J. J. SLAVIN.

AIRSHIP.

APPLICATION FILED OCT. 28, 1908.

988,039.

Patented Mar. 28, 1911.

3 SHEETS—SHEET 1.

Fig. 1

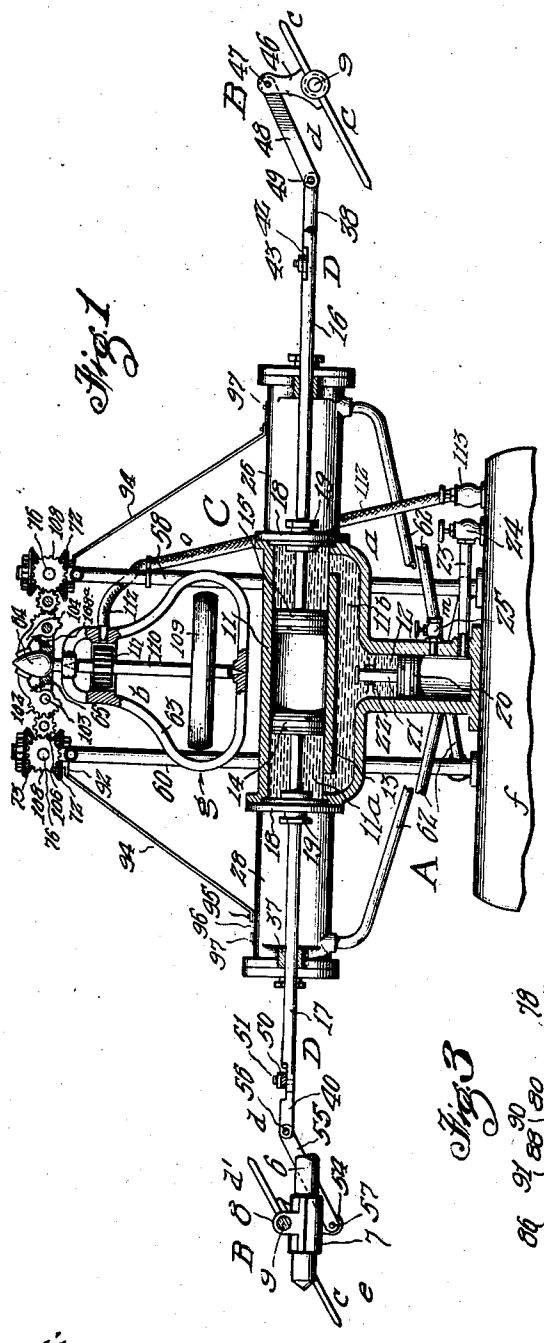


Fig. 2

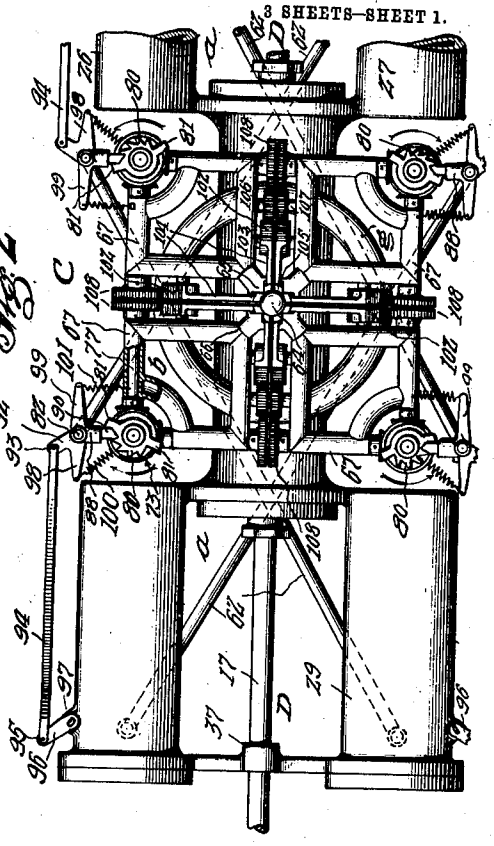
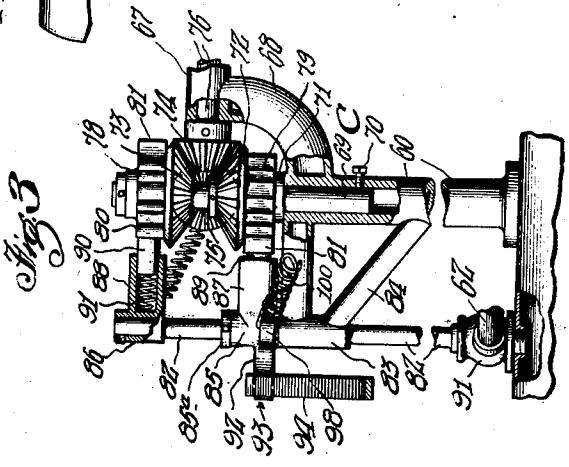


Fig. 3



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3 SHEETS—SHEET 2.

