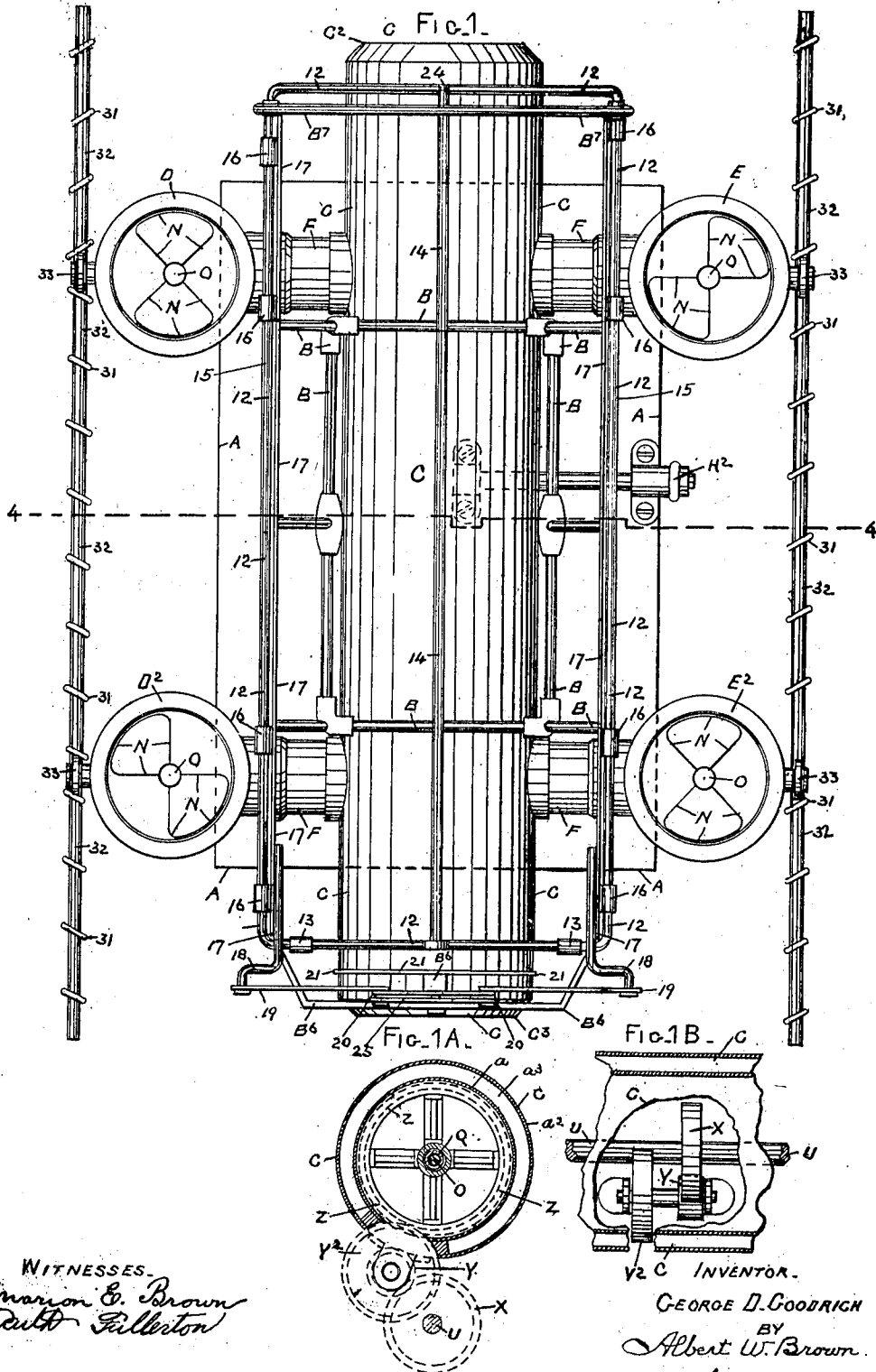


1,055,325.

G. D. GOODRICH.
AERIAL APPARATUS.
APPLICATION FILED JULY 26, 1911.

Patented Mar. 11, 1913.

