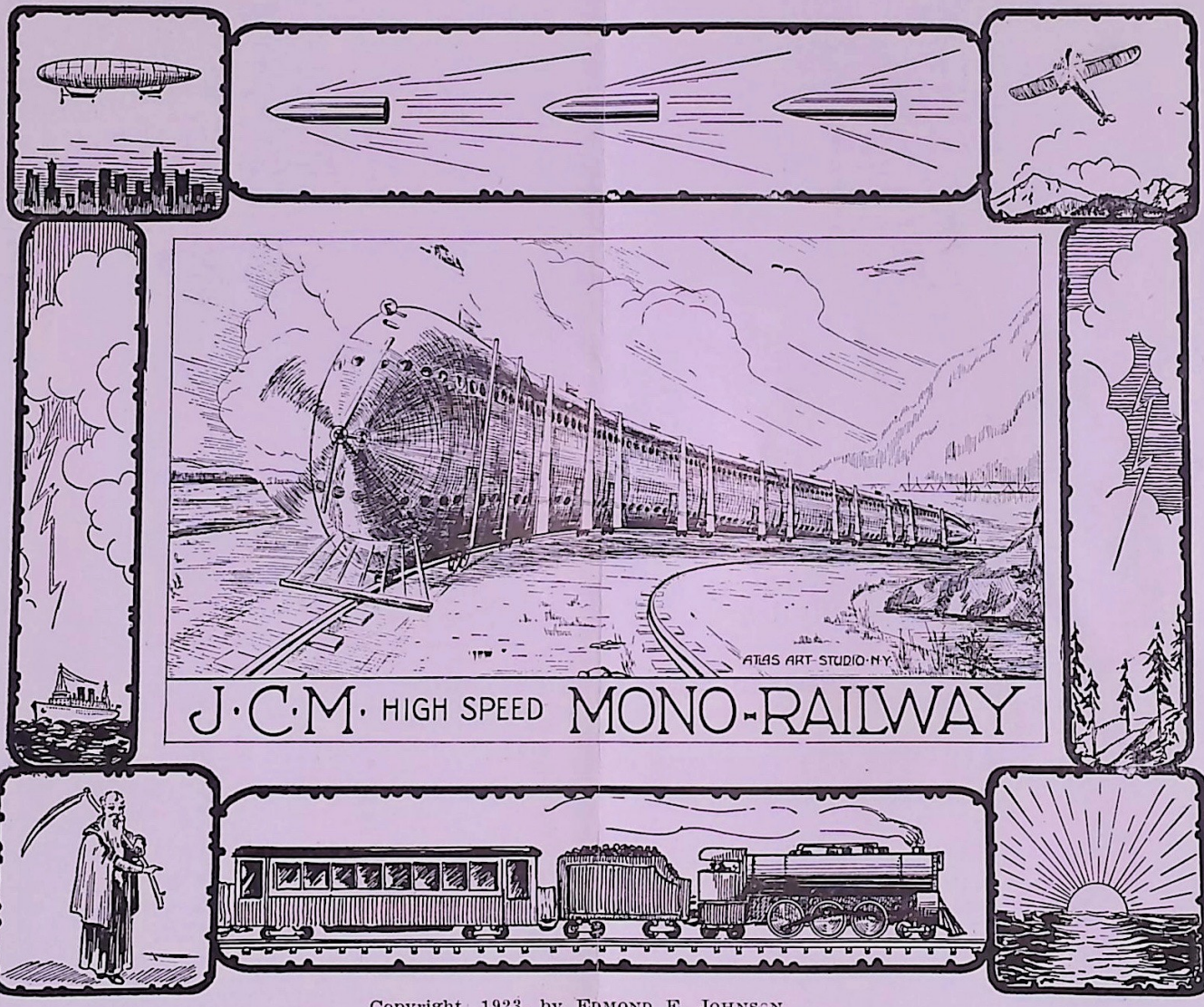
SAN FRANCISCO IN 1½ DAYS

WHAT IT MEANS TO YOU

CHICAGO IN 9½ HOURS

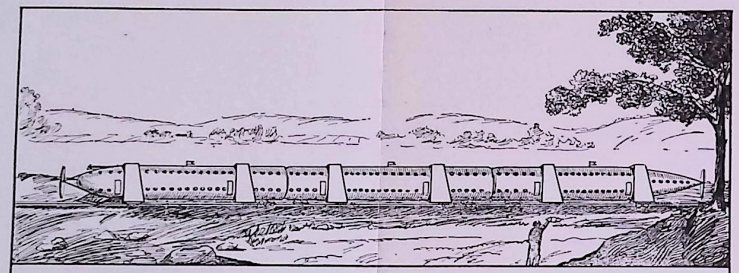


J·C·M· HIGH SPEED MONO-RAILWAY

RAILROADS for the conveyance of passengers did not exist 100 years ago, neither did electric trains 40 years ago, or automobiles 30 years ago, nor did aeroplanes 20 years ago.

The rivals which recently appeared on the horizon have already in the matter of RAPID TRANSIT left the railroads hopelessly behind; indeed, it may be said that railroads as far back as 70 or 80 years ago had attained a speed of over 80 miles per hour, which according to the railroad time tables, has not been exceeded to this day. Why? Because it becomes dangerous to run upon the twin-rail system at very high speed, not to mention the discomfort to the passengers due to shocks caused by jolts and jars arising from swaying or lateral oscillation; but this is not all.

Are the railroad engineers of to-day willing to content themselves with the speed attained by their grandfathers, while rapid transporation by more recent scientific methods has progressed by leaps and bounds? To that question there can be but one answer, for it is obvious, that the competitors already in the field have come to stay; furthermore, railroad engineers will be compelled to advance, if for no other reason than to meet competition, and they should not rest content until the railroads have regained the "Speed Record" which they held unchallenged for so many years.



J. C. M. HIGH SPEED MONO-RAILWAY

UNITED STATES PATENT NO. 1,437,183/22
ALSO FOREIGN PATENTS

The object of the J. C. M. MONO-RAILWAY is to provide RAPID TRANSIT over long distances.

Travelling will be hailed with delight, lateral oscillation will not exist, giving way to a sensation of steady gliding, and moreover, it will be SAFER because the track wheels will be locked to the MONO-RAIL; in the twin-rail system there is no such locking device to prevent derailment.

Lastly, to deal with the salient feature—RAPID TRANSPORTATION. It will be interesting to compare the railroad time table of to-day with the J. C. M. MONO-RAILWAY time table of to-morrow.

To be on the conservative side, assume a speed of 100 miles per hour (the system is good for this speed and more); the immediate effect would be a considerable reduction in the time occupied in transit. The comparative Time Table would then read:—

New York to Chicago Distance, 908 Miles	By Express Train (Twin-Rail System)	By J. C. M. Mono-Railway (Allowing 25 minutes for stops)
Lv. New York (E. T.) Ar. Chicago (E. T.)	2.55 P. M. 10.55 A. M. (20 HOURS)	12 Midnight 9.30 A. M. (9½ HOURS)
Lv. Chicago (C. T.) Ar. New York (C. T.)	12.40 P. M. 8.40 A. M. (20 HOURS)	12 Midnight 9.30 A. M. (9½ HOURS)

It will be seen by J. C. M. MONO-RAILWAY the journey is made in half the time or less. Then it will be possible for the business man, after putting in a full day (including the evening) in either city, to make the trip overnight without wasting valuable business and pleasure hours on the railroad. The longer the distance the more striking the contrast becomes, as will be seen by reference to the comparative Time Table hereunder:

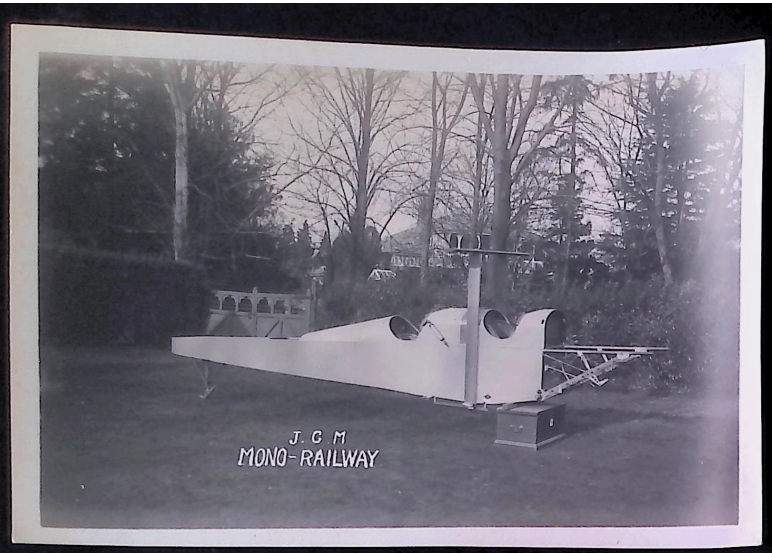
Distance 3,169 Miles	By Express Train (Twin-Rail System)	By J. C. M. Mono-Railway (Allowing 4 hours for stops)
New York to San Francisco	4 Days (96 HOURS)	1½ Days (36 HOURS)