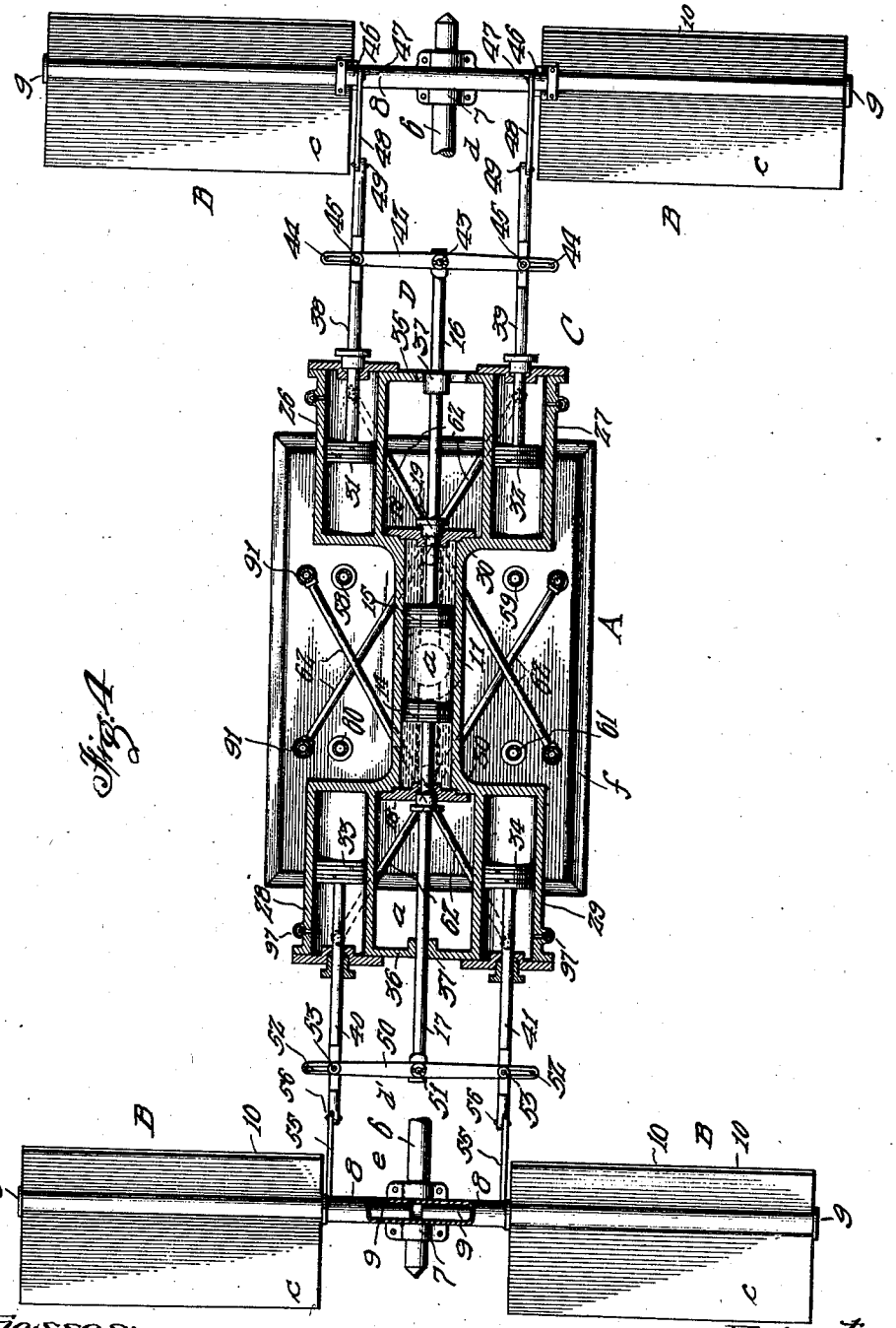

Fig. 4

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APPLICATION FILED OCT. 28, 1908.

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Patented Mar. 28, 1911.

3 SHEETS—SHEET 3.

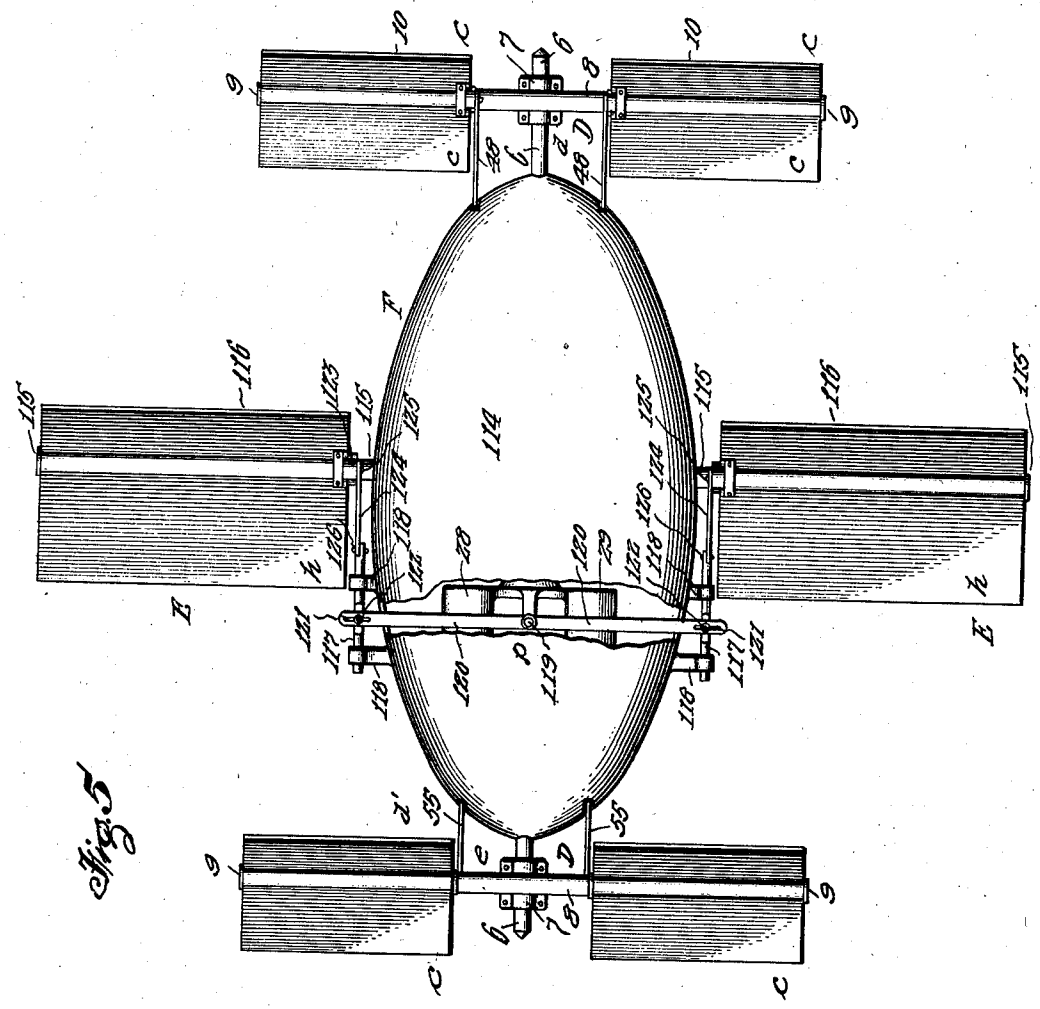

Fig. 5

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AIRSHIP.