4 SHEETS-SHEET 1.



WITNESSES.
Marion E. Brown
Cuth. Fullerton

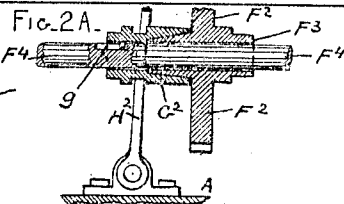
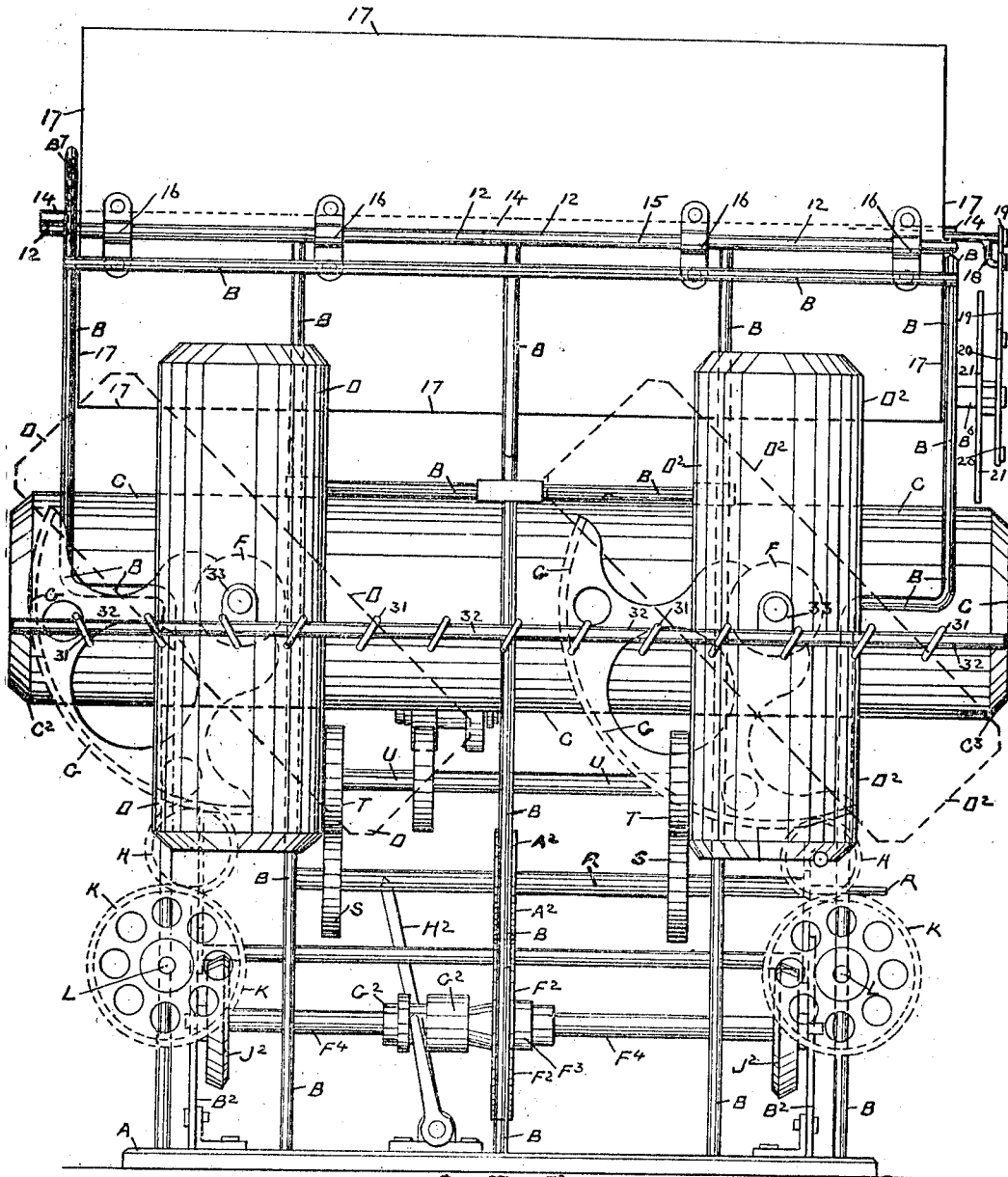
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1,055,325.

Patented Mar. 11, 1913.

4 SHEETS—SHEET 2.

FIG. 2.



