No. 892,606. PATENTED JULY 7, 1908.

C. A. MOORE & E. BARROW.

AERIAL NAVIGATION.

APPLICATION FILED JAN. 22, 1907.

2 SHEETS—SHEET 1.

Fig. 1.

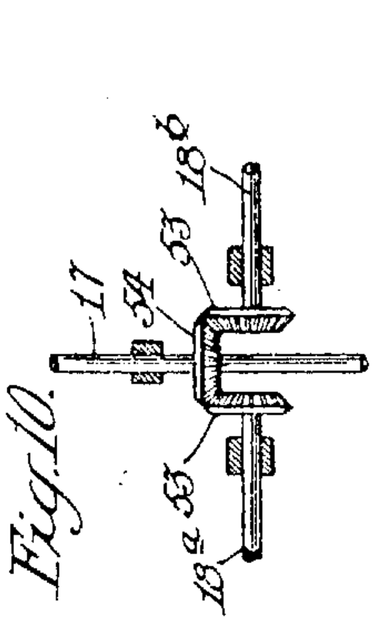

Fig. 10.

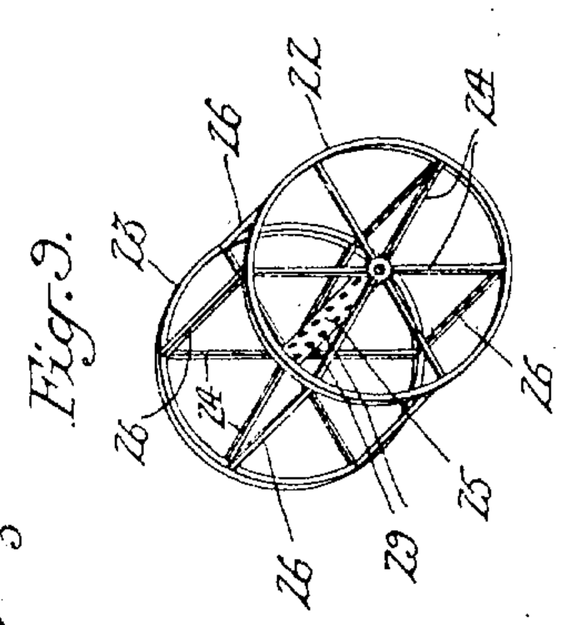

Fig. 9.

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2 SHEETS—SHEET 2.

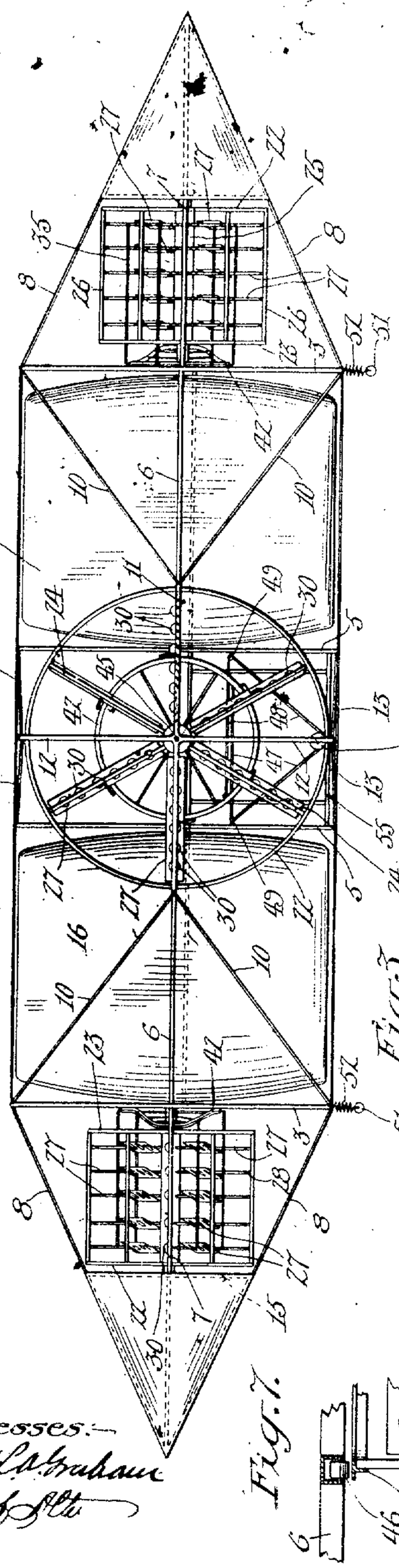

Fig. 2.