988,039. Specification of Letters Patent. Patented Mar. 28, 1911.

Application filed October 28, 1908. Serial No. 459,938.

To all whom it may concern:

Be it known that I, JAMES J. SLAVIN, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Airships, of which the following is a specification.

This invention relates to air-ships and more particularly to air-ships of the "heavier than air" type; and it has for its object to provide an organized air-ship, particularly with the object of obtaining stability of the same in air-supported condition and under all circumstances tending to affect the same with respect to stability, such as varying air pressure and variation in the disposition of the load. With this object particularly in view I provide means for producing, maintaining and conserving stability which in their operation are substantially automatic, the condition of stability being, in its production, maintenance and conservation, responsive to the action of said means which latter in turn are delicately and definitely responsive to variation of working conditions and positions and the conditions of the supporting medium and supported load.

In air-ships as heretofore produced and with varying successful operation, a general requirement has existed that stability be maintained by predetermined action of the operator or navigator, such as the application of specific means or mechanism, or the variation of the position of the load of the air-ship.

It is the primary object of this invention to obviate the necessity of such specific control of the air-ship by human supervision; and to that end I provide certain means, mechanism and combination of parts, elements and features, which coöperate and inter-operate to the accomplishment of automatic control and regulation.

With the above and other objects in view, the invention consists in the provision, construction, association, combination and relative arrangement of parts, members and features, all as hereinafter described, shown in the accompanying drawings and finally pointed out in claims.

In the drawings:—Figure 1 is a fragmentary side elevation, partly in longitudinal section and partly broken away for clearness of illustration, of an air-ship embodying the features of the invention; Fig. 2 is a top plan view of the same, parts being omitted and parts being broken away for clearness of illustration; Fig. 3 is a side elevation upon an enlarged scale, and partly sectioned and broken away for clearness of illustration, of certain essential features of the invention; Fig. 4 is a top plan view, partly longitudinally sectioned, and parts being omitted for clearness of illustration, of the construction shown in Fig. 1; and, Fig. 5 is a top plan view, partly broken away for clearness of illustration, of a modified form of construction, the same including, in combination certain of the other features and elements shown in the other figures and has certain additional features and elements for operation and utilization in association with or without the aforementioned features and elements.

Corresponding parts in all the figures are denoted by the same reference characters.

Referring with particularity to the drawings and to Figs. 1 to 4 of the same, inclusive, the improved air-ship comprises in the main, a body A, supporting or deflecting members B for the body, and means C controlling and regulating the supporting or deflecting members B and whereby the latter are inter-related. The body A is, in practice, properly organized for the reception of the load and motor and the convenience of the operator, such features being omitted in the drawings for better illustration of the working parts. According to the invention the controlling means C comprises two separate members or organisms *a* and *b*, respectively, both of which are operatively combined with the supporting or deflecting members B and each of which, according to its specific nature and functions, as hereinafter set forth, controls the supporting or deflecting members B in response to certain conditions to be met with in the operation and use of the entire air-ship.

The general reference character D designates operative connections between and among the supporting or deflecting members B and the controlling means C, including both parts of the same; whereby equalization of the effect upon the air-ship relative to stability, resulting from variation of working conditions, is established and maintained. The supporting or deflecting members B, each of which is illustrated as an aeroplane *c*, are thus operatively connected

through the agency of the operative connections D, and four of such supporting or deflecting members are illustrated as employed in the particular embodiment of the invention shown in the drawings, said aeroplanes being grouped in forward pairs *d'* and rearward pairs *e*, the members of each of which pairs are arranged in a plane transverse of the longitudinal plane of the air-ship, said aeroplanes of each pair of the same being disposed at the respective sides of the central longitudinal plane of the air-ship. It thus results that an aeroplane is provided at each of the four corners of the air-ship, speaking in general terms, so that said aeroplanes may jointly and severally operate to cause the supporting and balancing of the entirety at four points, two of which are forward, and two rearward of the center of the body A.

The member or organism *a* of the controlling means C performs the function of establishing and maintaining stability and equilibrium of the entire air-ship in opposition to varying or relatively varying conditions of the air, constituting the supporting medium; while the member or organism *b* of the controlling means C performs the function of establishing and maintaining stability and equilibrium of the air-ship with relation, more particularly, to shifting of the load of the air-ship. The members or organisms *a* and *b* both preferably perform their functions through the agency of pneumatic or hydraulic means, or both, the former of which includes an air-receiver or container *f*. Variations in the conditions affecting the aeroplanes *c*, or any of the same, are caused to affect all of the aeroplanes in such manner that stability is established and maintained through the agency of such pneumatic or hydraulic means and the member or organism *a* of the controlling means C. Variations in the dispositions of the load upon the body A affect the condition of the member or organism *b* of the controlling means C which latter, in turn, affect the aeroplanes *c* to establish and maintain stability. The member *b* of the controlling means, in the construction illustrated, includes a gyroscope *g* which is associated with the pneumatic or hydraulic means above referred to, in its control of the aeroplanes *c*, as described. The particular nature of the pneumatic and hydraulic means, as employed, will be hereinafter set forth.

Referring now to Fig. 5, an air-ship is illustrated embodying the features of the invention heretofore described, and supported by lateral supporting members E, which are disposed, respectively, laterally of the body F of the air-ship. In this form of construction, the parts, elements and features above recited, and shown in Figs. 1 to 4, inclusive, are provided; the same being designated by the same reference characters, as employed in connection with the other figures. The operative connections for the members *e*, the latter comprising each an aeroplane *h*, are specifically separate and distinct.