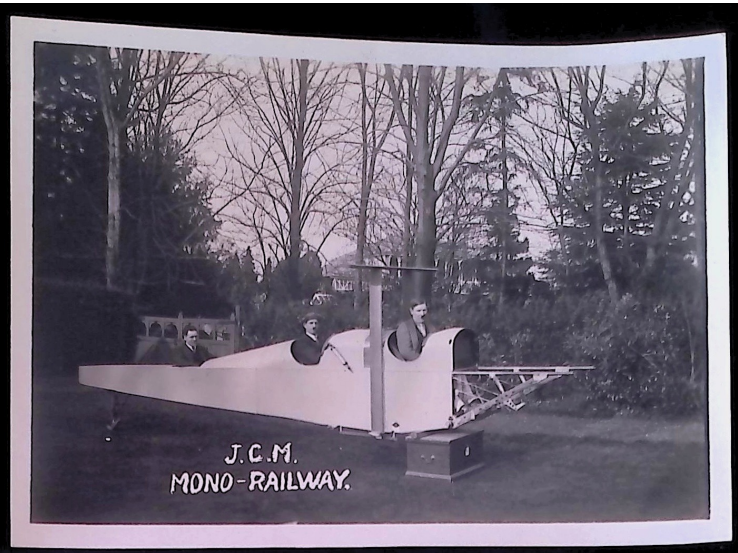
By J. C. M. MONO-RAILWAY to San Francisco, a day's business in that city and return to New York accomplished before the Express train by twin-rail system arrives at San Francisco, A SAVING OF 120 HOURS OR 5 DAYS TRAVELLING TIME. Just think what that means.

Further particulars will be furnished and appointments made on application.

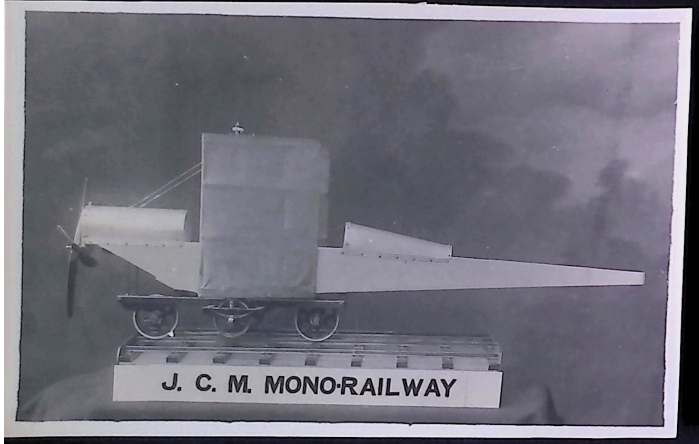
EDMOND E. JOHNSON
764 WEST END AVENUE
NEW YORK CITY
Phone: Riverside 9737

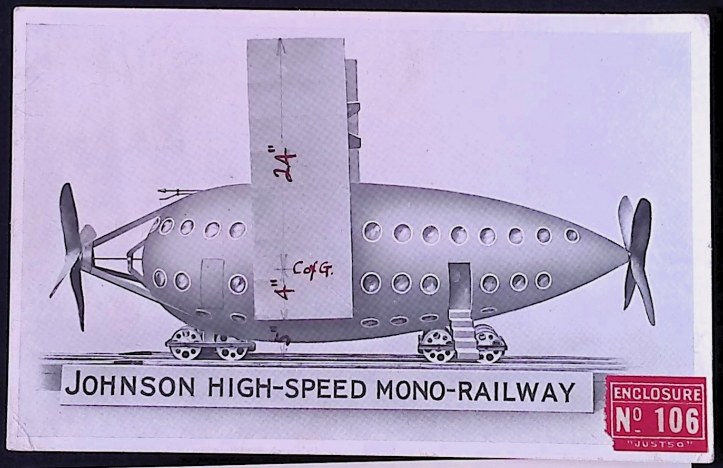
J. C. M. MONO-RAILWAY
MAIDENHEAD
ENGLAND
Phone: Maidenhead 297

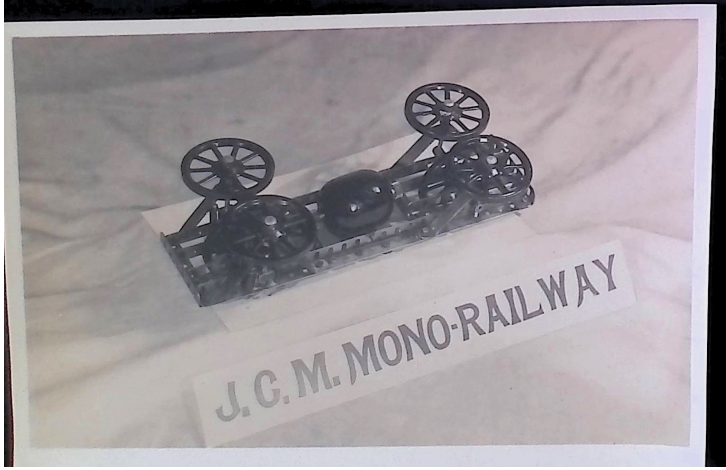

J.C.M.
MONO-RAILWAY

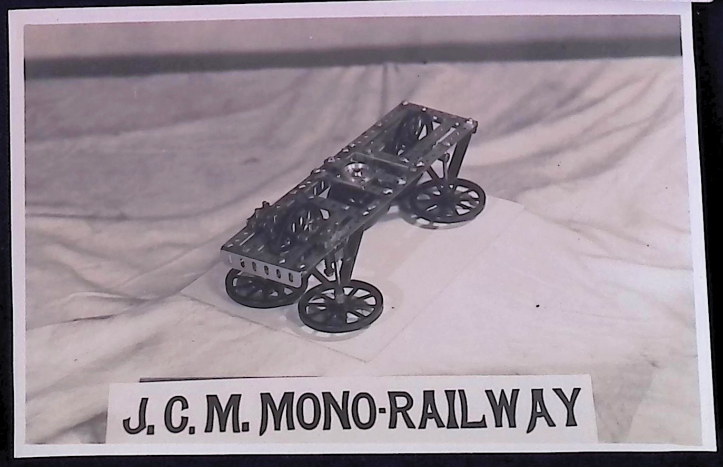

J.C.M.
MONO-RAILWAY.