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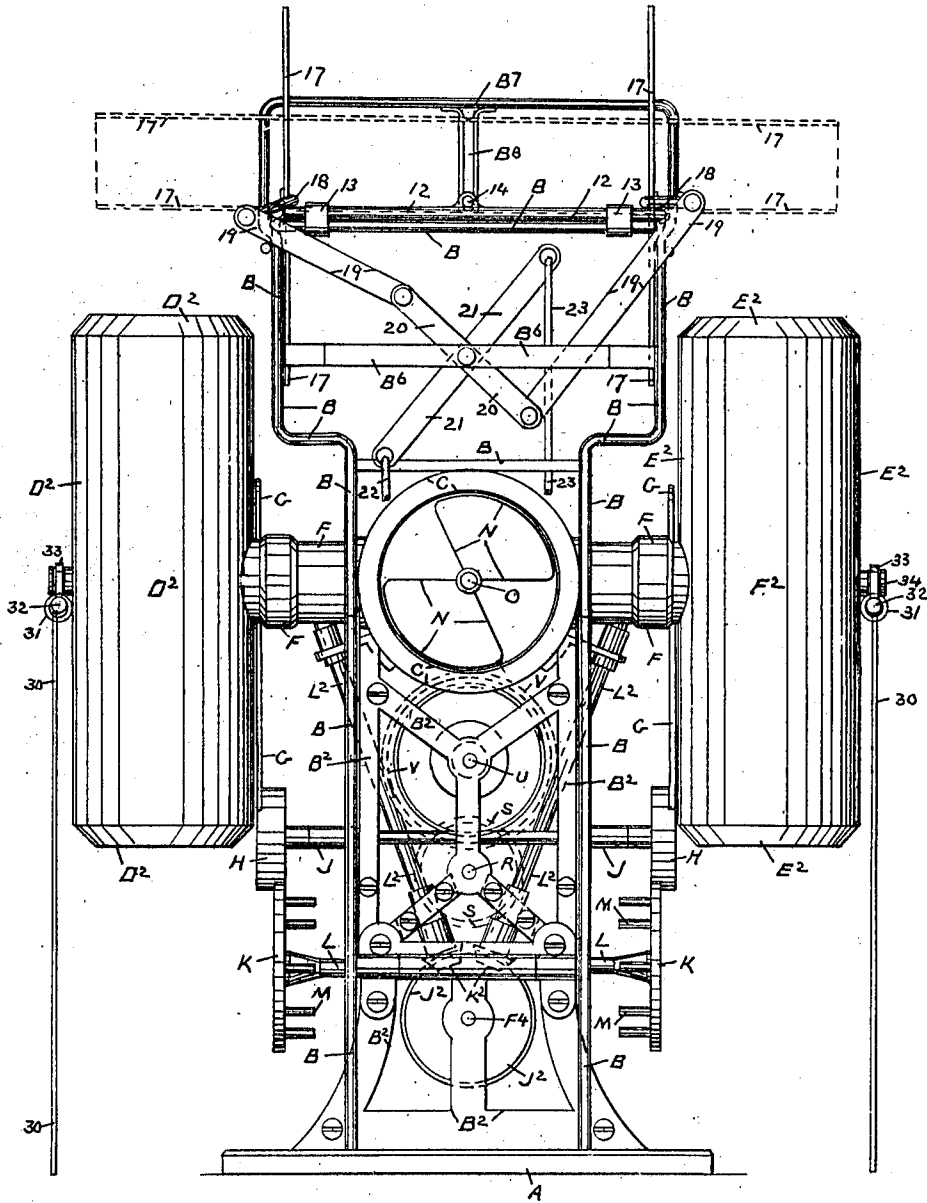
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Patented Mar. 11, 1913.

4 SHEETS-SHEET 3.

1,055,325.

FIG. 3.



