

Nov. 14, 1933.

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EQUIPMENT FOR MOORED AIRSHIPS

Filed March 7, 1932

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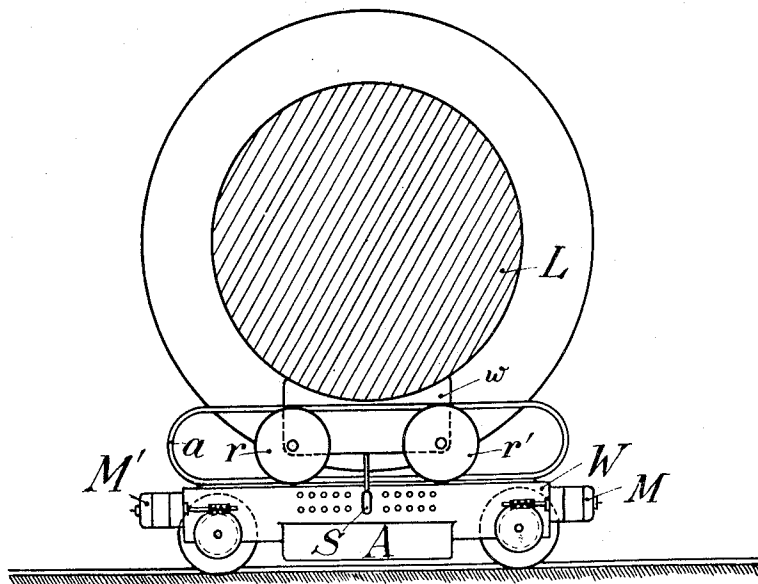


Fig. 1

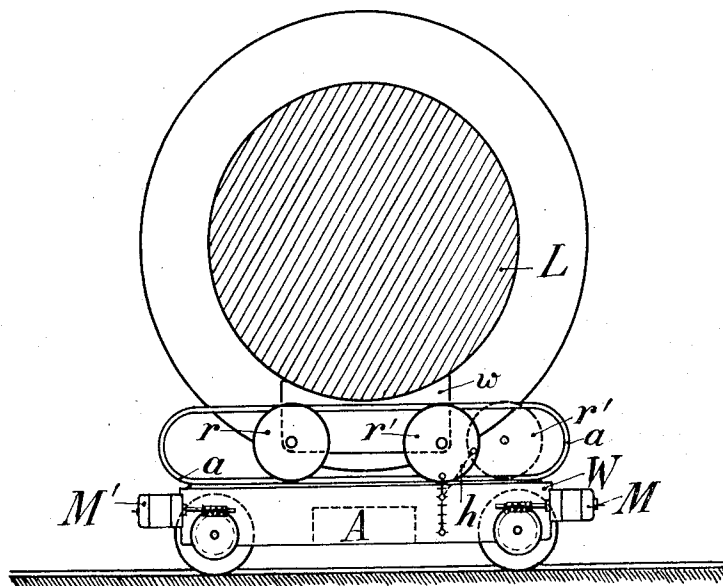


Fig. 2

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Fig. 3.

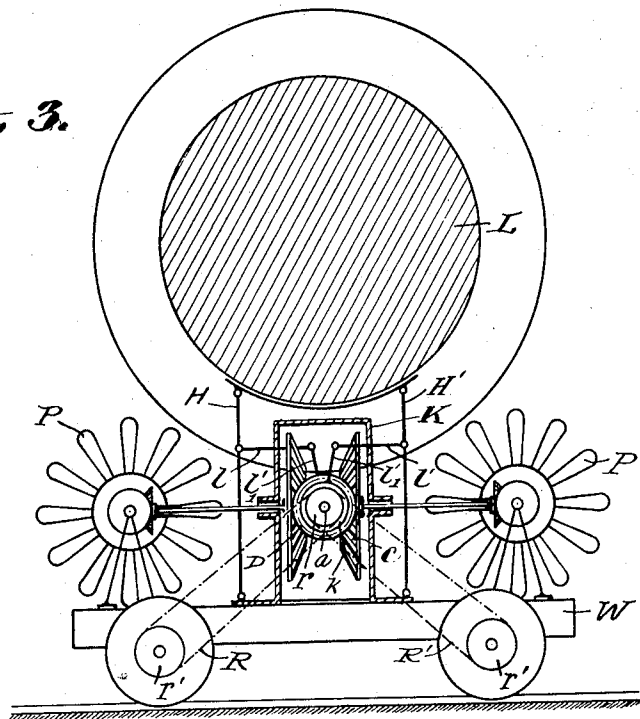
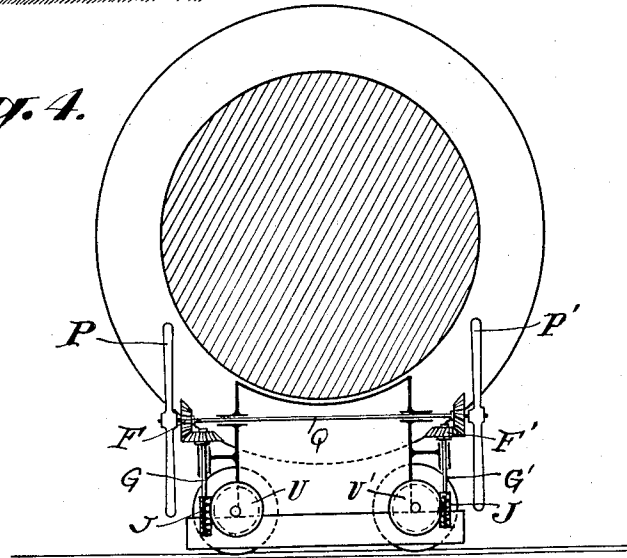