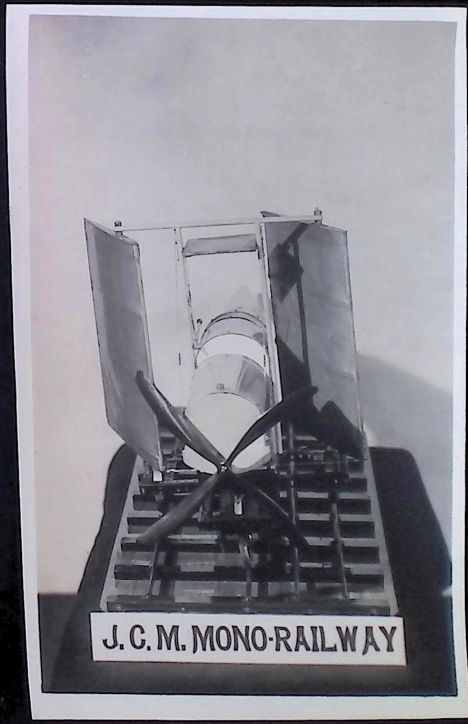

J. C. M. MONO-RAILWAY


J. C. M. MONO-RAILWAY

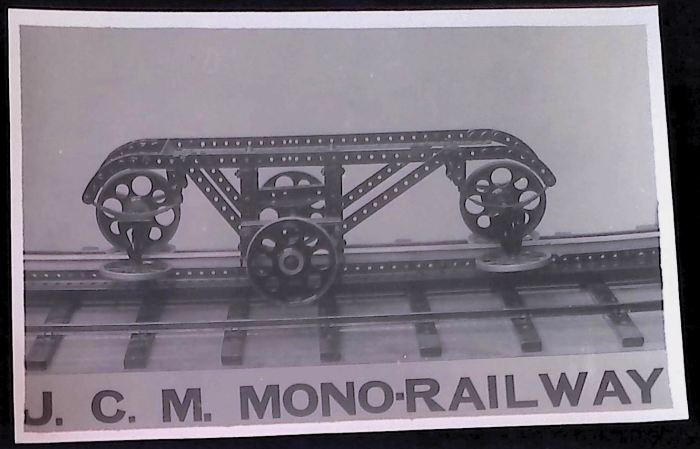

14"
4"
C of G.
JOHNSON HIGH-SPEED MONO-RAILWAY
ENCLOSURE
No. 106

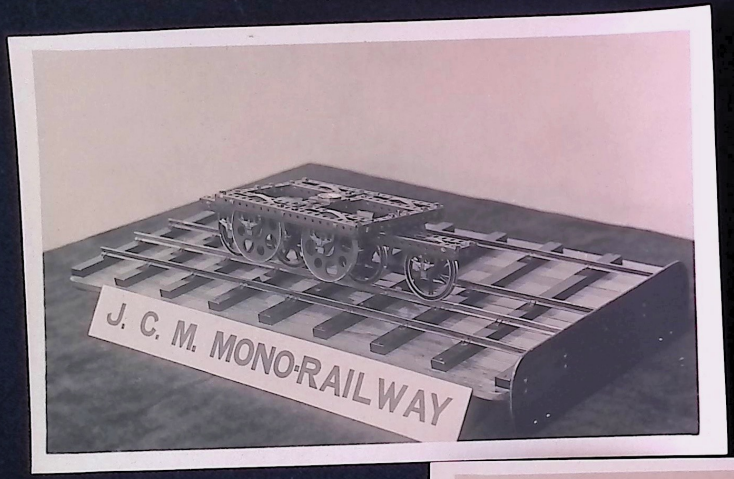

J.C.M. MONO-RAILWAY

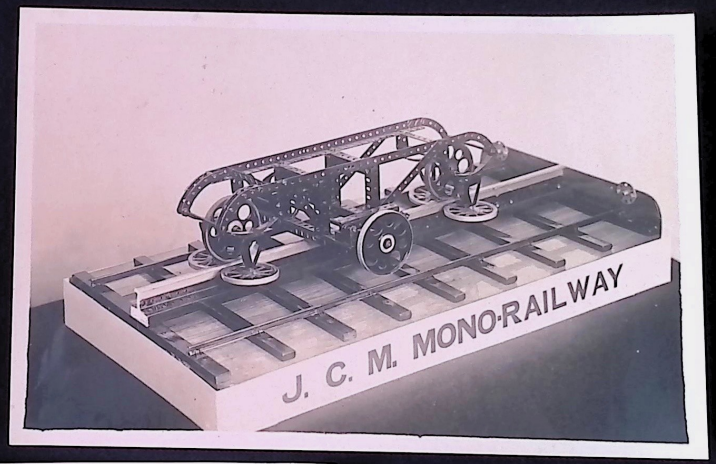

J.C.M. MONO-RAILWAY

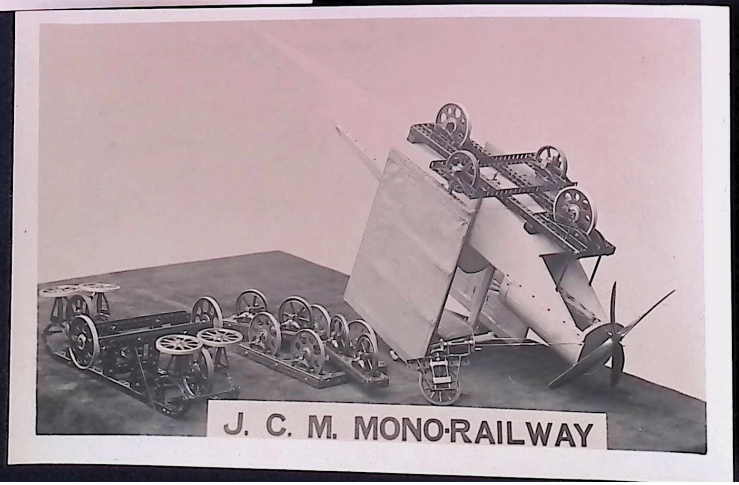

J.C.M. MONO-RAILWAY


J.C.M
MONO-RAILWAY.


J. C. M. MONO-RAILWAY


J. C. M. MONO-RAILWAY

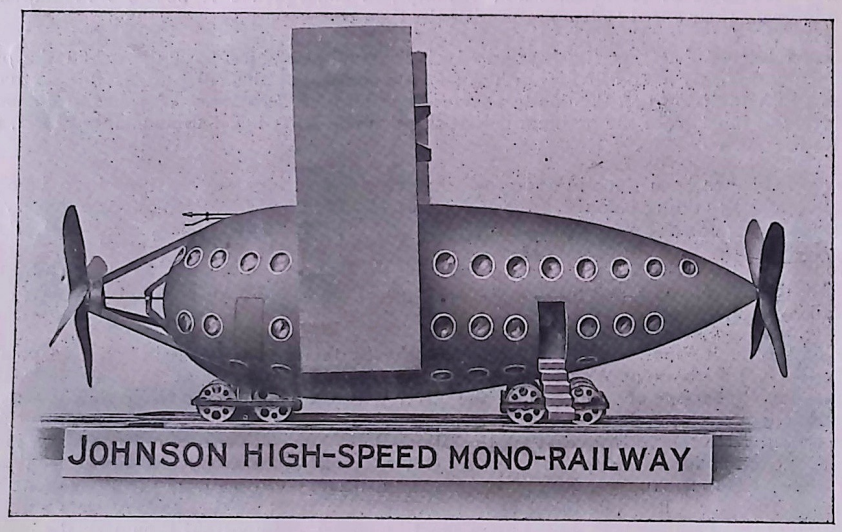

J. C. M. MONO-RAILWAY


J. C. M. MONO-RAILWAY

N MONO-RAILWAY.

PATENTS APPLIED FOR.

SPEED 100 TO 150 MILES PER HOUR.



Vehicle, Aerofoils and Pennant in normal position.

EDMOND E. JOHNSON,

MAESCOURT,
MAIDENHEAD, BERKS.

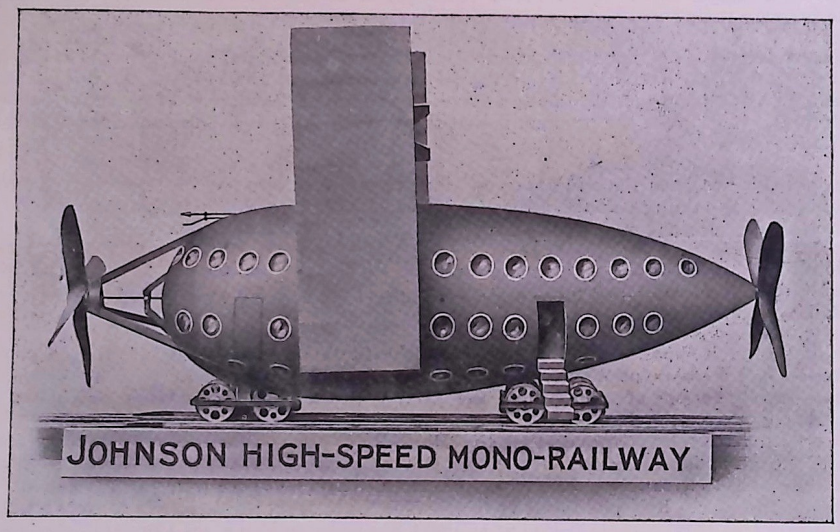
Telephone: No. 297 Maidenhead.'

1st EDITION.

JOHNSON MONO-RAILWAY.

PATENTS APPLIED FOR.

SPEED 100 TO 150 MILES PER HOUR.



Vehicle, Aerofoils and Pennant in normal position.

EDMOND E. JOHNSON,

MAESCOURT,
MAIDENHEAD, BERKS.

Telephone: No. 297 Maidenhead.'

Johnson Mono-Railway.

—SPEED—

100 TO 150 MILES PER HOUR.

BRIEF DESCRIPTION.

It is a recognised fact that present day Railways are too slow to compete with the faster forms of traffic, such for example as Aeroplanes and Airships, in consequence it becomes incumbent upon Railways to increase their speed to keep pace with the times.

It is an established fact that the best speed which can be obtained by Railways on the ordinary system (known technically as the Bi-Rail or Twin-Rail) is only about half that of Aircraft, so that if the Railway seeks to hold its own in this matter, some other form of Permanent Way has to be looked to, and the solution to this side of the problem is that same should be reduced to its simplest form, namely, the Mono-Rail.

In the past this has been done in numerous instances and various devices have been incorporated for the purpose of maintaining balance of the Rolling Stock upon the Mono-Rail, all of which have failed either from mechanical or commercial difficulties.

The Johnson Mono-Railway provides the solution to the problem, possessing all the advantages of High Speed Aircraft, while eliminating the disadvantages of same, and also the disadvantages of the slow speed Bi-Rail System.

In the first place it should be pointed out that the System advocated is in reality a compromise between the Bi-Rail Permanent Way System and the Mono-Rail, because at Railway Stations and at some distance on either side of same, where the Rolling Stock would be moving slowly, outer Track Wheels would operate on the Bi-Rail System; it is only when the Rolling Stock reaches a sufficient speed of say 50 miles per hour or over, that the Mono-Rail Track Wheels come into operation, at the point where the Bi-Rails cease to engage the Outer Track Wheels. Means have been taken (as hereinafter described) to isolate Side Wind Pressure and Centrifugal Force from the Permanent Way, and in consequence the Mono-Rail employed is of comparatively light section (for reasons stated in the Second Edition of this Pamphlet) mounted upon short Sleepers; an important Commercial consideration.

