which is two-fifths of its length. In this an angle of inclination of fifteen degrees may be had while the center of the bottom will not approach the ends nearer than one-fifth or one-sixth of the length. Thus atmospheric air admitted through the open tubes below, *k*, and resting on the bottom will never be entirely outside the said line, and consequently the aerostat will be securely held in any position which may be assumed by the aeronaut. Two of these will make a perfect machine in its simplest form, each of them made separately, pointed at the bow end and rounded at the other; each one covered by a separate net in the plainest and simplest manner, having about six points on each side for the attachment of cords, and to be well secured to the aerostat at both ends. This can be done by passing net-work or cords entirely around the aerostat some few feet from each end. When inflated for use, they must be brought together side by side, and the net-work and cords will naturally hold them in that position. A membrane or diaphragm attached to the two nets will connect them together and fill up the otherwise open space between them.

This membrane is made in two halves, one-half attached to each net at the horizontal equator of the aerostat. Of course one edge of each half-membrane is a curved line, and the other edge is a straight line. The curved edges are attached to the nets. When brought together, the straight edges of the membranes are tied to a longitudinal strip of wood, *w*, Fig. 7, running the whole length of the aerostats and extending a few feet beyond their ends. The straight edges of the membranes extend to the points of this longitudinal strip or bar of wood. To support the weight of this bar of wood toward its ends, cords may connect it with the top of the nets. The rudder has its seat on the stern end of this bar of wood. This membrane may be as wide as you please, provided you keep the aerostats apart by some inflexible fixtures; but there is sufficient resisting-surface for all ordinary purposes by allowing them to come in contact at their sides in their central portions. They will press together and be flattened there a few feet. If they be kept a little distance apart without adding too much weight by fixtures, of course the machine will operate much better. The longitudinal bar of wood may be made in parts, to be put together like a fishing-rod. This aereon just described is particularly designed as a war-aerostat. It can be taken apart readily and each aerostat folded up separately, and the bar of wood in short pieces can be easily carried. It is highly probable, however, that the longitudinal bar may be dispensed with. I have never tried the experiment without some kind of extending frame-work, but in every experiment I have found that some part previously used was unnecessary, and I am now satisfied that all the frame-work really required is enough to keep the bow-points extended to resist the pressure of air in a rapid motion and to support the rudder. The aerostats will preserve their forms, whatever shape they be, if kept full, and they are kept full at all times by the admission of air through the open tubes at the bottom. I know that for an ordinary rate of speed no frame-work is necessary, except that of the rudder itself.

The most important feature in the construction of this machine, as well as that of Fig. 1, is the longitudinal cavity extending from end to end, formed by the junction of two cylindrical bodies, both on the upper and under side, as hereinbefore stated. In the machine Fig. 1, there were double cavities and she slid, as it were, on two atmospheric rails. In the war-aerostat, Fig. 7 she will slide only on one atmospheric rail.

In my caveats for this invention, filed in the Patent Office in 1849 and 1850, I did not mention this longitudinal cavity, not having then tried it; but I have found by experiment that it adds very materially to its success.

I claim as my invention and desire to secure by Letters Patent—

1. The conversion of the perpendicular motion of a balloon or aerostat into a forward or horizontal motion by means of the construction or the form thereof, so as to make it ascend and descend on inclined planes in the atmosphere.

2. The arrangement beneath a balloon of an elliptical or oblong form to give it a semi-horizontal motion or a forward movement.

3. Constructing a balloon in the form of a cyl d, as described.

4. The combination of two or more cylindroids, so as to produce a concavity between them for resisting-surface.

5. The changing of the inclination of the aereon or aerostat by changing its center of gravity and the changing of the inclination of the disk or oblong sail, substantially as shown and described.

6. The arrangement of an angulometer in the aerial car, substantially as described.

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