Fig. 4.



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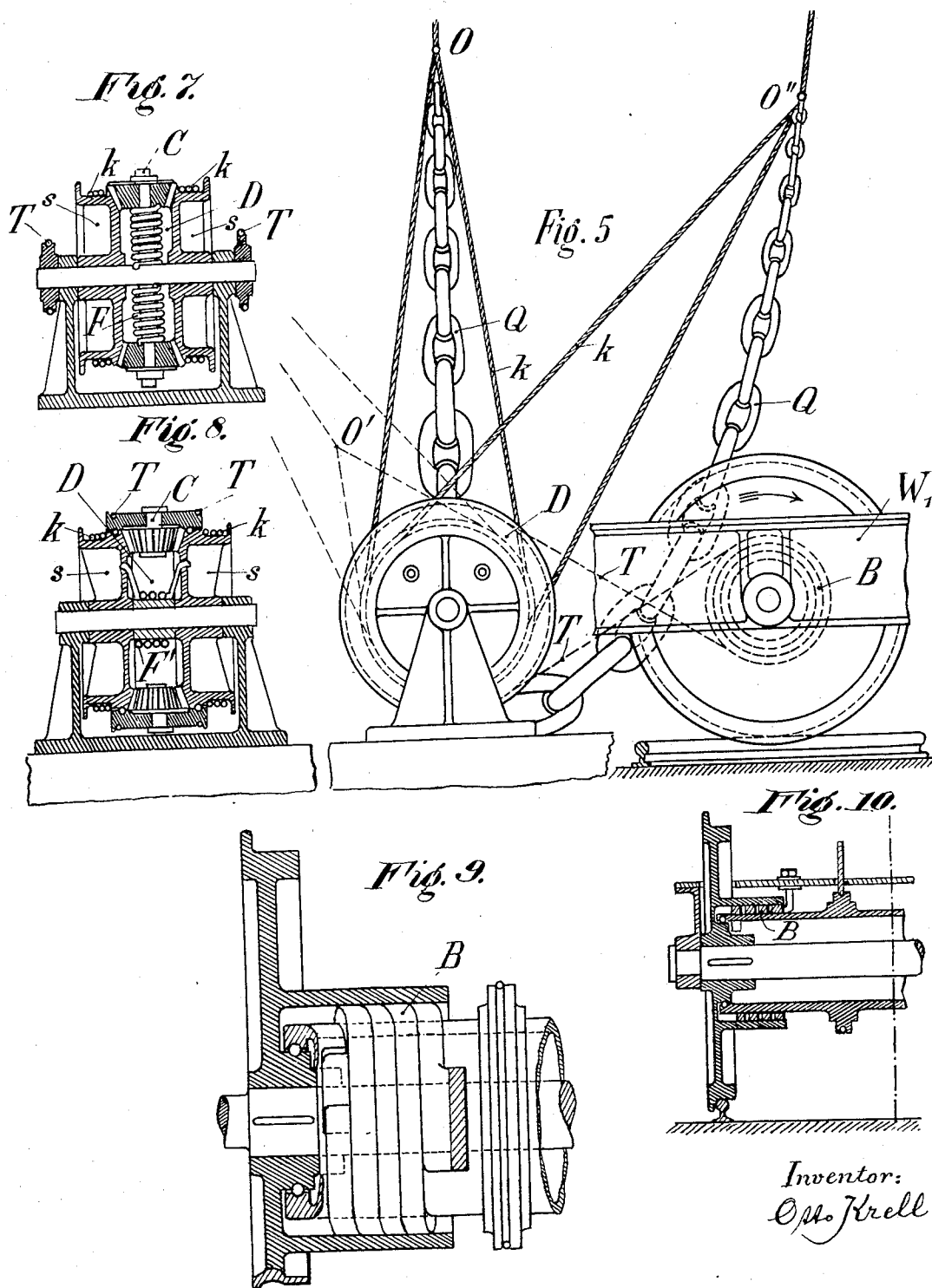
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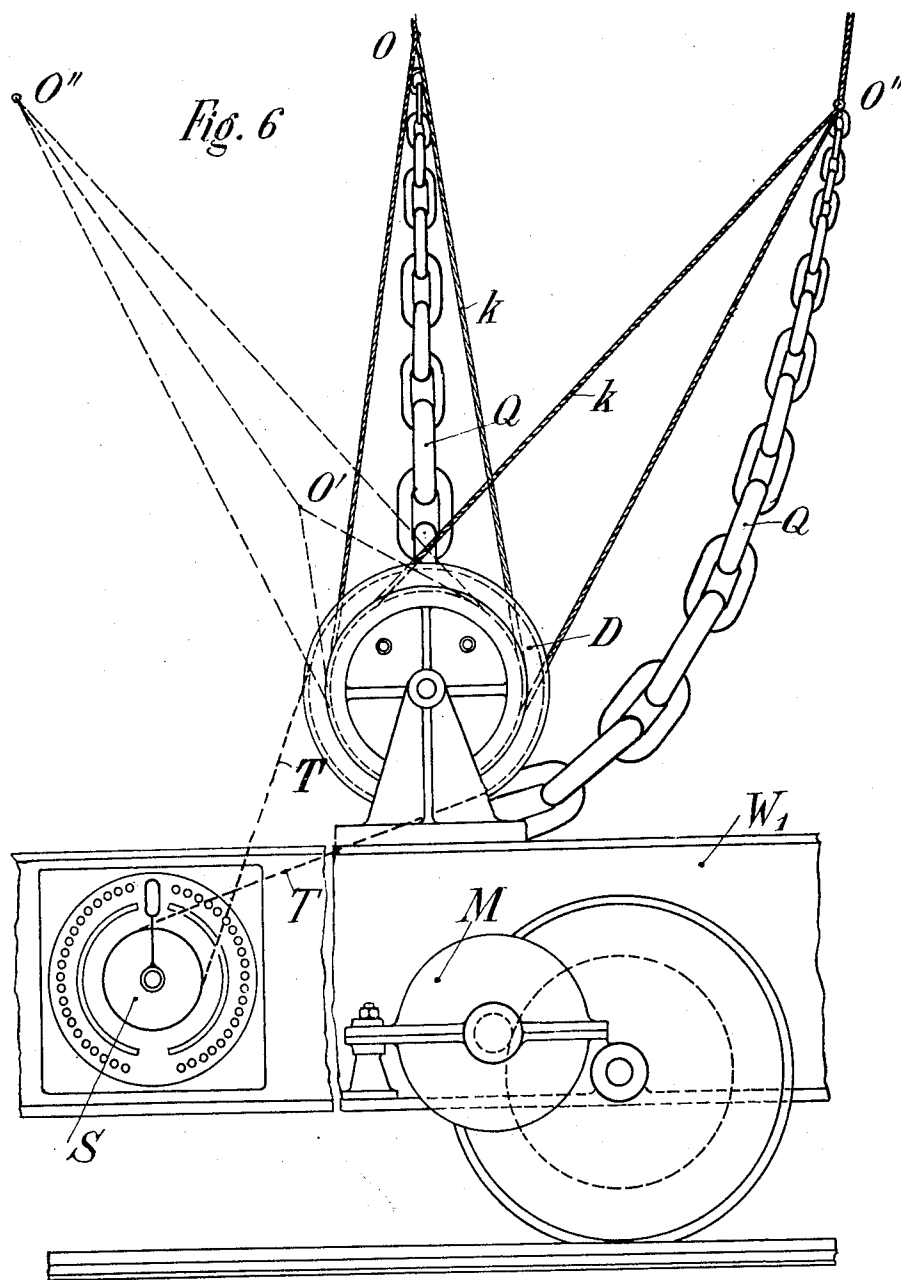
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UNITED STATES PATENT OFFICE

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EQUIPMENT FOR MOORED AIRSHIPS

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9 Claims. (Cl. 244—2)

My invention relates to improvements in equipment for moored airships.