A particular preferred form of provision, construction, combination, association and relative arrangement of parts, members and features, of an air-ship embodying the features of the invention, is as follows:—The aeroplanes *c* in their respective forward and rearward pairs, are firmly supported, and connected with the body A, by the frame member or members 6 ranging longitudinally of the air-ship. The particular location of the aeroplanes *c*, with respect to their distance from the body A, is a matter to be predetermined upon consideration of the working conditions and the requirements of the air-ship. The dimensions and proportions of the aeroplanes *c* are correspondingly to be predetermined. For each pair of the aeroplanes, oppositely directed sleeves are fixed to the frame member 6, as at 7; 8 designating each of said sleeves, which, as illustrated in Fig. 4, may be united in continuous formation. Each of the aeroplanes is provided with a transverse shaft 9, upon which the aeroplane is rigidly fixed; and the inner end of each of said shafts is received within one of the sleeves 8, and so accommodated therein as to freely rotate. Each of the aeroplanes *c* is preferably rectangular in form, and the shaft 9 which supports each of the same is preferably arranged nearer to the forward edge portion 10 of the aeroplane than to the opposite or rearward edge portion, thus supporting the aeroplane eccentrically; and the greater dimension of each of said aeroplanes is preferably transverse of the air-ship as an entirety.

The members *a* of the controlling means C comprise, together with the operative connections D, a cylinder 11, which is supported upon the body A, and arranged longitudinally and substantially centrally of the same; or substantially in a plane extending longitudinally of the air-ship and passing between the aeroplanes *c* of both pairs of the same, and centrally between the aeroplanes of each pair.

As illustrated, the cylinder 11 is supported directly upon the air container *f* by means of a vertical extension of the same constituting an auxiliary cylinder 12 communicating with the cylinder 11 which latter extends horizontally when the air-ship is in proper equilibrium. The cylinder 11 is divided into upper and lower chambers, 11^a and 11^b, respectively, by a horizontal transverse path or partition 13, the end portions of which are spaced from the end portions of the cylinder to permit communication between the chambers 11^a and 11^b. The lower

chamber 11^b, communicates directly and centrally with the auxiliary cylinder 12. Within the chamber 11^a are mounted opposite pistons, 14, and 15, respectively, which work longitudinally of the air-ship, and each of which is provided with a piston rod 16 and 17, respectively, both of which range longitudinally of the air-ship, the former ranging forwardly and the latter ranging rearwardly and being connected at their outer ends with, and embodied in, the operative connections D. The cylinder 11 is provided with detachable cylinder heads 18, each of which has a stuffing box 19, accommodating the respective piston rod 16 or 17. Within the auxiliary cylinder 12 is mounted a piston 20, having a stem 21 which passes slidably through a guide 22 to maintain alinement of the piston within the cylinder; the cylinder 11, with the exception of the space therein accommodating the pistons 14 and 15, and the space between such pistons, is filled with a suitable fluid, as indicated in Figs. 1 and 4, such fluid being of a low degree of elasticity of compressibility, such as water, gasolene, or vegetable or mineral oils; and the weight of such mass of liquid is disposed upon the lower walls of the cylinder 11 and upon the piston 20 within the cylinder 12. The normal spacing or relative separation of the pistons 14 and 15 is determined by the position of the piston 20 within its cylinder; such piston determining the height of the column of liquid within the cylinder 12. To regulate these conditions, I provide controlling means *m* associated with the pneumatic means employed and comprising a connecting pipe 23 extending between the lower portion of the cylinder 12 and the air container *f*, said pipe being controlled by valve or cock 24. By admission of a further quantity of compressed air to the cylinder 12 beneath the piston 20, the latter may be elevated and the pressure of the same upon the fluid within the cylinder 11 and the upper portion of the cylinder 12 will cause the elevation of a portion of fluid from the cylinder 12 into the cylinder 11 and the consequent relative approach of the pistons 14 and 15. The controlling means *m* may also include an exhaust valve or cock 25, whereby compressed air may be released from the lower portion of the cylinder 20 permitting predetermined descent of the piston 20 and consequent relative separation of the pistons 14 and 15.

The member *b* of the controlling means C comprises four cylinders 26, 27, 28 and 29, respectively, which are supported by the frame of the body A, being illustrated as connected with the cylinder 11, as at 30, at the inner end of each of the same. Said cylinders are arranged in pairs, two of which are disposed at the forward portion of the body, the remaining two being disposed at the rearward portion of the body; and each of said cylinders is provided with a separate piston, 31, 32, 33 and 34, respectively, which pistons operate longitudinally of the body A; the cylinders 26 to 29, inclusive all ranging longitudinally of the body, and two being disposed at each side of the longitudinal plane of the body. The cylinders 26 and 27 are connected by a web or flange 35, at their upper outer ends; and the cylinders 28 and 29 are similarly connected by a web or flange 36. Each of the webs or flanges 35 and 36 is formed into or provided with a bearing 37; and through each of said bearings plays one of the piston rods 16 and 17. The said piston rods are thus caused to act in proper alinement. Through the agency of the remaining features of the controlling means C and the operative connections D, each of the pistons 31 to 34, inclusive, is operatively connected with one and all of the aeroplanes *c*. To this end, each of the pistons 31 to 34, inclusive, is provided with a separate piston rod, 38, 39, 40 and 41, respectively; the piston rods 38 and 39 ranging longitudinally of the air-ship and forwardly, and the piston rods 40 and 41 ranging longitudinally of the air-ship and rearwardly. Outwardly of the cylinders 26 and 27, the piston rods 38 and 39 are connected with the forward end portion of the piston rod 16 through the agency of the connecting lever 42, centrally pivotally connected, as at 43, with the forward end portion of the piston rod 16, and provided with elongated end slots 44 receiving pins 45 projecting respectively from the forward end portions of the piston rods 38 and 39. Each of the shafts 9 of each of the forward aeroplanes *c* is provided, inwardly respectively of the aeroplanes, and in alinement with the respective piston rod 38 or 39, with an upwardly projecting arm 46 having predetermined angularity with respect to the body plane of the respective aeroplane; and each of said arms 46 is pivotally connected, as at 47, at its upper end, with a link arm 48 which is likewise pivotally connected as at 49, with the respective piston rod 38 or 39.