The Rolling Stock is of Semi-Streamline formation (to reduce Air Resistance), the maximum height of same being about double the maximum width, thereby affording accommodation for 2 Floors available for Passengers, and in addition the space below the lower floor can be utilised for Driving and other Mechanical apparatus.

Aerofoils are mounted vertically on either side of the Vehicle, having a variable angle of Incidence (for the purpose of counteracting the effects of Side Winds, Centrifugal Force, or Gravity), provided also with variable and reversible Camber (to attain the best efficiency according to the Speed) and whose centres of pressure are coincident laterally with that of the Vehicle.

These Aerofoils serve the purpose of preserving lateral balance under the most efficient conditions when the Vehicle is moving at speed, and are subsequently described in detail.

In order to reduce friction as far as possible, a special form of Track Wheel has been constructed whereby Flange Friction is eliminated, and in addition all Wheels are run on Ball or other anti-friction Bearings. Further details will be found under the heading of *Bogies* to be dealt with later on.

It may be stated generally that any form of Drive may be installed either, as for example, Track Wheel Drive or Track Wheel Drive used in combination with Air Propeller Drive, the drive being effected either electrically, by internal combustion engine or other motive power, but as the weight factor is an important item, the internal combustion engine has the advantage on this point.

In the case of an Aeroplane it should be borne in mind that 25% of the power is absorbed in keeping it in the air, whilst only 75% of power is left for propulsion, whereas with the Johnson Mono-Rail Vehicle this lost 25% of the power is available for useful propulsion, it follows in the matter of speed that the advantage would lie with the Johnson Mono-Rail System.

In regard to the COMMERCIAL side.

1. The PERMANENT WAY would cost less:—

(a) Because it is intended to follow as far as possible the contour of the country, thus reducing the cost of Cuttings and Embankments to a minimum.

(b) The Track would cost less because only one Rail of light construction would be required (only comparatively short lengths of double Track being called for at Railway Stations), moreover the Sleepers upon which the Mono-Rail is mounted are only half the usual length.

(c) Ordinary Platforms are not required, as Staircases will be lowered from the Vehicle at Railway Stations, discharging Passengers at ground level, or miniature Platforms can, if desired, be provided for the convenience of handling Passengers' luggage.

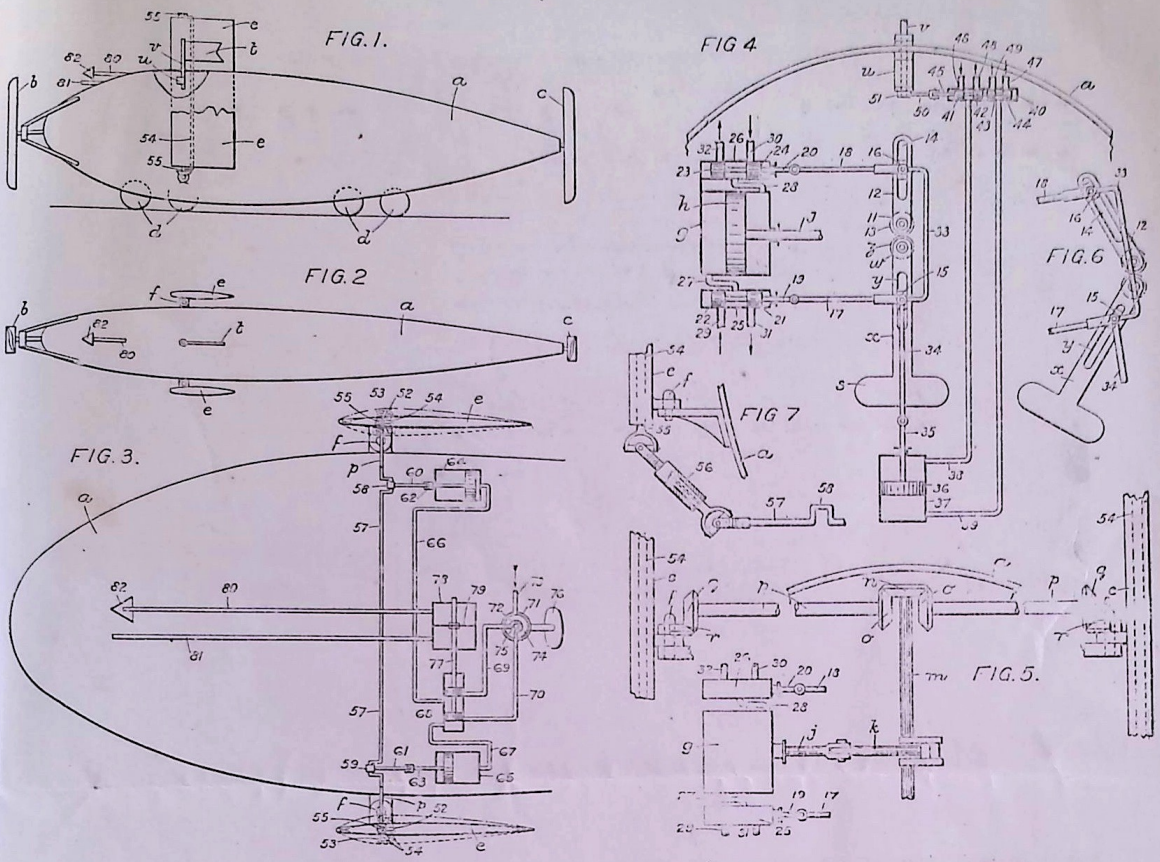
2. The ROLLING STOCK. This being built upon aeroplane lines is of essentially light construction. Each vehicle is a self-contained unit carrying its own motive power and having accommodation for one ~~or~~ two hundred passengers, and as it travels twice as fast as an ordinary railway train of the same capacity it carries double the number of passengers in a given time, and hence the saving under this heading would be considerable.

3. WORKING EXPENSES. Here again a considerable saving is effected, as the time occupied for a given journey would be just half that of an ordinary train, consequently the working expenses, so far as labour is concerned, would be about half. Other Working Expenses will depend upon the motive power adopted, which will be governed by the local conditions prevailing.

4. CAPITAL OUTLAY. The cost of installing the JOHNSON MONO-RAIL SYSTEM would be very much less than that of any other, the Permanent Way, Railway Stations and Rolling Stock all costing less.

THE JOHNSON MONO-RAILWAY CAN IF DESIRED BE ADDED TO AN EXISTING TWIN-RAIL SYSTEM.

The Second Edition of this Pamphlet giving further details and explanation of Drawings ~~appearing on Page 5,~~ will be furnished on application to those interested.



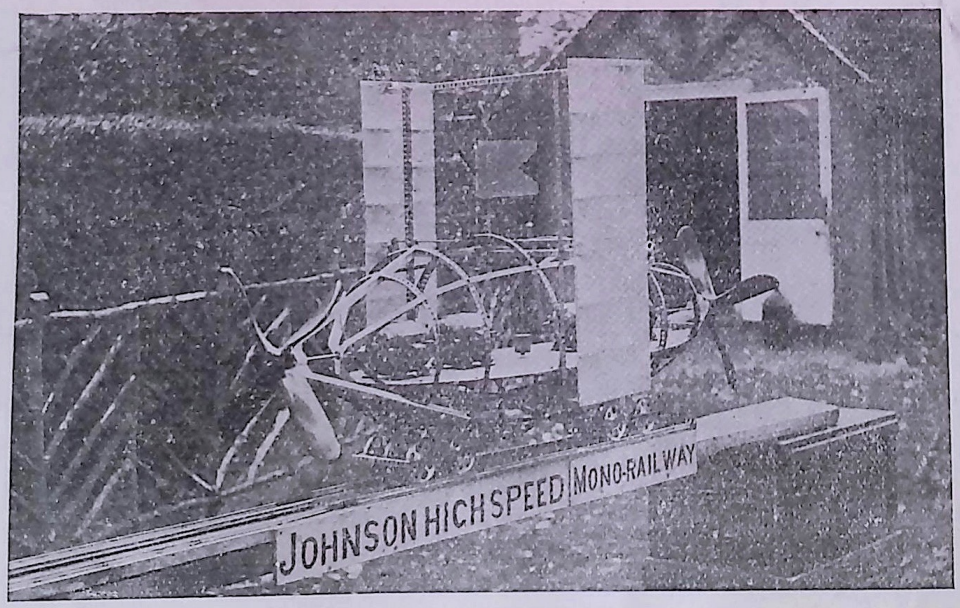


Fig. 8. Vehicle in normal position at Stations, without Shell, showing Pennant, Pendulum and Aerofoils all in normal position.