The auxiliary equipment for airships moored on masts is still far from perfect, whether a high or low mast, a separately mounted or a mast mounted above the inlet opening of a rotary hangar is employed.

It is above all necessary to maintain the airship tied up at or anchored to the mast in a steady horizontal position without preventing it from giving way in the horizontal direction or from swinging around the mast.

To protect an airship moored to a high mast against excessive vertical oscillations, I have suggested the employment of ballast bodies connected in the manner of the links of a chain, more particularly a plurality of chains combined into a tassel in such a way that at the top a single chain only is connected to the stern of the airship, which by the addition of further chains becomes more and more forked towards the free end so that a chain tassel is formed which becomes gradually heavier towards the end.

The main drawback in the application of such ballast chains, which steady the airship very satisfactorily as far as purely vertical movements are concerned is that during the horizontal swinging movements of the airship the chain must be dragged along the ground and that in this way a considerable resistance is opposed to the horizontal movements which on the airship tied up at the nose and on the other hand held back by the dragging chain must necessarily have the action that under the action of a cross wind the axis of the airship describes the convex surface of a cone, so that if the cross wind is sufficiently strong the stern of the ship may come in contact with the ground.

It thus suggests itself and has already been proposed to accommodate the ballast members or chain on a car or trolley and to let the car together with the chain be dragged along by the swinging airship. This is hardly an improvement however, because although the car will be made as light as possible it will still have a considerable weight in order to enable it to carry the weight of the chain, so that the power required for its acceleration will not be much less than the resistance of the chain hauled along the ground.

Conditions are somewhat different if the after portion of the ship near the stern is directly secured to a car or truck which describes a circular path around the point of attachment of the moored ship, as has repeatedly been done when mooring the airship to low masts, so-called stub

masts. For this circular path a railroad track is usually laid, as the car moving over rough ground would seriously jolt the airship, which is comparatively rigid owing to its great mass. A cushioning device strong enough to absorb these shocks is not easy to design. This arrangement has the further disadvantage that this car secured to the ship like the car carrying the ballast chain mentioned above must be made as light as possible so as not to oppose an excessively high resistance to its acceleration in the event of a cross wind striking the ship, so that the airship held fast at the bow and the stern is subjected to a bending strain. As compared with this the airship moored to high mast and steadied merely by chains has a certain resiliency and thus an advantage over the before described construction. To this must be added that the car secured to the stern of the airship should be so heavy that it cannot be lifted up into the air by vertical gusts of ground wind. The conditions for the construction of the car are thus contradictory.

To eliminate all these drawbacks, I employ means to connect the airship resiliently with the car and reduce the power for accelerating and retarding the car to a minimum by providing the car with a self-contained propulsion system and brakes adapted to be rendered operative and inoperative by the lateral starting and stopping movements of the airship.

This idea underlying my present invention highly improves the utility of the ballast chain of variable or towards the end increasing weight. The damping of the vertical oscillations may be carried to any desired extent by correspondingly choosing the proportions of the chain without increasing the resistance to the horizontal swinging motion of the airship. The chain carrying car and also the car to which the after portion of the ship is secured can now after providing it with self-contained propulsion means and thus enabling it to accelerate itself as soon as it receives an impact from the swinging airship, be made so heavy that it may be considered as an absolutely reliable means for steadying moored airships.

If further on in this specification storage batteries are suggested as sources of power for the self-contained car propulsion system, their high weight is rather an advantage than a drawback. They have, furthermore, in this case the particularly valuable property that they are always ready for service and dependable to an extent not attained by any other source of power.

The mode of operating the control gear of the

car in the case of high and the low masts will now be explained in greater detail with reference to the examples illustrated in the drawings affixed to my specification and forming part thereof.

Fig. 1 is an elevational view of the main and intermediate cars from the rear of the airship, the airship being shown in section and resting on the cars.

Figs. 2, 3 and 4 are similar views but of respective modifications of my device.