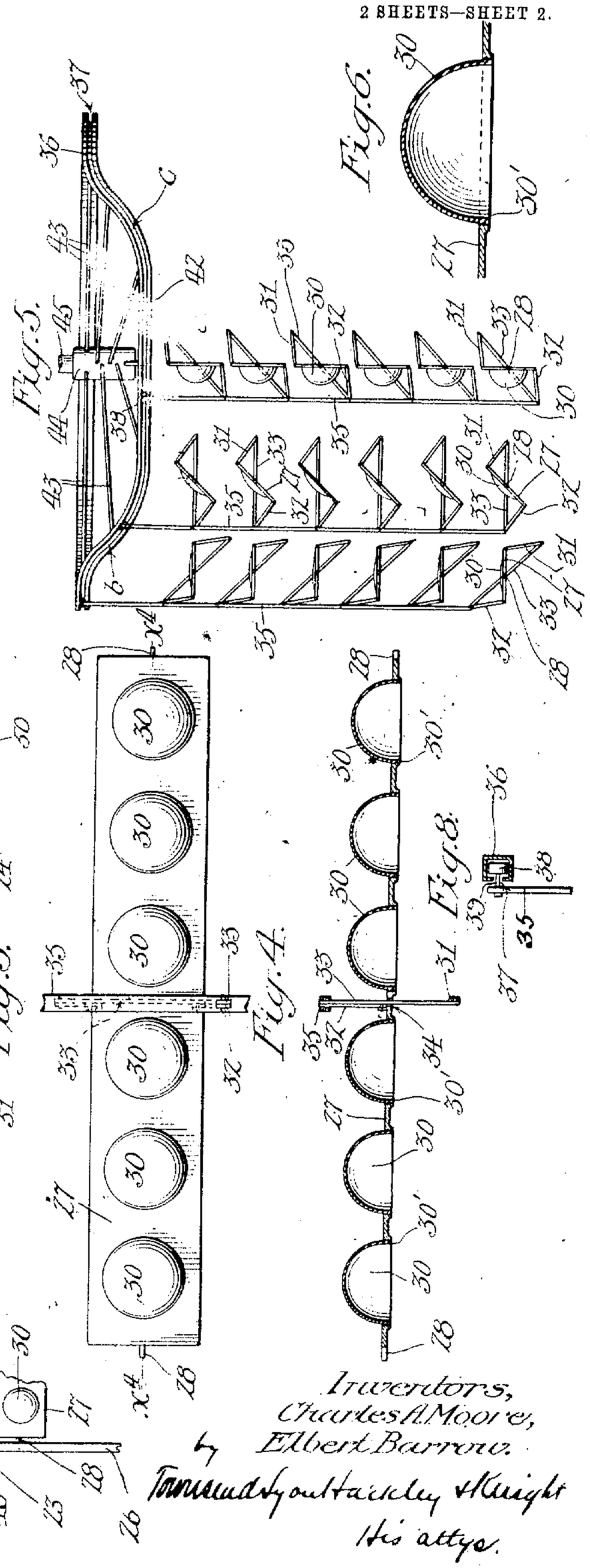

Fig. 5.

Fig. 6.

Fig. 3.

Fig. 4.

Fig. 8.

Fig. 7.

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UNITED STATES PATENT OFFICE.

CHARLES A. MOORE, OF LOS ANGELES, AND ELBERT BARROW, OF CAHUENGA, CALIFORNIA.

AERIAL NAVIGATION.

No. 892,606. Specification of Letters Patent. Patented July 7, 1908.

Application filed January 22, 1907. Serial No. 353,560.

To all whom it may concern:

Be it known that we, CHARLES A. MOORE and ELBERT BARROW, the former residing at Los Angeles, in the county of Los Angeles and State of California, and the latter residing at Cahuenga, in the county of Los Angeles and State of California, have invented new and useful Improvements in Aerial Navigation, of which the following is a specification.

This invention relates to aerial navigation, and the objects of the invention are to provide a novel and effective means for propelling a vessel through the air.

A further object is to provide for steering the vessel without employing rudders. The propelling means comprises a series of rotating blades and a further object is to provide a novel form of blade which will have a greater operating power against the air than any other device heretofore produced of which we are aware.

Further objects and advantages consist in the construction, combination and arrangement of the various parts as will be hereinafter set forth.

The accompanying drawings illustrate the invention, and referring thereto:—Figure 1 is a plan view partly in section of a machine for navigating in the air, constructed in accordance with our invention. Fig. 2 is a side elevation of the machine shown in Fig. 1. Fig. 3 is a plan view in detail, enlarged, of a propeller blade. Fig. 4 is a sectional view on line x^4—x^4 Fig. 3. Fig. 5 is a diagrammatical view illustrating the different positions of the propeller blades at different parts of the cycle of the propeller and illustrates the means for shifting the blades. Fig. 6 is an enlarged view in section of a blade disk. Fig. 7 is an enlarged view of a portion of the propeller showing the means for reducing friction between the propeller and the frame of the vessel. Fig. 8 is a detail view, enlarged, showing a section through the circular track and illustrating the manner of operating the universal connecting rod from the track. Fig. 9 is a perspective view showing a propeller with the wings removed. Fig. 10 is an enlarged detail view showing the manner of driving the end propeller shafts from the side propeller shaft.