Both of the piston rods 40 and 41 are connected with the piston rod 17 through the agency of a connecting lever 50 which is centrally pivoted, as at 51, in connection with the rearward end portion of the piston rod 17 of the said connecting lever 50 being provided with elongated end slots 52 receiving pins 53 projecting respectively from the piston rods 40 and 41. Each of the shafts 9 of the rearward aeroplanes *c* is provided with a downwardly directed arm 54 extending at predetermined angularity with respect to the body plane of the respective aeroplane; and each of said arms is connected at its outer end with the adjacent end portion of the alined piston rod 40 or 41 by

a link arm 55 pivotally connected at one end, as at 56, with the respective piston rod, and pivotally connected at the other end, as at 57, with the respective arm 54.

From the construction as so far developed, by description, it will be manifest that movement of either of the pistons 14 and 15 within the cylinder 11, will be accompanied by movement of the other piston and movement of all of the four aeroplanes; and that likewise movement of any one of the pistons 31 to 34, inclusive, will be accompanied by movement of each and all of the others of said pistons and movement of all of the aeroplanes *c*, thus, both of the members *a* and *b* of the controlling means C are interdependent and jointly operative through the agency of the operative connections D, to the end that all of the aeroplanes are affected as to their operative positions of angularity through the operation of each of the members *a* and *b*.

Referring now to the member or organism *b*, the controlling means C, including the gyroscope *g*, the same comprises four upright tubular supports 58, 59, 60 and 61, respectively, which project upwardly from the air container *f*. The uprights 58 to 61, inclusive, are arranged in an equally spaced group, in which said supports are disposed at the four corners of a square. Between the outer end portion of each of the cylinders 26 to 29, inclusive, and the air container *f*, at points adjacent to the respective supports 58, 59, 60 and 61, extends a separate air connection pipe 62.

The frame 63 of the gyroscope *g* is provided at its smaller and upper end portion with an upwardly projecting conical bearing head 64, which is mounted for oscillation or universal movement in a bearing or seat 65 supported at the opposed inner corners 66 of rectangular frames 67, each of which is connected, as at 68, at the corner diametrically opposite the corner 66, with one of the tubular uprights 58 to 61, inclusive, as best illustrated in Fig. 3. Within the upper portion of each of said tubular uprights is mounted a short shaft 69, fixed therein, as at 70, against rotation; rotatably mounted upon the shaft 69 above the upper end of the respective upright, is a collar 71, which is in turn fixed to the lower of opposed beveled gears 72 and 73, respectively, which are loosely mounted upon the shaft 69. Meshing with both of said gears 72 and 73 are two beveled gears 74 and 75 respectively, the axes of which are arranged at right angles each to the other, each of said beveled gears 74 and 75 being fixed to the outer ends respectively of horizontal shafts 76 and 77, respectively, which extend through tubular members of the adjacent frame 67; a separate pair of shafts 76 and 77 is provided for each of the pairs of beveled gears 74 and 75. Loosely mounted upon the shaft 69 above the upper beveled gear 73, and fixed thereto is a collar 78. Each of the collars 71 and 78 is provided with a mutilated or segmental ratchet 79 and 80, respectively, the end teeth 81 of each of which are enlarged with respect to the intermediate teeth for the purpose hereinafter specifically described. At one side of each of the tubular uprights 58 to 61 inclusive is arranged a vertical shaft 82 which is rotatably mounted in a sleeve 83 supported by a bracket 84 mounted upon the respective upright support. Loosely mounted upon the shaft 82 laterally of the ratchet 79 and beneath a collar 85^a fixed to the shaft 82 is a collar 85; and fixed to the shaft 82 laterally of the ratchet 80 is a collar 86, above the collar 85^a. From each of the collars 85 and 86, respectively opposite the ratchets 79 and 80, projects a tubular housing 87 and 88, respectively, for a separate pawl or pin 89 and 90, respectively, which pawls or pins respectively operate in connection with the ratchets 79 and 80. Within each of the housings 87 and 88 is disposed a coil spring 91 tending to force the respective pawl or pin outwardly or into engagement with the respective ratchet. As the beveled gears 72 and 73 rotate in opposite directions, under the drive of the beveled gears 74 and 75, the ratchets 79 and 80 are oppositely driven, and said ratchets are formed so that the pawl 89 or 90 of each rides over the same without rotating the respective collar 85 or 86, upon rotation of the shaft 76 or 77 to cause the beveled gears 72 and 73 to operate each in one direction; and whereby, oppositely, each of said pawls is caused to rotate its collar upon the rotation of the shaft 76 or 77 in an opposite direction, in each case, to that above stated. The ratchet 80 and its pawl 90 cause the rotation of the shaft 82 in one direction; and the ratchet 79 and its pawl 89 cause the rotation of the collar 85 in the opposite direction. As above stated, during the operation of each of the pawls 89 and 90 to rotate the collar 85 or the collar 86, the other of said pawls moves inoperatively over the face of its ratchet.

The above description concerns but one of the shafts 82 and the attendant parts, together with one of the shafts 76 and one of the shafts 77 for oppositely rotating two of the beveled gears 72 and 73. It is to be understood that there are four sets or groups of such parts and features, one separate set being associated with each of the tubular uprights 58 to 61, inclusive. There are four of the shafts 76 and four of the shafts 77. Each of the shafts 76 is provided at one end with a beveled gear 74 meshing with one of the beveled gears 72 and one of the beveled gears 73; and each of the shafts 77 is provided at one end with a beveled gear 75

meshing with one of the beveled gears 72 and one of the beveled gears 73.

The shaft 82 in each of the four installations of the same, controls the admission of air from the container *f* to the respective connection pipe 62, through the agency of a suitable valve 91 at the lower end of such shaft 82. In connection with the collar 85 mounted loosely upon the shaft 82 and projecting laterally therefrom, is an arm 92, which is pivotally connected at its outer end, as at 93, with a connecting rod 94, which is likewise pivotally connected, as at 95, with the outer end of an arm 96 controlling an exhaust valve 97 of any preferred form arranged at the outer end portion of the respective cylinder 26 to 29, inclusive.