Figs. 5 and 6 are fragmentary elevational views of further respective modifications of my device. In these views an additional indication of another position of the ballast chain is shown in full lines rather than conventional dot-and-dash showing to better illustrate the features of the ballast chain and mooring cables.

Figs. 7 and 8 are longitudinal sectional views of respective modifications of planet wheels or reversing gear D of the devices of Figs. 5 and 6.

Figs. 9 and 10 are longitudinal views, partly in section, of respective modifications of a car wheel and braking mechanism therefor.

If the airship is moored to a low or stub mooring mast and it is desired to support it resiliently against vertical forces upon a car located near the stern and, if desired, also upon a second car located at the after portion of the ship nearer the middle of its length, the control motion between car W and the body of the airship L is effected by an auxiliary or intermediate car *w*, Figs. 1 and 2, located between the supporting car proper and the airship. This auxiliary car or carriage *w* is only capable of movement in the horizontal direction of the railroad track while it is secured against being vertically lifted off the main car. The carriage or auxiliary car *w* is on the other hand firmly secured to the airship L. If now the airship is swung sideways by a cross wind, it commences to move together with the auxiliary car *w* without, however, carrying along the main car W. This leading motion of the auxiliary car in relation to the main car is utilized for controlling the main car. If electrical driving means are provided upon the main car the switching of the motors M, M' may be effected by the auxiliary car directly operating the switch lever S, Fig. 1, or by means of relays. If the auxiliary car is provided with large wheels *r*, *r'*, to facilitate its motion, the brake and the switch lever *h* may be operated from one of these wheels, *r'*, Fig. 2, or a drum-type controller may be directly mounted upon a wheel axle of the auxiliary car. The lateral movement of the auxiliary car in relation to the main car is of course limited by suitable means, even if the propelling forces should be so proportioned that the auxiliary car never travels right up to the end abutments *a*. The mode of operation of this auxiliary car is as follows: if the airship swings around its point of attachment under the action of a cross wind the auxiliary car is displaced in relation to the main car stationary at the time. The brakes of the main car, which are applied as long and as soon as the airship stands substantially vertically above the center of the main car, are simultaneously lifted off. After releasing the brakes the auxiliary car proceeding along its path switches in the self-contained propulsion system of the main car to a gradually increasing extent and the car follows the airship with increasing acceleration until it reaches her. If the car overtakes the airship because of the action of the cross wind on the airship has ceased

or because the car has attained a high speed, the auxiliary car stops behind and, in the reverse order, disconnects first the propulsion system and then applies the brakes as soon as its center stands vertically above the center of the main car. The control process remains the same for right-hand and left-hand swings of the airship owing to the symmetrical arrangement of the parts of the switchgear. The two cars, the car at the stern and the car at the after portion nearer the middle of the airship may each by itself be controlled by utilizing the relative motion (leading and lagging) of the airship. The control of the second car nearer the middle of the ship may also be made dependent upon the movement of the stern car, it being then necessary to take into account the difference in the swinging radii and of the velocities of the two cars. An automatic and correct distribution of the propulsion forces and velocities over both cars may be obtained by a series connection of the electrical driving means stepped in the ratio of the swinging radii.

If value is attached to smooth starting, the Ward-Leonard connection should be chosen as it is particularly suitable for this purpose. It is then necessary to mount a constantly running Leonard converter upon the car. The Ward-Leonard converter set comprises a D. C. generator adapted to be driven at a constant speed by an electric motor directly coupled with it. The electric motor is preferably fed with current from a storage battery mounted on the car itself. The magnetic field of the electric motor M driving the car is constantly and fully excited, while in the exciter line of the generator there is connected a regulating resistance which permits of the excitation and thus the voltage of the generator being regulated from zero or the lowest voltage generated by the remanent magnetism (about 1.5 to 2 volts) respectively up to the full operating voltage. The armature of the generator is connected in series with the armature of the motor for driving the car. The speed of the car driving motor is directly proportional to the voltage supplied to the armature. In this way the speed of the driving motor may be regulated in very fine steps, and, more particularly, a very smooth starting of the car insured. The regulating resistance for the excitation of the generator is operated by the idle motion of the auxiliary carriage *w*. Instead of a single driving motor for the car a plurality of such motors may equally well be used, the armatures of which are then connected in parallel with one another and in series with the generator armature, or whose armatures are connected in series with one another and with the armature of the generator. The reversal of the direction of motion of the car is attained by the reversal of the field excitation of the generator, while the field excitations of the driving motors remain unchanged.