WITNESSES.
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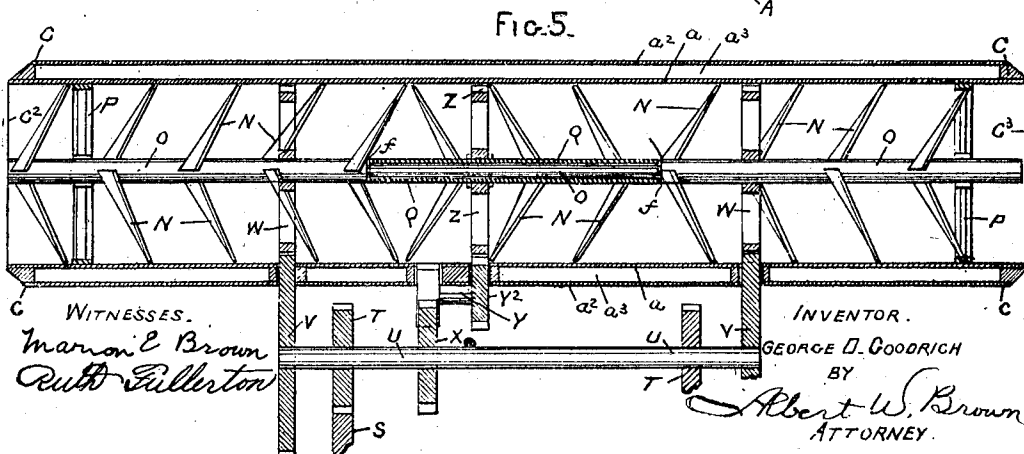
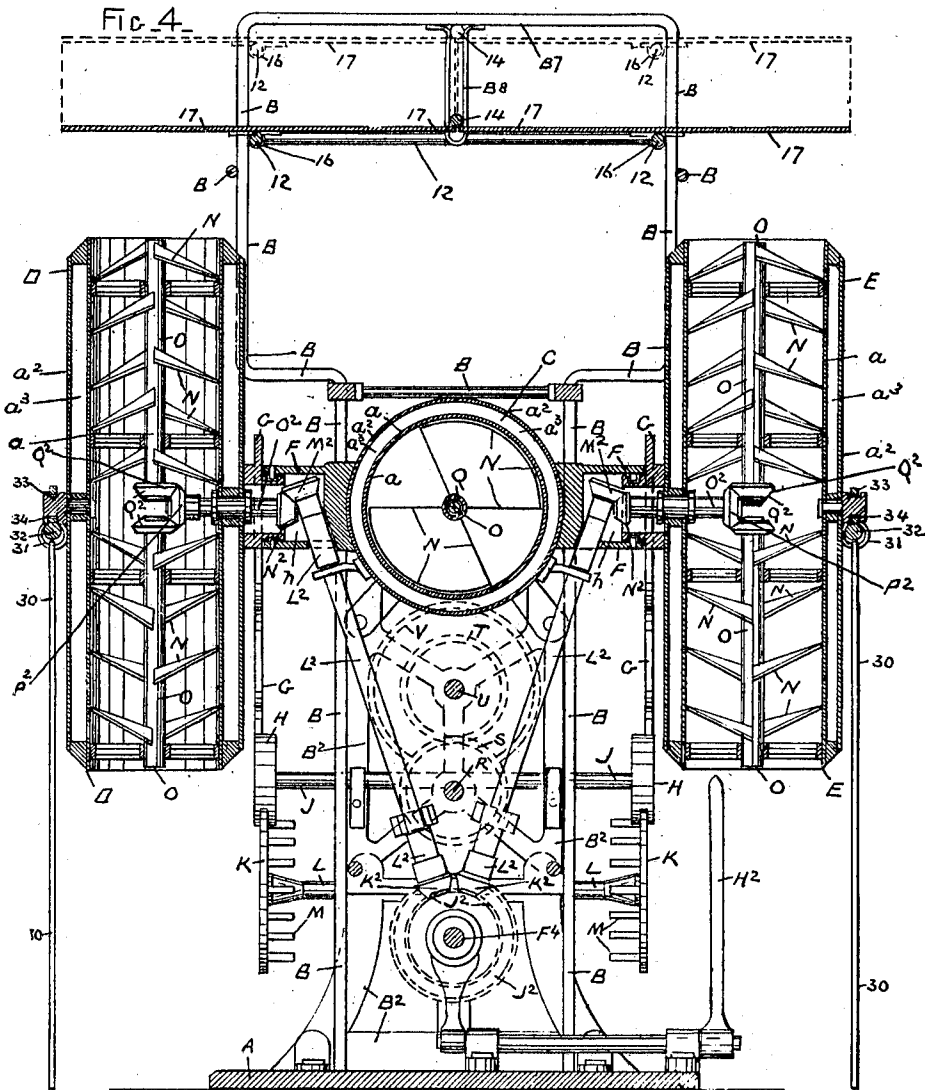
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AERIAL APPARATUS.

APPLICATION FILED JULY 26, 1911.

Patented Mar. 11, 1913.

4 SHEETS—SHEET 4.

1,055,325.



UNITED STATES PATENT OFFICE.

GEORGE D. GOODRICH, OF SOMERVILLE, MASSACHUSETTS.

AERIAL APPARATUS.

1,055,325.

Specification of Letters Patent. Patented Mar. 11, 1913.

Application filed July 26, 1911. Serial No. 640,686.

To all whom it may concern:

Be it known that I, GEORGE D. GOODRICH, a citizen of the United States, residing at the city of Somerville, in the county of Middlesex and State of Massachusetts, have invented new and useful Improvements in Aerial Apparatus, of which the following is a specification.

This invention relates, more particularly, to the propulsion of aerial apparatus through the air, to raising and holding it raised from the ground, and to holding it against, more especially, lateral or sidewise tipping, while in the air. And to securing these several ends this invention consists, in substance, First. In providing the apparatus with open end tubular-passages or ways severally suitably located and held on the apparatus, in combination with a series of spirally running blades arranged so as to be rotated within each of said passages, and all in a manner for air to be drawn in at one of the open ends of each of said passages and to be forced therethrough and discharged under pressure, at the other open ends thereof. Second. In providing the apparatus with an open end tubular-passage or way held on and centrally or midway located along the length of the apparatus, and with open end tubular-passages or ways at each side of said centrally located passage, and each of said side-passages adapted for being placed vertically, or in other words, for being placed so that the axial line of each will extend transversely of the axial line of said centrally located passage, in combination with a series of spirally running-blades arranged so as to be rotated within each of said passages, and all in a manner for air to be drawn in at one of the open ends of said passages and to be forced therethrough and discharged, under pressure, at the other open ends thereof.

Further than the above, the invention consists in other features of improvements, all as will hereinafter fully appear.

In the drawings, forming part of this specification, the present invention is illustrated.