It is to be understood that there are four of the valves 91 for the respective connection pipes 62 and four of the valves 97 for the respective cylinders 26 to 29, inclusive. In the four installations of the shafts 82 and valves 91, the shafts 82 control the four pipes 62 through the respective valves 91, the pipes 62 being arranged and extended to such end, in such manner that each valve 91 controls the admission of air from the container *f* to the outer end of the cylinder, 26 to 29, inclusive, respectively which cylinder is diagonally opposite to such valves and the shaft 82, controlling the same, as clearly illustrated in Figs. 2 and 4.

From the above description it is manifest that rotation of each vertical shaft 82, namely in that direction indicated by the respective arrow, in Fig. 2, will admit air from the container *f* to the respective connection pipe 62 and to the outer end portion of the respective cylinders 26 to 29, inclusive; and that rotation of the collar 85 in the opposite direction will operate to open the respective exhaust valve 97 and permit the escape of compressed air from the respective cylinder 26 to 29, inclusive. From the collar 85 projects a lateral arm 98; and opposite from the collar 86 projects laterally an arm 99. Contractile springs 100 and 101, respectively, extend between the outer end portions of the arms 98 and 99 and the adjacent frame 67, or other convenient point of attachment. Said springs normally tend to rotate the collars 85 and 86, respectively, in opposite directions to maintain the admission valve 91 closed and the exhaust valve 97 open. The collar 85 acts upon the valve 97 through the connecting rod 94 and the collar 86 acts upon the valve 91 through the shaft 82.

A plurality of sets, four in number, of mutilated ratchet gears 102, two in each set, are mounted respectively between the frames 67, in alternation therewith, upon short shafts 103 fixed in the sides of said frames; and each of said gear heads is provided with an inwardly directed arm 104; the end portion of which is loosely accommodated in a separate socket bearing 105 fixed to the upper portion of the conical bearing head 64. Said arms and their bearings 105 are in adjacent sets of the same, separated by angles of 90°. Each of the gear heads 102 meshes with a separate pinion 106 rotatably mounted in pairs upon separate short shafts 107 supported by two of the frames 67; and each of said pinions 106 meshes with a separate gear 108, two of which are fixed, respectively to the opposed ends of shafts 76 and 77, of two of the sets of gears 74 and 75. Each of the pairs of gears 108 is arranged in an open space between two of the frames 67, wherein one of the pairs of gear heads 102 and one of the pairs of pinions 106 are accommodated. Two of the arms 104, as shown in Fig. 2, are preferably longer than the other two of said arms, being opposed arms 104. And to accommodate such extra length, the pinions 106 and the shafts 107 of the same are omitted with respect to the groups of elements including such longer arms 104. The purpose of such construction and arrangement will hereinafter be pointed out. Contractile springs 108^a tend to hold the ends of the arms 104 in engagement with their socket bearings 105. To cause operation of the rotating or spinning member 109 of the gyroscope *g*, which is suitably mounted within the frame 63, the shaft 110 of the same is provided with a plurality of buckets or blades 111 against which a motive medium may be projected by operating means *o* which in the present instance comprises a flexible air pipe 112 connected at its discharge end with the frame 63 of the gyroscope and extending to a valve 113 through which air may be admitted to the pipe 112 from the container *f*.

Referring now to the modified form of construction, shown in Fig. 5, the same may be organized partially or completely *in toto* to conform with the construction and arrangement herein above described, and shown in the other figures. In addition to such construction and arrangement, however, the body F comprises a shell or housing 114 which, as shown, may be elliptical in form with the longest axis extending longitudinally of the body; and such shell or housing may contain such of the operative features of the airship as may be desired. The lateral supporting members E, one at each side of the body F, are rotatably mounted upon a common shaft 115 extending transversely of the body, or said shaft may be divided into two parts if desired. The axis of rotation of each of said aeroplanes *h* is preferably farther toward a forward edge portion 116 of such aeroplane than toward the rearward edge portion of the same. *p* designates operative connections between the aeroplanes *h*, and said opera-

tive connections include two longitudinally slidable shafts 117, one at each side of the body F, and slidably mounted in spaced brackets 118, projecting laterally from the body. Centrally pivotally supported by the body, as at 119, is a connecting lever 120, each end portion of which is provided with an elongated slot 121, receiving a pin 122 projecting from one of the slidable shafts 117. Each of the aeroplanes *h* is provided with an upwardly directed arm 123, at the inner end portion of such aeroplane; and between the upper end of each of said arms and the adjacent end of the respective shaft 117 extends a connecting rod 124, which is pivotally connected with the respective arm at one end, as at 125, and pivotally connected with the respective shaft 117 at the other end, as at 126.