As source of power for driving the ballast car wind wheels or propellers may, for instance, be employed as shown at P, P' in Figs. 3 and 4. These windwheels are arranged on the car as high as possible above the ground with their axes located parallel to the axis of the airship, Fig. 3. Preferably two air propellers P and P' are employed, one on the right and the other on the left of the airship. The wind sweeping along the hull of the airship will continuously drive the full admission windwheels. The blades of the wind wheels P and P' have opposite pitch

and thus rotate in opposite directions under the action of the wind sweeping along the hull of the airship from the front towards the back. The wind wheels are connected with each other by the bevel wheel reversing gear C mounted on the car W in a housing or frame K. The two planet wheels D of the reversing gear are free to turn on the horizontal driving shaft *a* for the car W, but are adapted to be alternately clutched to the said shaft by means of a suitable clutch by operating the system of levers or rods H, H', *l*, *l*' and *l*', *l*'. The clutch or coupling must be so designed that the turning motion of the rods *l*₁ and *l*'₁ is converted into an axial motion along the driving shaft *a*. If, for instance, the lever *l*'₁ and *l*₁ are connected with a sliding sleeve or bushing on the said shaft, which by means of a helical face cam contacts with an abutment, this sleeve will move axially upon the driving shaft and clutch one of the planet wheels to the driving shaft, for instance, by means of a friction clutch. In the diagrammatic drawing Fig. 3 the clutches *k* are arranged between the planet wheels D and the driving chain wheel *r*. On the driving shaft are mounted belt or rope pulleys, or chain wheels E which by means of the driving members R and R' drive the wheels or the axles of the wheels of the car W. If the airship moored to the mast swings to the left due to a variation in the direction of the wind, the levers *l*, *l*' and *l*', *l*' are operated by the parallel levers H and H' moving together with the airship and that planet wheel of the reversing gear D is clutched to the driving shaft, which moves the car also towards the left, through the agency of the driving members or chains R and R'. If the airship moves towards the right due to the change in the direction of the wind, the other planet wheel D turning in the opposite direction is clutched to the wheel driving shaft and the car is thus also moved towards the right. In the central position of the airship both clutches or couplings are thrown out of gear so that both planet wheels are able to rotate freely on the driving shaft and the car is no longer driven by the wind wheels.

The employment of windwheels has a further special advantage. Their power depends upon the strength of the wind so that the propulsion of the car takes place in correspondence with the strength of the wind.

Another example for the application of a windwheel or propeller drive of the cars supporting the airship would be an arrangement in which the axes of the windwheels stand vertically to the axis of the airship, Fig. 4, so that the wind streaming along the hull of the airship flows along the plane of the windwheel and thus does not operate the windwheels. Only if a component develops transversely to the axis of the airship admission of the wind takes place to the control windwheels, which in this case are permanently coupled with the self-contained propulsion system of the car. The provision of special brakes is likewise superfluous because the windwheels themselves take over the task of braking when standing still and reversing. In contrast with the windwheels with full admission which must be located as high as possible above the ground, as described in the preceding example and illustrated in Fig. 3, the windwheels located with their axes transversely to the axis of the airship must be placed at a lower height in order that they may present as

large as possible a surface to the current of cross wind streaming along underneath the hull of the airship and more particularly the stern of the airship. This arrangement is similar to the device employed in windmills and which is employed for automatically setting the plane of the wings at right angles to the direction of the wind. As the wind wheels P and P' are struck from the same side by a cross-wind and both are mounted on the same shaft Q they must have both either right-hand or left-hand pitch. The rotation of this shaft Q is transmitted to the car W by two pairs of bevel wheels F and F' mounted on vertical shafts G and G' which at their lower ends carry worms J and J' which mesh with worm wheels U and U' mounted on the wheel axles. The direction of rotation of the wormwheels U and U' must be so chosen that the car is able to yield in the direction of crosswinds.