Figure 1 is a plan view and Figs. 1^A and 1^B are detail views, as will hereinafter appear. Fig. 2 is a side elevation of the apparatus as shown in Fig. 1, and Fig. 2^A is a detail view, as will hereinafter appear. Fig. 3 is an elevation at the front end of the apparatus as it is shown in Figs. 1 and 2.

Fig. 4 is a vertical transverse section substantially along the dotted line 4—4, Fig. 1. Fig. 5 is a central longitudinal section of the central located tubular passage or way of the apparatus.

In the drawings, A is a horizontal platform and B is a framework composed of metal vertical and horizontal rods, and two end-uprights B². This framework is constructed and arranged in its several parts, and otherwise all as shown in the drawings and as will hereinafter appear so as to constitute and make a framework suitable to support the several running and stationary parts of the apparatus of this invention.

C, and D, D², and E, E² are tubular-passages or ways each open at their opposite ends, but otherwise substantially closed, and each of these ways has double, or inner and outer walls, *a* and *a*², with an inclosed space or chamber *a*³, between them (Figs. 4 and 5) as and for purposes as will hereinafter appear. The tubular-way or passage C is stationary, and it extends horizontally lengthwise of and is suitably fixed and held centrally or midway along and in the upper portion of the framework B. The several tubular-ways or passages D, D², and E, E² are in pairs D, D², and E, E², respectively, on opposite sides of the central tubular-way C and at corresponding distances therefrom, and those of each pair are correspondingly separated and each is directly opposite the corresponding one of the other pair. Each side tubular-passage is exteriorly and midway of its length and on one side, hung by a horizontal swiveling trunnion-joint F which is, in part, on said tubular passage and, in the other part, on the central tubular-way C, all so that each may be swung on said central tubular-passage in a vertical plane.

G, G are vertical quadrantal, or sector-gears held on the part of a trunnion F which is on a side tubular-passage and, in each instance, each sector-gear G, at its lower edge, meshes with a vertical gear-wheel H, and the gears H which are on the same side of the central tubular-passage C, are, at opposite ends of a transverse horizontal shaft J mounted in suitable bearings of the framework B and each of said gears H meshes with a vertical gear-wheel K. These gears K, at the same side of the central tubular-passage C, are at opposite ends of a transverse horizontal shaft L mounted

in suitable bearings of the framework B, and each of these shafts L is to be adapted, in any suitable manner, to be rotated, as for instance, by spaced horizontal and lateral projecting-handles M on each of said gears K, and thus, through the intermediate gearing described, and which is between said shafts L and the trunnions F of said side tubular-passages, to swing said side tubular-passages on their trunnions and so place them in positions, as may be desired, to wit, in direct vertical positions, as particularly shown in the drawings, or in vertically inclined positions, as shown in dotted lines, Fig. 2. The circular run of the sector-gears G, as is obvious, limits the extent of the swing of the side tubular-passages, from positions in which the longitudinal median lines thereof lie at right angles to the longitudinal median line of said central tubular passage C, to positions in which the first said median lines lie parallel with the median axial line of said central passage C, and in all of said positions said side tubular-passages are to be held against accidental displacement or movement by means suitable therefor, and applied to their said operating parts, but no means for this purpose are shown, as they are so self evident. Said central tubular-passage C and each of said several side tubular-passages D, D², and E, E², have a series of spirally running blades N arranged about their longitudinal axes of a diameter corresponding substantially to the internal diameter of their respective passages but such, however, as to permit them to move freely around therein, and again said blades N of each tubular-passage are carried by a horizontal axial shaft O, and each of these shafts O is supported and turns in suitable bearings of open circular frames P rigidly held on the inner side of the passage. The portion of the blades N which is between the two end-portions of the blades on the shaft O of the central tubular-passage C is carried by a longitudinal sleeve Q and this sleeve surrounds the central portion of said shaft, and, at its opposite ends, is confined against lengthwise movement on the shaft by shoulders f thereof. The several blades N at both end-portions of the central tubular-passage C run in the same spiral direction, while the blades which are between them run in the opposite direction. Again the blades of each of the side tubular-passages run in the same spiral direction and in each instance this direction is such that the blades, under rotation, as will hereinafter appear, will draw air in at the upper ends thereof and, forcing it through said passages, discharge it under pressure at the lower ends thereof. As to the central tubular-passage C the spiral-run of its several blades, which are at the end-portions thereof, is such as to draw air in at

the front end C² of said passage and discharge it, under pressure, at the rear end C³ thereof, while by the spiral run in an opposite direction of the blades at the central portion of said tube, the tendency of the air in its said movement through the tubular-passage from end to end, to revolve with the blades is prevented to a substantial and practical extent, the advantages of which are obvious without particular mention, it being understood as will hereinafter appear, that said end series of blades N rotate in one and the same direction, and that said central series of blades N rotate in the opposite direction. Mechanisms are provided for rotating said several series of spirally running-blades N of the said several tubular-passages by rotating their respective carrying-shafts O and these mechanisms, in each instance, consist of trains of gear-wheels, to be now particularly described, which are severally operated from a common horizontal and longitudinal driving-shaft R turning in suitable bearings of the end-uprights B² of the framework B.