The operation, method of use and advantages of the improvements in airships constituting the invention will be readily understood from the foregoing description, taken in connection with the accompanying drawings and the following statement: In the flight of the airship, the aeroplanes *c* sustain the entirety in the supporting medium, namely the surrounding air, their normal inclination with respect to the horizontal transverse plane of the airship presenting resistance to the air, as required. This normal inclination of all of the aeroplanes is capable of variation, by variation of the normal relative positions of the pistons 14 and 15 within the cylinder 11, which is accomplished by the controlling means *m* acting upon the piston 20 to vary the height of the column of liquid in the cylinder 12. It is manifest that, because of the inter-dependence of all of the aeroplanes *c* through the agency of the operative connections D and the controlling means C, that any variation in the status or condition of the atmosphere supporting the airship, and affecting any one of the aeroplanes *c*, will affect each of the other aeroplanes *c*; and will so affect each and all of the other aeroplanes *c* as to cause a compensation, throughout the whole series of aeroplanes, with relation to the disturbance or interruption of stability produced by such variation in working or supporting conditions; for instance, if a puff of air of accelerated motion strikes the downwardly inclined aeroplane *c* at the upper right hand corner of Fig. 4, and is deflected therefrom, the piston rod 38 connected therewith will be moved forwardly or outwardly, the piston rod 39 connected with the aeroplane *c* at the lower right hand corner of Fig. 4, will be moved inwardly through the agency of the connecting lever 42, acting upon the outer end of the piston rod 16 as a center. The piston rod 16 will be forced outwardly, forcing the piston 15 outwardly, and forcing the piston 14 inwardly through the medium of the liquid in the cylinder 11. The liquid within the cylinder 11 will be redistributed accordingly, accommodating the said movements of said pistons. The piston rod 17 will be moved forwardly, moving the piston rod 40 and 41 inwardly through the connecting lever 50, and increasing the angularity or inclination of the rearward aeroplanes *c*, until the wind pressure is equal on all four planes. These series of operations and actuations will cause a reëstablishment of stability or equilibrium of the airship. The tendency of the airship to rock or tilt laterally because of the increased pressure upon the forward left hand aeroplane *c*, engaged by a puff of air, will be counteracted by the increase of inclination of the forward right hand aeroplane *c*, and the increased resistance thereof to the air. The increase of inclination of both rearward aeroplanes will counteract the tendency of the forward end portion of the airship to soar or rise under the pressure of a puff of air upon the forward left hand aeroplane and because of the increased resistance afforded by the increased inclination of the forward right hand aeroplane. Varying effects produced by variations of atmospheric conditions and air and air pressures upon others of the four aeroplanes of the forward and rearward pairs, will, in manifest varying manners affect all of the four aeroplanes, through the controlling means C and the operative connections D to establish and maintain stability and equilibrium of the entire airship.

The above description of operation has been with respect to the member or organism *a* of the controlling means C. Such movements of the pistons 31 to 34, inclusive, within the cylinders 26 to 29, inclusive, as accompany the movements of the piston rods 38 to 41, inclusive, as above described, will be idle in their effect with relation to the member or organism *a*. The movements of such latter pistons, under positive actuation in the manner predetermined with respect to the member or organism *b* of the controlling means C, are caused in the following manner:—The gyroscope *g* is free to gyrate in all lateral directions upon its support or seat 65, and the rotating element 109 thereof, is constantly rotated by the operating means *o*. If the stability or equilibrium of the entire airship be disturbed or interrupted, particularly by shifting of the load of the body A, the gyroscope *g* still maintains its vertical position substantially, or tends to maintain such position, so that its shaft 110 extends vertically. When the body A is tilted in any direction so as to leave the horizontal position, the gyroscope *g* maintains its vertical position, there being however a relative movement between

the body A and the gyroscope, through the bearing head 64 and its seat 65, and one of the pairs of the mutilated gear heads 102 is caused to mesh with one of the pairs of gears 108 or a pair of pinions 106 meshing therewith, and two alined shafts 76 or 77, are correspondingly rocked or rotated. Normally, the mutilated gear heads 102 are out of mesh with the gears 108 or the pinions 106. Two of the pairs of arms 104 are made longer than the other pair of arms 104 so as to permit freedom of play or gyration of the gyroscope *g* and the proper meshing of the gear heads 102 with the gears 108 or pinions 106, as now being described. Let it be assumed that the lower side of the body A, that is the side nearest to the right hand margin of the sheet, in Fig. 2, is slightly depressed, due to shifting of the load. This will throw the gear heads 102 of the arms 104 at the upper side of the body A into mesh with the gears 108 associated therewith and cause the rotation of the shafts 77 of the latter so as to rotate the beveled gears 73, at the upper corners of Fig. 2, in the direction denoted by the adjacent arrows, and so as to cause the beveled gears 72 at the upper corners of Fig. 2, to rotate in the directions opposite to those denoted by the arrows adjacent thereto. The beveled gears 73 which likewise mesh with the beveled gears 75 upon the shafts 77 will be operated in each instance in the direction opposite that in which the opposed gears 72 rotate. Each of the ratchets 80 fixed to the beveled gear 73 will be rotated to cause the pawls 90 to intermittently oscillate the collars 86 and the shafts 82, intermittently opening the valves 91 and intermittently admitting compressed air to the outer end portions of the cylinders 27 and 29. The springs 100 maintain the exhaust valves 97 closed, the pawls 89 passing inoperatively over the ratchets 79. When the ratchets 80 are turned so that the pawls 90 are engaged with the elongated teeth 81 at the farther end of said ratchets, or the ends opposite to those engaged by the ratchets in Fig. 2, said elongated teeth tend to maintain the valves 91 open, so that continuous pressure of air is admitted to the cylinders 27 and 29 through the connection pipes 62. The admission of air, in this intermittent manner to the outer ends of the cylinders 27 and 29 causes the pistons 32 and 34 to move inwardly of the cylinders 27 and 29 respectively, causing the piston rods 39 and 41 to increase the inclinations of the aeroplanes 10 at the lower side of the tilted body A, the increased resistance of such aeroplane to the air tending to right the body A or restore it to equilibrium. Through the connecting levers 42 and 50 the piston rods 38 and 40 are caused to move outwardly, and the inclinations of the aeroplanes 10 at the upper side of the body A are decreased through the link arms 48. The decreased resistance to the air of the last mentioned aeroplanes supplements the action of the increased inclination of the other pair of aeroplanes, tending to right the tilted body A. As the body A gradually rights, or is righted as above described, relative movement of the gyroscope *g* and the frame A, the gyroscope tending to maintain its equilibrium or upright position causes a reverse movement of the shafts 77, the collars 87 being actuated intermittently through the pawls 89 and the gears 72 to intermittently open the exhaust valves 97. At the same time the pawls 90 ride inoperatively over the ratchets 80, permitting the closing of the valves 91 under actuation of the springs 101. The air is thus gradually exhausted from the outer ends of the cylinders 27 and 29, and the aeroplanes 10 all reassume their normal relative inclinations through the member or organism *a* in the manner above described.

From the above it will be seen that variation in conditions of atmospheric pressure, as well as variations in center of gravity of the body A, inasmuch as the same affect the equilibrium of the body A, are met and provided for by the organisms or members *a* and *b* of the controlling means C; and that said members or organisms *a* and *b* are inter-related in their functions and operations, to the end that a sensitive response of the controlling means C is made to any variation of conditions of stability or equilibrium affecting the body A and its connected parts and members; the specific illustrations of operation above given being paralleled by corresponding operations resulting from variations of the conditions of disturbances presupposed.