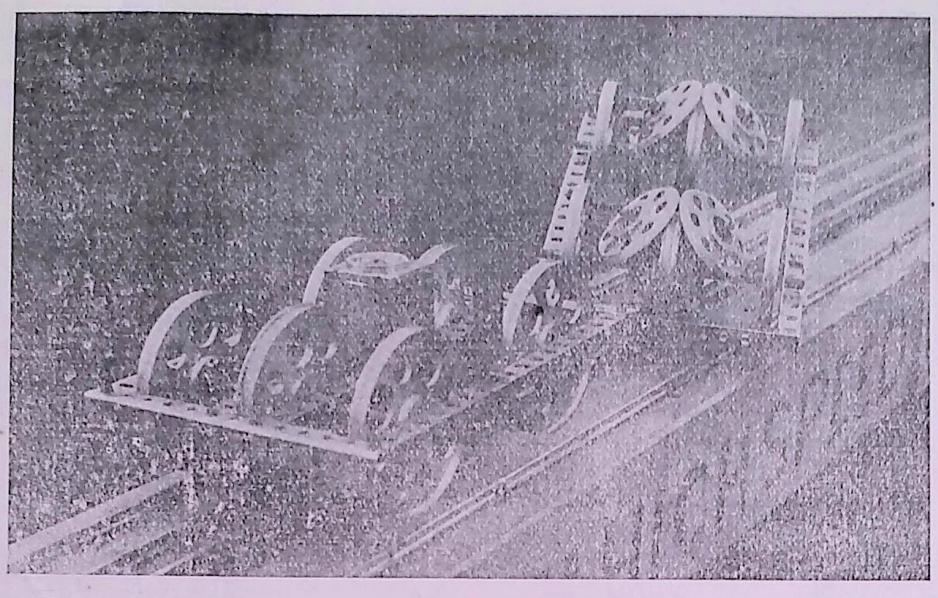


Fig. 9. **BOGIES.** The one in the background inverted to illustrate Pilot Wheels.

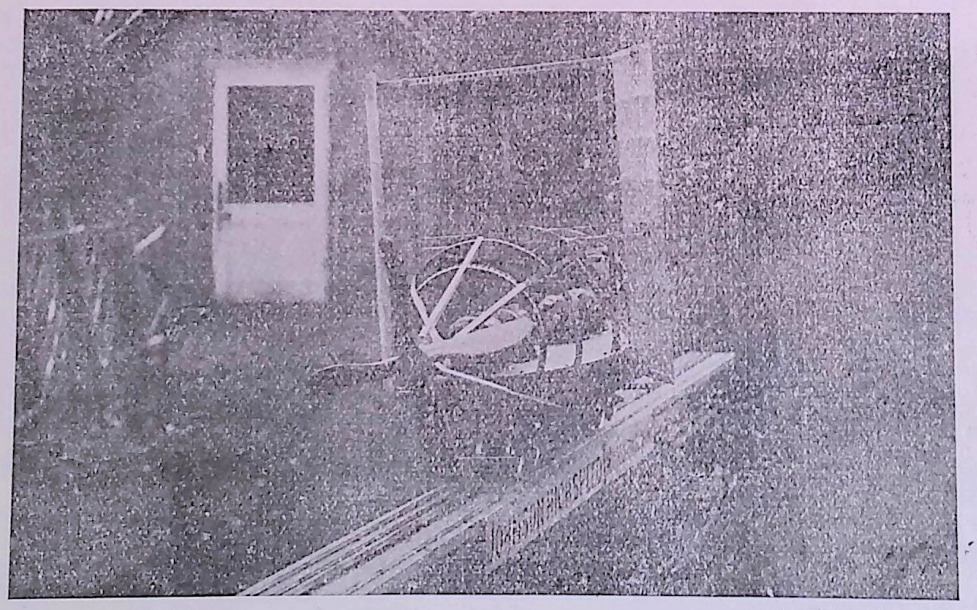
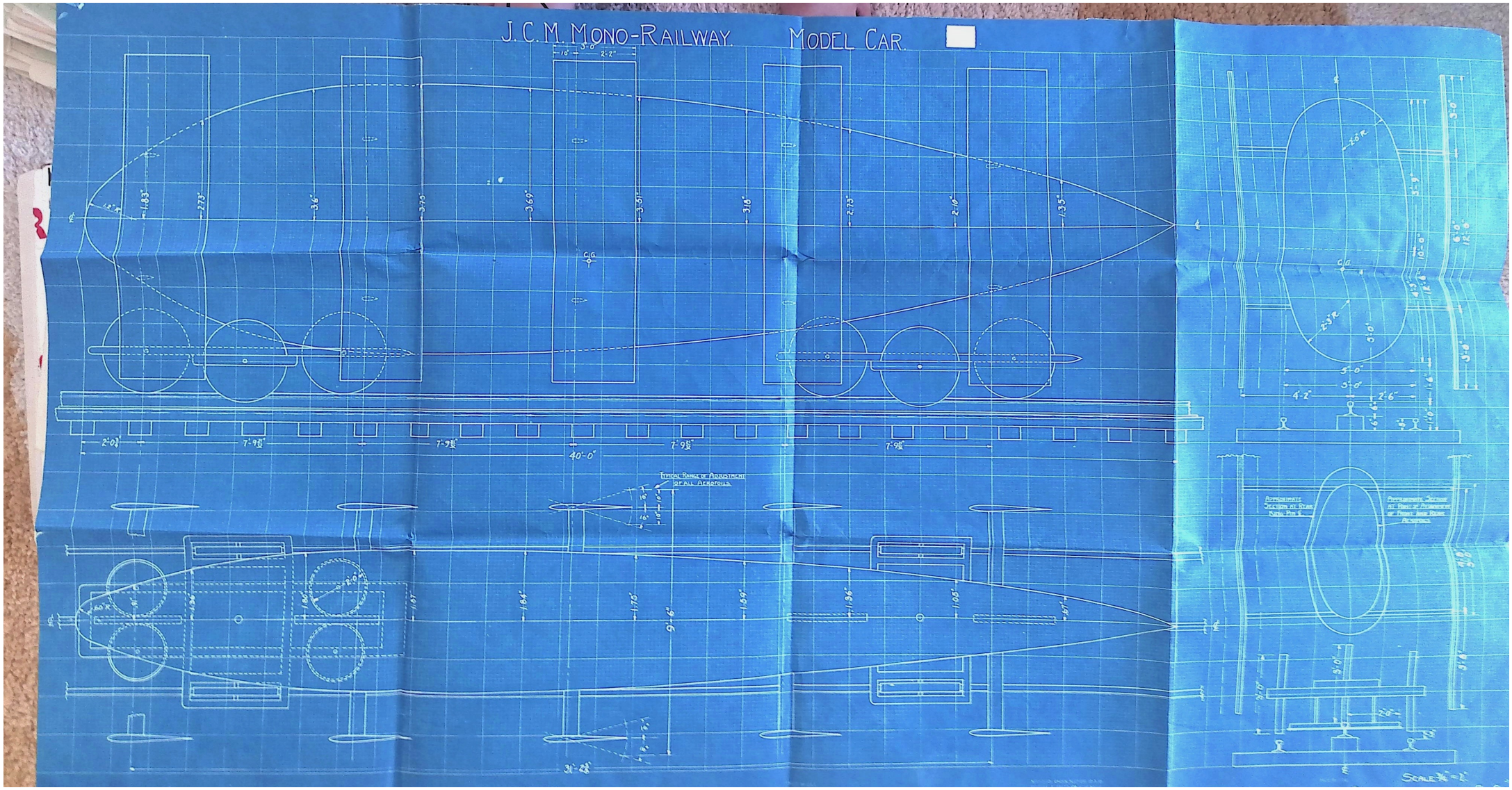


Fig. 10. **Vehicle without Shell at Starboard cant upon Mono-Rail with Aerofoils automatically set by Pendulum to carry the Vehicle over from Starboard to Port.**

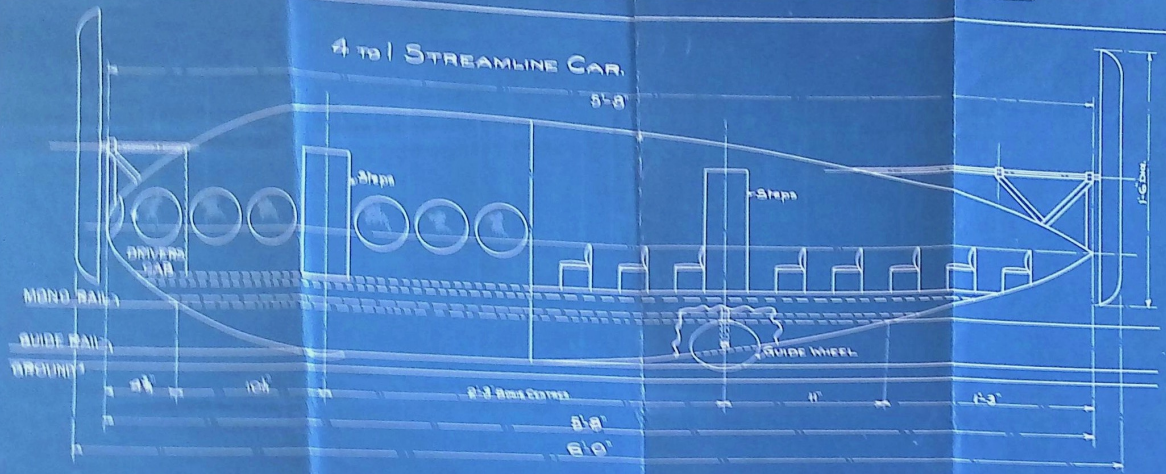

J.C.M. MONO-RAILWAY. MODEL CAR.
40'-0"
TYPICAL RANGE OF ANGLE OF ATTACK FOR ALL AEROFOILS
SCALE ½" = 1'