S, S are two similar vertical gear-wheels at opposite end-portions of the driving-shaft R and each of these gears meshes with corresponding vertical gear-wheels T, T of a common longitudinal horizontal shaft U located above the driving-shaft and turning in suitable bearings of the framework B. This shaft U carries, at its opposite end-portions, similar vertical gear-wheels V, V (Fig. 5) meshing at their upper edge with vertical gear-wheels W, W carried by the opposite end-portions of the horizontal and axial-shaft O of the common tubular-passage C and thus, as is plain, the rotation of the driving-shaft R is communicated to said axial-shaft of said central tubular-passage and so its opposite end-portions are rotated in one and the same direction. The shaft U geared by gear-wheels V, V to the gear-wheels W, W of the axial-shaft O of the central tubular-passage C carries, between its said opposite end-gears V, V, a vertical gear-wheel X, which is connected by a train Y of vertically arranged and meshing gear-wheels, (Figs. 1^A and 1^B more particularly) suitably supported from, and having their respective shafts turning in suitable bearings on the outer side of the central tubular-passage C, said train having its gear-wheel Y² in mesh with a vertical gear-wheel Z carried by the sleeve Q surrounding the axial-shaft O of said central passage C and thus said sleeve is rotated, carrying with it its several spirally running-blades N and, as is plain, this rotation is created by the rotation of the driving-shaft R and in a manner similar to that in which the axial-shaft O on which said sleeve is mounted is rotated, but the train of gearing Y above explained consists of gears so arranged that said sleeve

will be rotated in an opposite direction to that of the shaft on which the same is mounted.

A² is a vertical gear-wheel carried by the driving-shaft R between its two end-gear-wheels S, S, and this gear-wheel A², at its lower side, meshes with a vertical gear-wheel F², which, by its hub F³, turns on a horizontal shaft F⁴ suitably supported, at its opposite ends, in bearings of the end-uprights B² of the framework B. This hub F³ is put into and out of connection with the shaft F⁴ by means of a sliding clutch-collar G² arranged on and connected to the shaft by a spline-joint *g* and otherwise adapted to be moved into and out of engagement through an operating vertical-lever H², see Figs. 2 and 2^A more particularly. The shaft F⁴, having the clutching-mechanism above explained, at its opposite end-ports, has vertical bevel gear-wheels J², J², and each of these bevel-gears meshes with a similar but smaller or pinion bevel-gear-wheel K², K² and each of these bevel-pinions K², K² is at the lower end of one of a pair of inclined shafts L² severally supported and turning in suitable bearings of the framework B and each, at its upper end-portion, entered into the chamber *h* of a trunnion-hanging F and in the portion thereof which is on the central tubular-passage C, and therein each of said shafts L carries a more or less horizontal bevel pinion gear-wheel M² in mesh with a vertical bevel pinion gear-wheel N² on a horizontal shaft O² which is located axially within said chamber *h* of the trunnion-hanging F and in the horizontal plane of the axis of the central tubular-passage C and is suitably supported and turns in a bearing of the wall of said side tubular-passages. These shafts O², within the side tubular-passages, are each provided with a vertical bevel pinion gear-wheel P² in mesh with a similar horizontal bevel pinion gear-wheel Q² on the axial shaft O of said passages, and thus, as is plain, from the description given and with the shaft F⁴ and gear-wheel F² in engagement, the spirally running blades of the said several side tubular-passages D, D², and E, E², are rotated therewithin, on rotation of the driving-shaft R. All of the several gear-wheels herein above mentioned are shown in every instance in blank outline and either in full or dotted lines.

The gear-wheels W, W, and Z in the tubular-passage C are of an open or skeleton-frame so as not to interfere with the movement of the air through the passage.

In the operation of the mechanism, described, it is evident that the rotation of the spiral running-blades N within the several tubular-passages, by drawing air in and forcing it therethrough and discharging it, under pressure, from one end of each there-

of, necessarily secures the movement or travel of the apparatus in the opposite direction to said movements of the air, and so thereby causes, in the case of the central tubular-passage C, a forward movement or travel, and in the case of the side tubular-passages D, D², and E, E², an upward movement or raising of the apparatus, it being understood that said side-passages are then in their vertical positions as shown, full lines, in the drawings. Continuation of the rotation of the several series of propelling-blades N obviously continues the movements of the apparatus as above described and said movements, obviously, as to their speed, direction and otherwise may be changed or regulated by suitable guiding or steering mechanism with which the apparatus is to be provided, but not shown herein, as also by regulating the speed of rotation of the several series of propelling-blades N, and by adjusting, as described, the vertical positions of the side tubular-passages relative to the axial line of the central tubular-passage.