In the modified form of construction shown in Fig. 5, the operation is the same as that above described with the exception of that of the lateral supporting members E. These supporting members being interrelated and inter-operative, through the connecting lever 120, it results, from their particular mounting and operative connection, that if a variation in atmospheric pressure affects one of the members E, so as to vary its inclination, the inclination of the opposite member E will be oppositely affected, through the slidable shafts 117 and the connecting rods 124, so that there will be a tendency to maintain or restore stability, or equilibrium of the body F. These members E have a compensating inter-relation automatically combining to act for the maintenance or restoration of equilibrium.

I do not desire to be understood as limiting myself to the specific construction, provision, combination, relative arrangement and association of parts, members and fea-

tures shown and described; but reserve the right to vary the same, in adapting the improvements to varying conditions of use, without departing from the spirit of the invention and the terms of the following claims.

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

1. Improvements in airships, comprising a body provided with supporting members, and controlling means for said supporting members; said controlling means comprising separate members or organisms responsive respectively to variations of atmospheric pressure and position of load.

2. Improvements in airships, comprising a body, supporting members for the body inter-related so as to be responsive to variations in atmospheric pressure, and controlling means for the supporting members; said controlling means including a member or organism responsive to variation in position of load.

3. Improvements in airships, comprising a body, supporting members for the body, and controlling means for the supporting members; said controlling means comprising separate members or organisms responsive respectively to variation of atmospheric pressure and support of load; and said members or organisms of said controlling means being inter-related.

4. Improvements in airships, comprising a body, adjustable aeroplanes for the support of the body, and controlling means for the aeroplanes including mechanism whereby said aeroplanes are so inter-related that variation of atmospheric pressure upon one of said aeroplanes causes variation of inclination of another of said aeroplanes.

5. Improvements in airships, comprising a body, adjustable aeroplanes for the support of the body, and controlling means for the aeroplanes including mechanism whereby said aeroplanes are so inter-related that variation of atmospheric pressure upon one of said aeroplanes causes variation of inclination of the others of said aeroplanes.

6. Improvements in airships, comprising a body provided with a plurality of adjustably supporting aeroplanes; and controlling means including mechanism whereby said aeroplanes are so inter-related that variation of atmospheric pressure upon one of said aeroplanes causes variation of inclination of the others of said aeroplanes; said controlling means comprising a plurality of pistons and a mobile medium affected by said pistons.

7. Improvements in airships, comprising a body provided with a plurality of adjustably supporting aeroplanes; and controlling means including mechanism whereby said aeroplanes are so inter-related that variation of atmospheric pressure upon one of said aeroplanes causes variation of inclination of the others of said aeroplanes; said controlling means also comprising a plurality of pistons, a cylinder adapted to contain a mobile medium forming a connection between said pistons, and means for varying the relative positions of said pistons.

8. Improvements in airships, comprising a body provided with a plurality of adjustably supporting aeroplanes; and controlling means including mechanism whereby said aeroplanes are so inter-related that variation of atmospheric pressure upon one of said aeroplanes causes variation of inclination of the others of said aeroplanes; said controlling means also comprising a plurality of pistons, a cylinder adapted to contain a mobile medium forming a connection between said pistons; and means for varying the relative positions of said pistons through the agency of said mobile medium.

9. Improvements in airships comprising a body provided with a plurality of supporting adjustably inter-related aeroplanes; and controlling means for said aeroplanes responsive to variation of atmospheric pressure; said controlling means also comprising a cylinder, a plurality of pistons within said cylinder and provided each with a piston rod, and connecting levers carried by said piston rods and connected respectively with said aeroplanes.

10. Improvements in airships, comprising a body; a plurality of adjustable inter-related aeroplanes for the support of the body; and controlling means for the aeroplanes responsive to variation of the position of the load of the body; said controlling means comprising a plurality of cylinders, a plurality of pistons respectively in said cylinders and respectively operatively connected with said aeroplanes, pneumatic means, and gyroscopic means controlling said pneumatic means with respect to the admission of compressed air to and exhaust of compressed air from said cylinders.

11. In improvements in airships, an adjustably supported aeroplane, a cylinder, a piston in the cylinder operatively connected with the aeroplane, a compressed air supply, valve means controlling the admission of compressed air to the cylinder, valve means controlling the exhaust of compressed air from the cylinder, and means controlling both said valve means; and said last named means permitting intermittent admission of air to and exhaust from said cylinder.

12. In improvements in airships, an adjustably supported aeroplane, a cylinder, a piston in the cylinder operatively connected with the aeroplane, a compressed air supply, valve means controlling the admission of compressed air to the cylinder, valve means controlling the exhaust of compressed

air from the cylinder, and gyroscopic means controlling both said valve means; and said last named means permitting intermittent admission of air to and exhaust from said cylinder.

13. Improvements in airships, comprising a body, a plurality of adjustable members disposed for resistance to atmospheric pressure, and controlling means for said members; said controlling means comprising separate members or organisms responsive respectively to variation of atmospheric pressure and imposition of weight of load.

14. Improvements in airships, comprising a body, a plurality of adjustable members disposed for resistance to atmospheric pressure, and controlling means for said members; said controlling means comprising separate members or organisms responsive respectively to variation of atmospheric pressure and imposition of weight of load; and said members or organisms of said controlling means being inter-related.

15. Improvements in airships, comprising a body, adjustable members disposed for resistance to atmospheric pressure, and mechanism whereby said members are so interrelated that variation of atmospheric pressure upon one of said members causes variation of inclination of another of said members.

16. Improvements in airships, comprising a body, adjustable aeroplanes eccentrically connected with the body, and mechanism whereby said aeroplanes are so inter-related that variation of atmospheric pressure upon one of said aeroplanes causes variation of inclination of another of said aeroplanes.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

JAMES J. SLAVIN.

Witnesses:
F. A. MANSFIELD,
TILLIE E. ADAM.