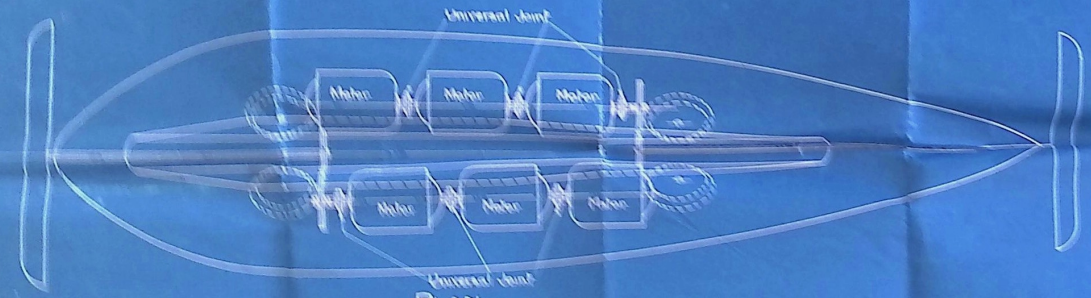
Johnson Mono Railway.

Rolling Stock Bogies and Permanent Way.

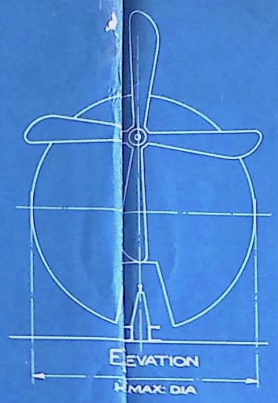
ENCLOSURE No. 930

4 to 1 Streamline Car.



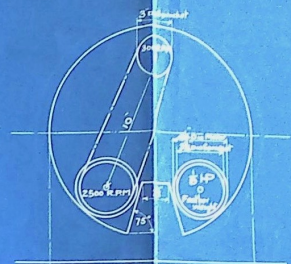


Plan

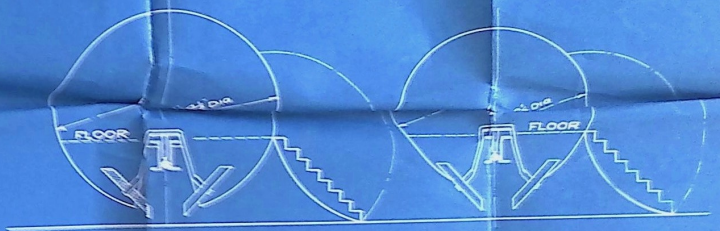


Elevation

Max. Dia



Section at fore Ring of after Bogie.

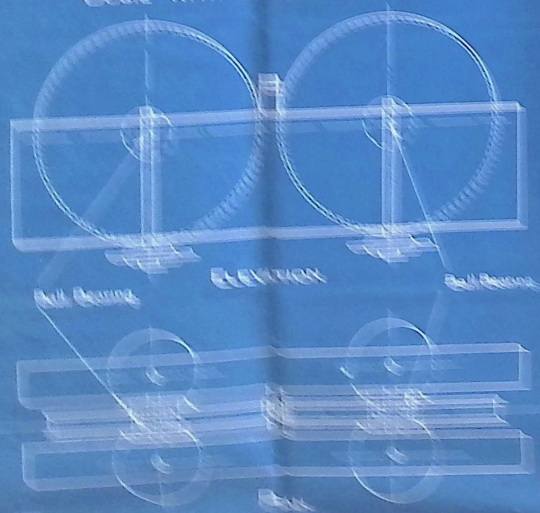


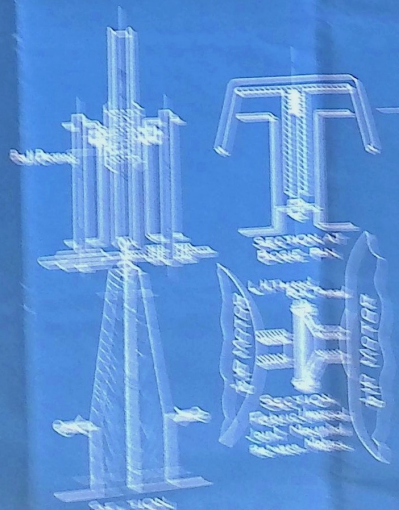
Nose Bogie Section at King Pin.

Tail Bogie Section at King Pin.

Scale 3=1 Foot.

Bogie with Track and Pilot Wheels.

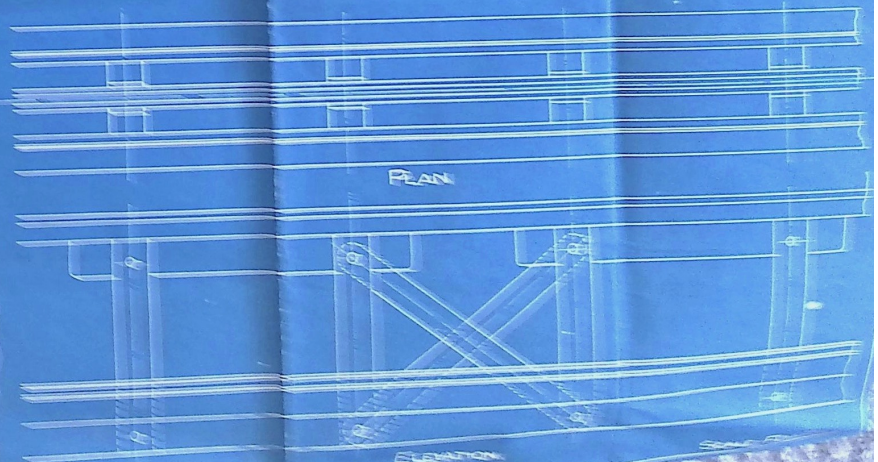




Side View

Bogie with Track and Pilot Wheels.

Permanent Way.



Plan

Elevation

Johnson's COMPLETE SPECIFICATION (2 SHEETS) SHEET 1

TRUE COPY

Fig. 1

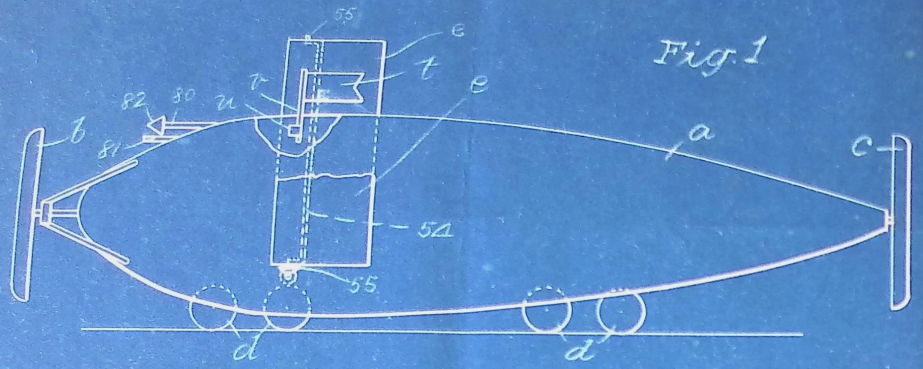


Fig. 2

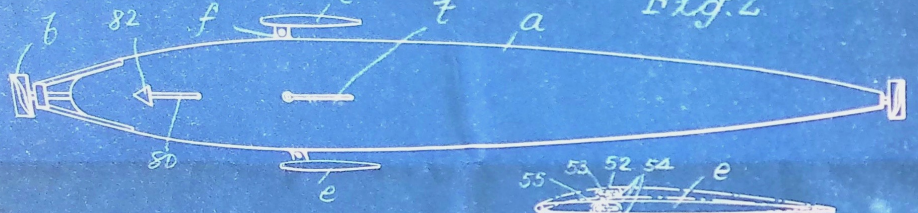
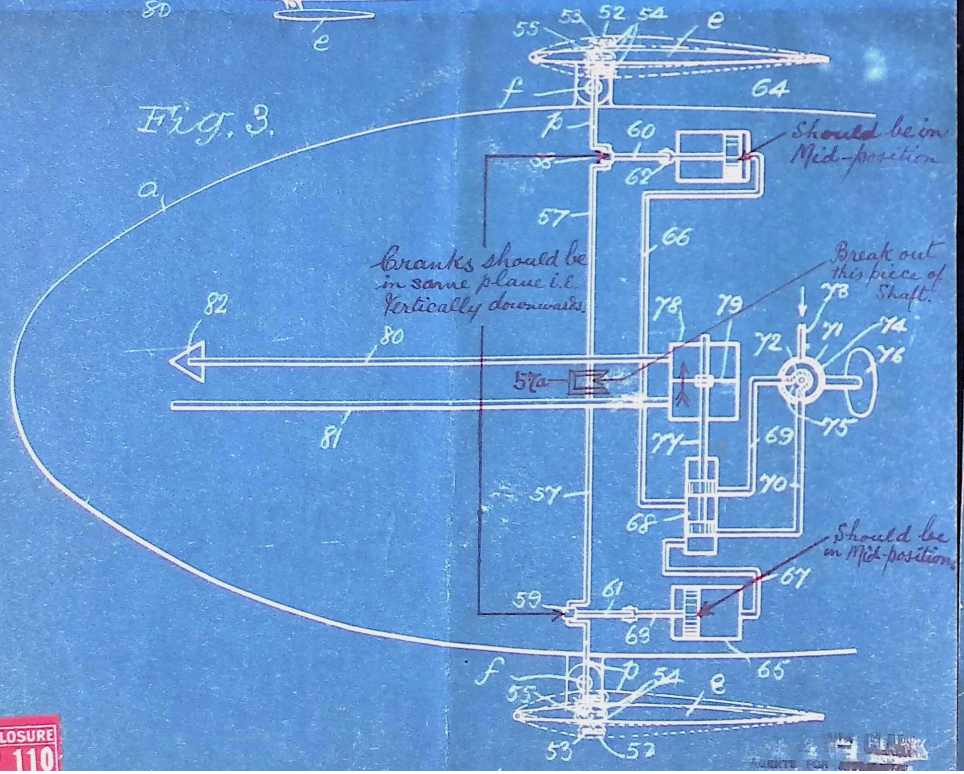