The rotation of the blades N may be reversed in direction, if desired, by reversing the direction of rotation of the driving-shaft R. Again the blades N may run continuously around their respective shafts O, or they may be in separated sections or parts, as is shown, and their pitch may be more or less great all as is thought best.

The framework B, Figs. 2, 3, and 4, extends above the central tubular-passage C and this extended portion is widened out and at the top it terminates in a continuous rectangular frame of parallel side and end-rods, all in a common horizontal plane, running lengthwise of and having its central line in the vertical plane of the longitudinal axis of said central tubular-passage C, or of the apparatus as a whole.

12 is a rectangular frame of side and end-rods substantially corresponding in length and width with, and normally at rest on the horizontal upper rectangular frame-portion, above mentioned, of the framework B. This frame 12, at one end, is hung by hinges 13, 13 to, but otherwise it is free of the framework B. This frame 12 has a rod 14 which is fixed to and joins its opposite end-rods and extends along its longitudinal central line, and to each of its side-rods 15, 15 is hung by loops 16, 16, spaced apart, a "plane" 17 of flat thin sheet metal, or of other suitable material, or construction, and each of said hangings of the "plane" 17 is along the central portion thereof and it is also such that the "planes" 17 can be swung from a vertical position (Figs. 1, 2, and 3) to a horizontal position (Fig. 4) and vice versa, and in their vertical position each "plane" 17 rests against the inner side of the framework B, and in their horizontal position each "plane" 17 lies against the

under side of the central rod 14 of the frame 12. The "planes" 17 are all of the same length and width and adapted to be freely swung as described, and in their horizontal positions to meet with their side edges under said rod 14, and to then practically roof over the apparatus, see Fig. 4.

For swinging the "planes" 17 as explained, mechanism is provided, as follows:—18, 18 are crank-arms held on and projecting from one and the same end of each of the "planes" 17 and the ends thereof which are toward the rear end C³ of the central tubular-passage C. To each of these crank-arms 18 is hung one end of rods 19, 19 which, at the other ends, are hung respectively to the opposite and outer ends of a common vertically swinging beam or rod 20, which, midway of its length is hung on a horizontal cross-piece B³ of the framework B and is provided at and has fixed on it a lever-arm 21 which at its opposite and outer ends has operating ropes 22 and 23 respectively. By a downward pull on the operating-rope 22 the "planes" 17 are swung into their vertical positions and by a downward pull on the operating-rope 23, the "planes" 17 are swung into their horizontal positions, and in either instance, by properly securing said ropes, obviously, the "planes" can be secured in the said positions as may be desired.

As the frame 12 carrying the "planes" 17 is hung at one end to the framework B its other or free end is obviously free to rise and fall, and the height to which this free-end can rise is limited by the abutment of the end 24 of the central rod 14 of the frame 12 against the under side of the cross-rod B¹ of the framework B, and this cross-rod B¹ has a downwardly projecting vertical guideway B² receiving said end 24 of the central rod 14 of the frame 12.

The "planes" 17 when it is desired to raise the apparatus in the air, are placed and secured in their described vertical positions, and when the apparatus is traveling through the air they are in their described horizontal positions, and being then so placed they, as in the case of all such "planes" in aerial apparatus, act to hold and buoy up, as it were, the apparatus in the air as it is being impelled therethrough as aforesaid. And again the adapting, as has been explained, of the "planes" for an upward play or swing on the apparatus, obviously is of advantage in that the "planes" can the better accommodate themselves to the desired action thereof.

As is shown in the drawings, Fig. 4 more particularly, the apparatus has, along each of its sides, curtains 30, 30, and these curtains are suspended at and along their upper edges by rings 31, from horizontal longitudinal side-rails 32, 32 which, in turn,

are each hung on vertical hangers 33, 33, suspended from the outer side of each of the side tubular-passages D, D² and E, E², by swiveling joints 34, 34, the axes of which, are in alinement with the axes of the trunnion-joints F of the tubular-passages upon which the said swiveling joints are formed. In this way the side tubular-passages can swivel on said curtain-hangers, as they are swung from vertical to horizontal positions as has been explained. These curtains 30, 30, are of suitable dimensions to embrace or cover the apparatus on its opposite sides, from the hangers downward and so, being made of any suitable material resistant to ball or other shot such for instance, as wire netting or perforated metal plates, the apparatus will be protected to a certain extent against injury from ball or other shot discharged against and striking them. Open curtains such as stated are preferable in that they can be seen through and will not materially affect the passage of light and air.

A chambering of the walls of the several tubular-passages as has been explained while sensibly reducing the weight of said passages does not necessarily affect the strength or rigidity thereof and again it affords a means for effectively offsetting the weight of said passages, or in other words, for giving them increased buoyancy by charging such chambers with gas, vapors or such like, lighter than air.