If the airship is moored to a high mast, the deflection, Figs. 5 and 6, which the upper end O of the chain tassel Q or, as shown in the drawings, the chain with the upwards gradually decreasing links produces in relation to the chain conveying car W₁ when the airship advances ahead of the car, is utilized for making the necessary control connections. The stationary car is shown in the braked condition. These brakes B are by means of cables and across a differential gearing D connected to the upper end O of the chain tassel and thereby to the airship herself. If the airship performs merely vertical oscillations, the springs F and F' are only strained and relaxed, but the shaft C of the planet wheels of the differential gear does not change its position in space and no switching motion is carried out, which is adapted to be effected by the movement of the shaft C of these planet wheels. The main or sun wheels of the differential gearing *s*, *s* are designed as cable or rope drums or barrels upon which two ropes *k*, *k* bifurcating from the top point of the chain tassel are wound up in opposite direction. The drums are turned in opposite directions by the springs F and F' so as to hold the two wound-up ropes taut. In this way it happens, as described above, that in the event of a purely vertical movement of the point O, O', at which the rope bifurcates, the shaft C of the pair of planet wheels does not change its position in space. If, however, the bifurcating point is laterally displaced towards O'' or O''' by a swinging motion of the airship the shaft of the pair of planet wheels is carried along in the same direction by means of the ropes T, T. The deflection may then be utilized for operating the brakes, for instance the screw operated band-brake shown in Fig. 5 or the switchgear shown in Fig. 6. The greater the lead of the airship in relation to the car, the more propelling means are switched in and the car follows the airship with increasing speed. If the swinging motion of the airship slows down and the car W₁ overtakes the ship, the switching motion and thus the switching process are reversed, the propelling means are gradually switched out more and more and finally the brakes are applied when the airship stands vertically above the chain transport car.

I claim as my invention:

1. In auxiliary equipment for airships moored to masts, consisting of cars located underneath the airship and to which the after portion of the ship is secured or connected by means of ballast chains, and which describe the same circular paths as the corresponding points of the airship

and are thus able to follow the swinging movements of the airship, said cars having a self-contained propulsion system and brake means.

2. In auxiliary equipment for airships moored to masts, a main car located underneath the after portion of the airship, a self-contained propulsion system, including braking means and switchgear mounted upon said car, an intermediate car secured to the airship and adapted to travel along said main car and to permit the swinging airship to lead or lag behind in relation to the main car, and means for utilizing this relative movement of the auxiliary car to the main car for operating said system on the main car.

3. In auxiliary equipment for airships moored to masts, a main car located underneath the after portion of the airship, a self-contained propulsion and braking system, and switchgear mounted upon said car, an intermediate car to which the after portion of the airship is secured and adapted to travel along said main car and to permit the swinging airship to lead or lag behind in relation to the main car and means for utilizing the rotary motion of the wheels of said intermediate car for controlling the system to effect starting or braking.

4. In auxiliary equipment for airships moored to masts, cars, to which the after portion of the airship is secured, windwheels fully exposed to the wind and permanently driven, mounted on said cars, and reversing gearing for coupling said windwheels with said cars and adapted to set them in motion in the direction in which the airship leads or lags behind the cars.

5. In auxiliary equipment for airships moored to masts, cars, to which the after portion of the ship is secured, windwheels mounted on said cars so arranged that they drive the car then only if the airship is struck by cross winds.

6. In an auxiliary equipment for airships moored to masts, cars to which the after portion of the airship is secured, brakes and electric pro-

pulsion means mounted on said cars, a storage battery for feeding said propulsion means, and a Ward-Leonard converter connected between said battery and said propulsion means.

7. In an auxiliary equipment for airships moored to masts, cars to which the after portion of the airship is connected by means of ballast chains, brakes for said cars, self-contained propulsion means mounted on said cars, and control means for said propulsion means adapted to be operated by the deflection of said ballast chains when the airship leads or lags behind in relation to said car.

8. In auxiliary equipment for airships moored to masts, cars to which the after portion of the airship is connected by means of draw members, a self-contained propulsion and braking system on said cars and adapted to be controlled by said draw members following the vertical oscillations of the airship.

9. In auxiliary equipment for airships moored to masts, cars to which the after portion of the airship is connected by means of draw members, self-contained propulsion systems and braking means on said cars and control gear therefor, said system adapted to be controlled by said draw members following the vertical oscillations of the airship, means for keeping said draw members in a taut state, consisting of two cable drums upon which the bifurcated ends of the draw member are wound in opposite directions, springs between said drum tending to turn said drums in opposite directions and intermediate wheels connecting said drums, the shaft of said wheels adapted to maintain its position in space when said draw member is moved up or down but to change it when the draw member is pulled sideways, the change in the position of said shaft being utilized for operating the control gear for the self-contained propulsion and braking system of said car.

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