Fig. 3.



Johnson's COMPLETE SPECIFICATION (2 SHEETS) SHEET 2

TRUE COPY

Fig. 4

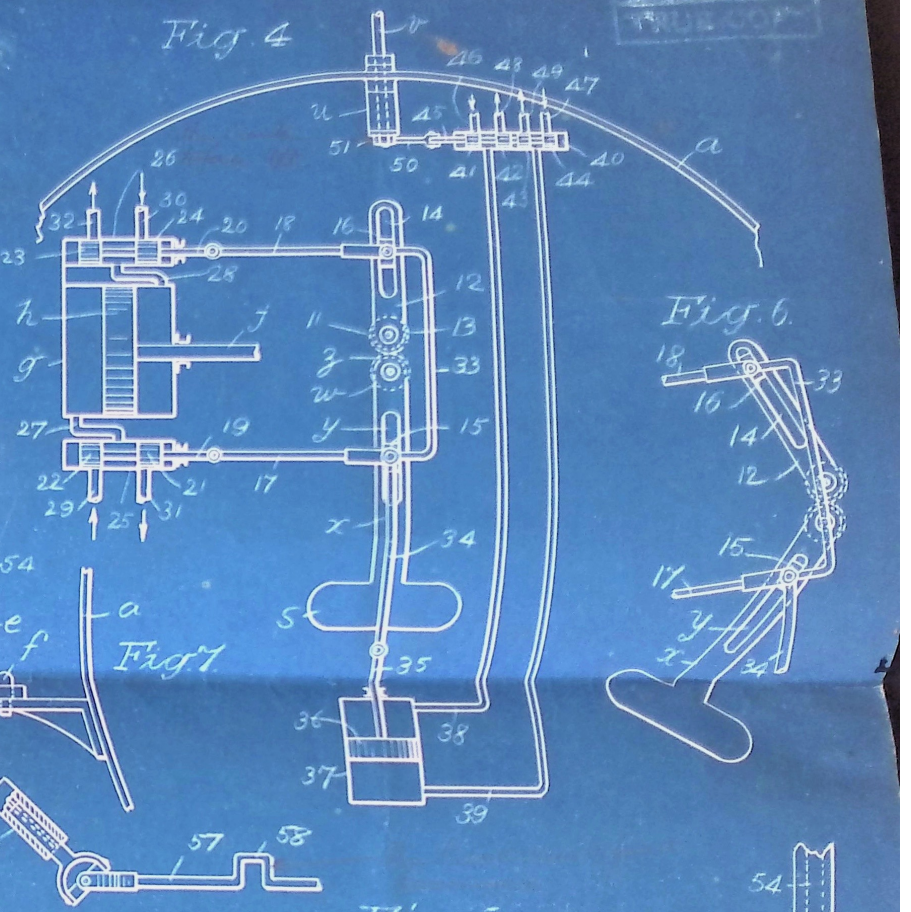
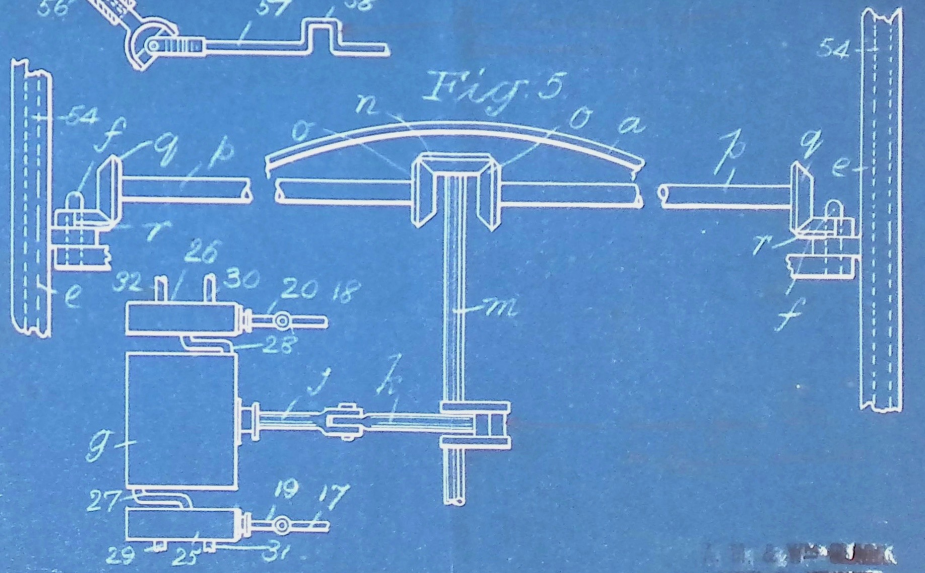


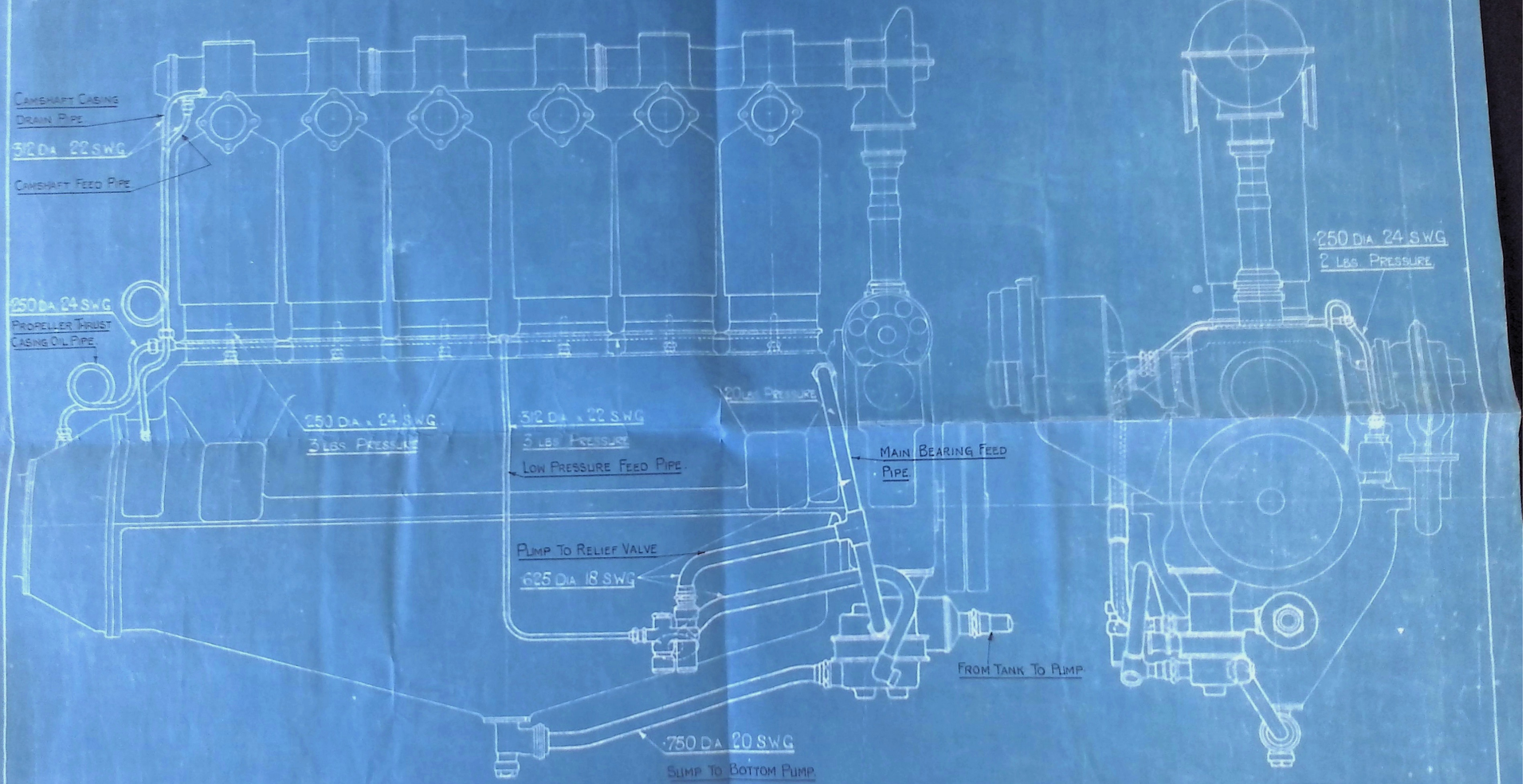
Fig. 6.