The propelling-blades N of the central tubular-passage C in lieu of being in sections as has been explained, to wit, a central and two end-sections of different spiral runs, may be of the same spiral run for the whole length of the passage, in which case, of course, the sleeve Q on the shaft O, as also the gearing for rotating said sleeve would be dispensed with, and the blades for that central portion now attached to said sleeve would be attached directly to the shaft O; it being understood that the spiral run of the so attached blades would be the same as that of the end-portions of the blades.

In the practical use of the apparatus described and with it traveling through the air, it might be and probably would be preferable to place the several side tubular-passages in downward inclining positions relatively to the axis of the central tubular-passage as shown in heavy dotted lines, Fig. 2, in which case the rotation of the blades within such side-passages would not only more or less act to maintain the apparatus in a raised position but also to propel the apparatus forward.

It may be well to observe that all parts of the apparatus are to be made of material as light and buoyant as is possible consistent with the necessary strength and stiffness.

As shown, Fig. 4, by a vertical section of two of the side-tubes or passages D, E, the shafts O of the side-tubes or passages D, D² and E, E² are in two separate sections or lengths, and each length is suitably supported and turns in fixed bearings of the tubes. Again the blades N of the two lengths run in opposite directions, and the two lengths are geared to and on opposite sides of a common bevel-gear-wheel P² of the shaft O² and so as is plain, the sections of blades rotate in opposite directions, all for reasons manifest from the foregoing description and not needing further explanation. Again it will be observed that side-tubes or passages, each with rotating blades as explained, may be used to advantage in aerial apparatuses of various constructions and arrangement of parts other than that particularly described, and the central tube or passage may be dispensed with, it being, of course, understood that suitable supports are provided on which to hang them for the changes in positions as has been explained. Again the central tube or passage C in lieu of being directly horizontal from end to end, when the apparatus is in its normal position, as is shown, may be on an incline from its front end C² to its rear end C³.

Each of the Figs. 3 and 4, shows the planes 17 in full lines as in one position and in dotted lines in their other positions relative to the framework B of the apparatus.

Fig. 1^b which is a detail central and horizontal longitudinal section of the central tube C for a portion of its length is broken out in its bottom part so as to expose the train of gearing Y which is arranged below and carried on the underside of said tube.

Having thus described my invention what I claim and desire to secure by Letters Patent is,

1. In an aerial apparatus, a tubular-passage or way open at both of its ends, but otherwise closed and having spirally running blades axially located and arranged to be rotated within said passage, and tubular-passages or ways on opposite sides of said fixed tubular-passage and severally open at their opposite ends, but otherwise closed, and severally provided with spirally running blades axially located and arranged to be rotated within them and severally hung by swivel or trunnion-joints on the sides of said fixed longitudinal tubular-passage in combination with curtains at said side tubular-passages, side-rods on which said curtains are hung, and swivel joints hanging said rods on said side-passages.

2. In an aerial apparatus, a tubular pas-

sage or way open at both of its ends, and surrounded by a chamber adapted to contain a lighter-than-air fluid, said passage having a series of spirally arranged blades located at opposite ends thereof, and adapted to be rotated about a common axis in one and the same direction, a series of spirally arranged blades located within the space intervening between said end series of blades, and adapted to be rotated about said common axis in an opposite direction, tubular passages or ways on opposite sides of said first named tubular passage, severally open at their opposite ends and surrounded by chambers adapted to contain a lighter-than-air fluid, and severally provided with spirally running oppositely disposed blades axially located and adapted to be rotated therewithin, each of said last named passages being hung by a trunnion joint upon the side of said first named passage, and means adapted to rock said last named passages on their several trunnions relatively to said first named passage.

3. In an aerial apparatus, a tubular passage or way open at both of its ends, and surrounded by a chamber adapted to contain a lighter-than-air fluid, said passage having a series of spirally arranged blades located at opposite ends thereof, and adapted to be rotated about a common axis in one and the same direction, a series of spirally arranged blades located within the space intervening between said end series of blades, and adapted to be rotated about said common axis in an opposite direction, tubular passages or ways on opposite sides of said first named tubular passage, severally open at their opposite ends and surrounded by chambers adapted to contain a lighter-than-air fluid, and severally provided with spirally running oppositely disposed blades axially located and adapted to be rotated therewithin, each of said last named passages being hung by a trunnion joint upon the side of said first named passage, a frame arranged to be swung about an axis disposed substantially parallel to the pivotal axes of said side tubular passages, and planes mounted on said frame and adapted to be rocked about axes arranged substantially parallel to the median axial line of said first named passage.

In witness whereof, I have hereunto set my hand in the presence of two subscribing witnesses.

GEORGE D. GOODRICH.

Witnesses:

ALBERT W. BROWN,

MARION E. BROWN.