1 designates a horizontal frame which is connected at each end with horizontal cross bars 2. At each end of each cross bar 2 are vertical rods 3. At the center of the longitudinal frame 1 is a platform 4 extending on either side, at the corners of which platform are four vertical rods 5 similar to the rods 3. At each side, extending parallel with the frame 1, are side bars 6 which are connected to inclined rods 7, the latter extending forward and aft and tapering to a point as shown in Fig. 1. As shown in Fig. 2, rods 8 also extend to points fore and aft and conical hoods 9 are mounted on each pointed end. As shown in Fig. 2, diagonal braces 10 extend from the outer ends of vertical rods 3 to a side bar 11, there being one side bar 11 on each side of the ship as shown in Fig. 1. Intersecting with each side bar 11 is a vertical bar 12, the upper ends of which are connected by braces 13, as shown in Fig. 2, with vertical bars 5. In order to prevent suction each hood 9 is closed by a wall or curtain 15.

Four gas bags 16 are employed, and as shown in Fig. 1 they are separated by floor 1 and floor extensions 4. These gas bags 16 may or may not be employed as desired. Their presence, however, is an additional safe-guard, as in the event that the engines failed, the propellers would stop operating and at such times the gas bags would sustain the ship until the engines could be again started or repairs made to other mechanism which had necessitated stoppage of the engines. Obviously the gas bags 16 when employed give additional buoyancy to the vessel, although the propelling mechanism about to be described is alone sufficient to sustain the ship.

Four propellers are preferably employed, one at each end of the ship and one on each side of the ship as shown in Fig. 1. The propellers are constructed substantially alike, the two side propellers being, however, larger than the end propellers. The side propellers are driven by a shaft 17 and the end propellers are driven by shafts 18 and 18ª through the medium of suitable gearing hereinafter described. The engines 20 are preferably mounted on the floor 1. The shafts 17 and 18 are connected with the propellers through the medium of universal joints 21 which permits of the necessary relative movement of the different parts of the ship when in operation, as while all the parts of the ship are thoroughly braced and connected it is of course evident that in such a structure it will strain in operation and parts will yield some-

what, as absolute rigidity is difficult to maintain and in fact is believed would be a detrimental feature in such apparatus.

Each propeller comprises an outer and an inner ring 22 and 23, as shown in Fig. 9, which are connected by spokes 24 with a tubular hub 25. The rings 22 and 23 are connected together by cross rods 26, there being in the present instance six cross braces 26. In each propeller there are six wings and each wing consists of a set of six blades 27, which blades project radially from the hub and are pivotally mounted with respect to the hub. Each blade 27 has, as shown in Fig. 3, a trunnion 28 at each end, which trunnion projects into an orifice 29 in the tubular hub 25 which forms a bearing for the inner end of the blade, while the outer trunnion 28 projects into a bearing in the adjacent cross bar 26. Each blade 27 is provided with a series of expansible disks 30, each formed of rubber with a vulcanized rim 30′ provided with threads to enable the disk to be detachably fastened to the blade. If a disk becomes destroyed it may thus be readily replaced by another disk, and to this end it is desirable to provide a supply of spare disks when operating the ship. The blades 27 are automatically actuated axially on their trunnions 28 as the propeller as a whole rotates. Connected to one edge of each blade is a link 31, as shown in Figs. 3, 4 and 5, and connected to the opposite edge of the blade is a link 32, the links 31 and 32 being connected together by an intermediate floating link 33, the link 33 passing unrestricted through an orifice 34 in the center of the blade 27.

Extending parallel with the hub of the propeller is a universal connecting bar 35, with which bar the respective links 32 of a set of blades are articulated, so that when reciprocatory motion is imparted to the universal connecting rod 35 all of the blades connected with it are turned on their pivotal points and by reason of the respective blades being pulled from both edges, twisting or bending of them is obviated and their action is smooth and even. The universal connecting bars 35 are automatically reciprocated through the revolution of the propeller by means of a circular cam track 36. A cross section of the track 36 is shown in Fig. 8, from which it will be seen that the track is hollow and formed with a slot 37, and a roller 38 rides within the track 36 and has a stem 39 which passes through the slot 37. The stem 39 carrying roller 38 is mounted in the end of the universal connecting bar 35. Each cam track 36 has an offset portion 42 which extends through an arc of less than half a complete circle, the offset portion having a straight section *a* and two inclined sections *b* and *c*. The track 36 is a revoluble track and is supported by spokes 43 which project from a block 44, which block forms a bearing for a short shaft 45, the outer end of which shaft is mounted in bearings in the bars 11 and 12. The inner end of shaft 45 is connected to universal joint 21. The tubular hub 25 of the propeller wheel is mounted on the shaft 45.

In operation there may be at times a tendency for the side propeller wheels to move laterally toward the bars 6, and in order to prevent any friction of the wheels against bars 6, anti-friction rolls 46 are employed which will receive the thrust of the rings 23 if the latter move towards the bars 6, although ordinarily in operation the rings 23 revolve free from rollers 46. In operation as the propeller wheel revolves, the blades 27 are held parallel with the shaft 45 during the time that the universal connecting rod is traversing section *a* of the circular track and the blades are gradually turned on their pivots as the universal connecting bar traverses section *c*, and when the universal connecting bar reaches the straight portion of the circular track the blades are turned at right angles to the shaft 45. In other words the plane in which they then lie is parallel with the plane of rotation of the propeller wheel so that the blades are feathered during the greater part of their cycle, and when they arrive at the section *b* they are gradually turned back again and become gradually effective for duty, doing full duty while traversing the section *a*. By reason of the expansible disks 30 in the blades the action is to compress the air in them when they are expanded and this greatly increases the effective working power of the blade. If the blade were flat this compression of air would not occur. But with the disks the air is accumulated and confined and the effectiveness of the blade is thus very great.

By adjusting the circular tracks so that the blades do duty during their down stroke the action of the blades is then to exert a lifting power which will raise the ship. By adjusting the circular tracks so that the blades are effective during their rear stroke they become effective to propel the ship forward, and by giving intermediate adjustment to the circular track the blades may be caused to exert a combined action, tending to drive the ship forward and upward, and it is evident that any desired degree of adjustment to secure the exact ratio between these two combined forces may be secured readily by adjusting the circular track. The tracks may be adjusted in any desired manner as, for example, by means of ropes 47 and 48 which are connected to the track and pass over sheaves 49 thence to a drum 50, around which the ropes are wound. By turning the drum 50 in one direction, rope 47 is wound up and rope 48 is unwound, which results in turning the circular track clockwise (Fig. 2), while by turning the drum 50 in the opposite direction the circular track is adjusted coun-

ter clockwise. The end propellers are used for turning the ship around. In order to prevent the ship from rubbing against objects, as in starting to ascend or in coming to rest on the ground, we employ rollers 51 which are supported by springs 52. During the feathering action of the blades the rubber disks 30 spring back and lie substantially flat in the plane of the blades so that there is the minimum resistance against the air of the blades when traversing the idle portion of their cycle.

The end propellers are preferably driven in opposite directions so that while they both exert a lifting power, the tendency of either one to turn the ship is counterbalanced by the tendency of the opposite one to turn the ship in the opposite direction. The shafts 18^a and 18^b are respectively provided with bevel gears 53 which mesh with a bevel gear 54 mounted on shaft 17.

The navigator stands on a deck 55 which is suspended underneath the floor 1, on which the engines 20 are mounted, and by reason of the four large spaces between the respective gas bags the navigator has a good range of vision.

While I have termed the expansible diaphragms 30 "disks," they need not necessarily be circular.

What we claim is:—

1. A propeller comprising a shaft, radial wings on said shaft, each wing comprising a series of blades, each blade having a series of expansible disks and means for automatically feathering said blades as the propeller revolves.

2. In aerial navigation, a propeller blade provided with self flattening air compressing expansible disks.

3. In a propeller, a blade provided with a series of self flattening expansible disks.

4. In a propeller, a blade having a plurality of threaded orifices, and expansible disks screwed in said orifices.

5. In a propeller, a blade provided with a plurality of orifices, and rubber expansible disks screwed in said orifices.

6. In a propeller, a blade having a plurality of orifices, a series of expansible disks registering with said orifices, and means for detachably fastening said expansible disks to the blade.

7. A propeller comprising radial wings, each wing consisting of a series of pivoted blades, a pair of links connected to opposite edges of each blade, an intermediate link passing through the center of the blade and connected to the first links, a universal bar to which two of said links are connected, rotating means for supporting said blades, and means for gradually shifting said universal rod as the blades rotate.

8. A framework comprising a longitudinal floor with central lateral extensions, a pair of gas bags on opposite sides of said floor at one end thereof, another pair of gas bags on opposite sides of said floor at the other end thereof, said gas bags being separated fore and aft by said lateral extensions, propellers supported by said frame on each side thereof and at each end of the frame, and antifriction rollers between the side propellers and said framework.

In testimony whereof, we have hereunto set our hands at Los Angeles California this 11th day of January 1907.

CHARLES A. MOORE.
ELBERT BARROW.

In presence of—
GEORGE T. HACKLEY,
FRANK L. A. GRAHAM.