Fig. 5



ENCLOSURE No. 110

E.1668S

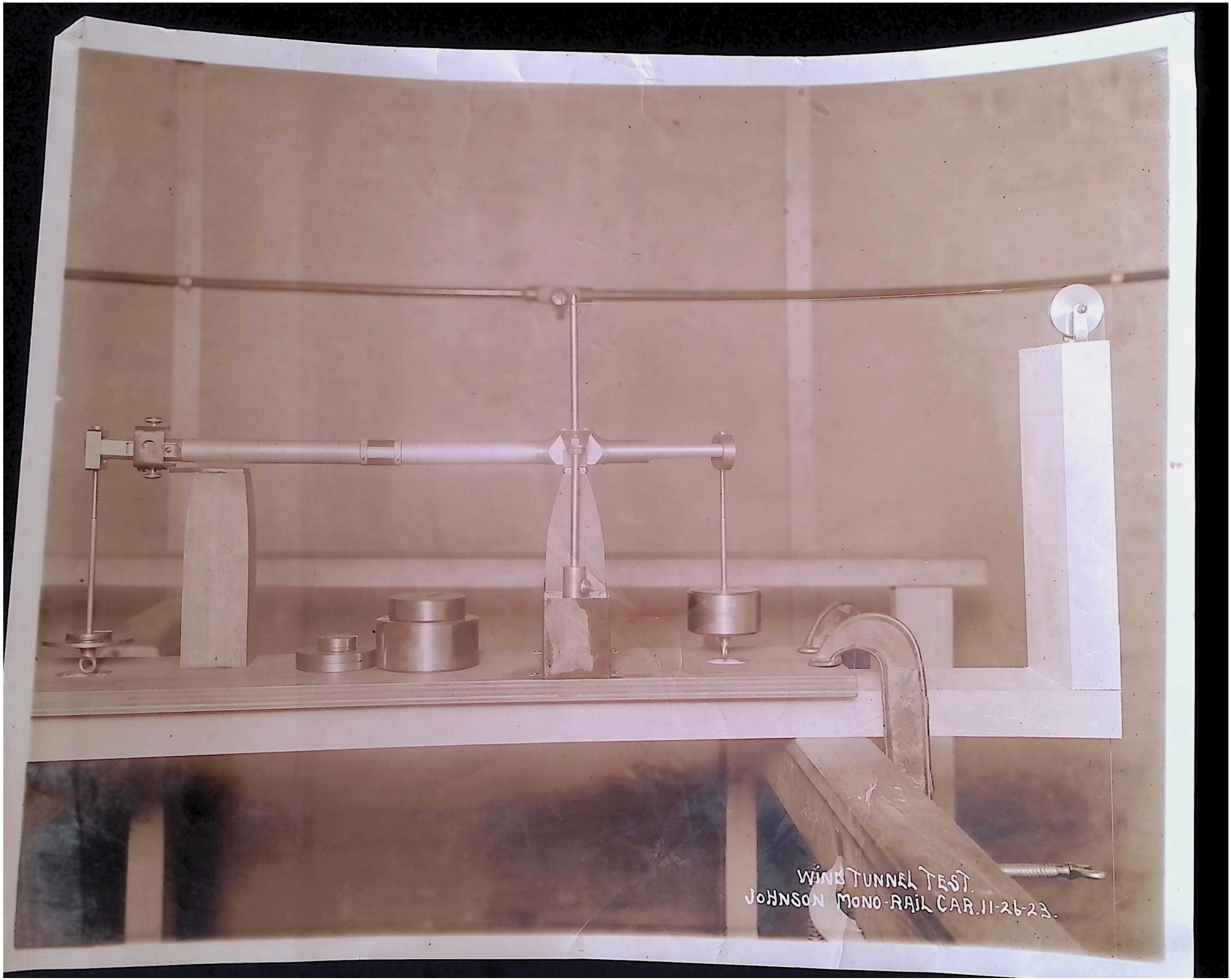


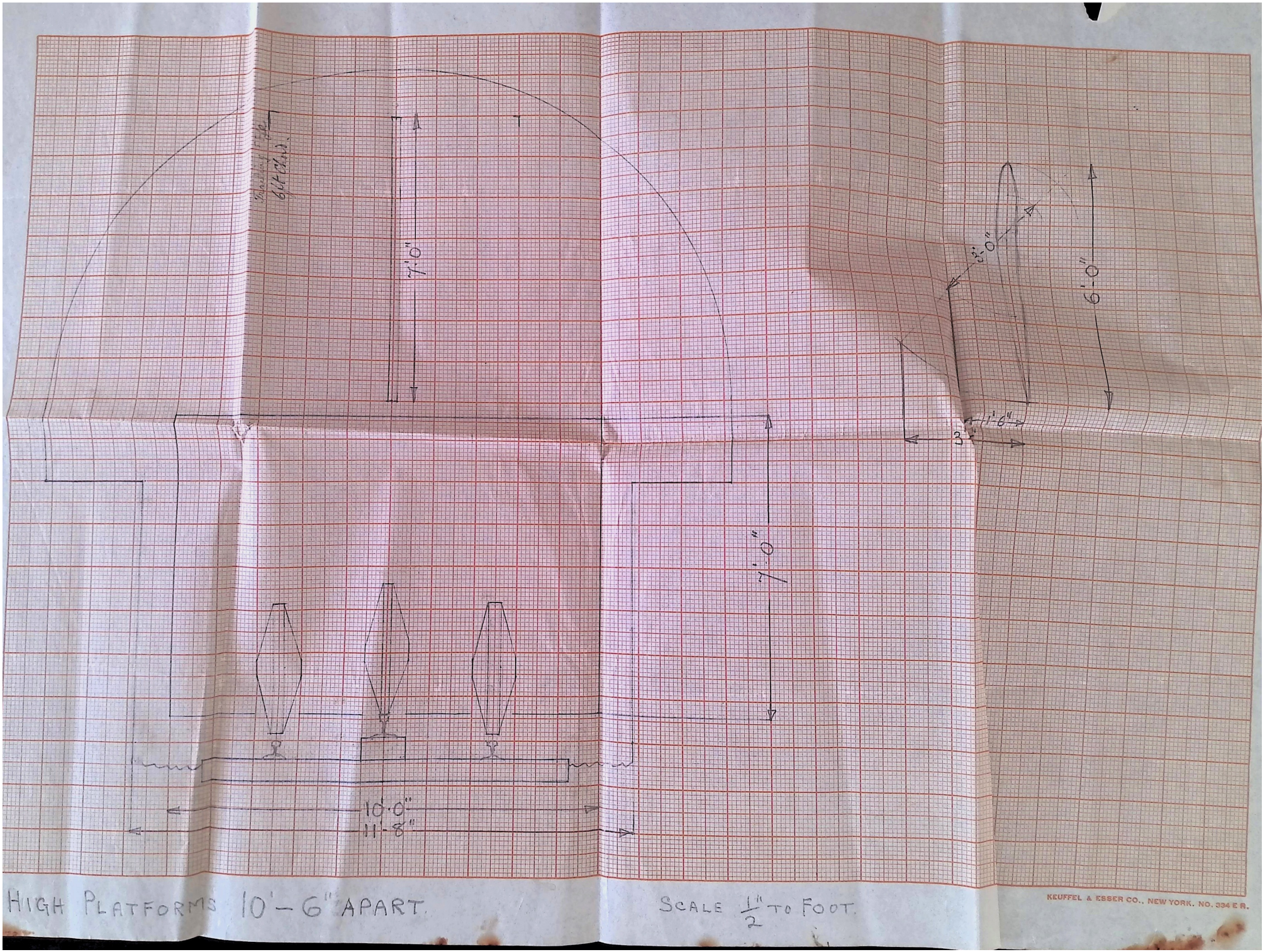
E.L.

26-10-17

Arrangement of Hawk Engine.

E.1668S


WIND TUNNEL TEST.
JOHNSON MONO-RAIL CAR. 11-26-23.



HIGH PLATFORMS 10'-6" APART.

SCALE $\frac{1}{2}$" TO FOOT.

E. E. JOHNSON.

MEANS FOR STABILIZING MOVING BODIES.

APPLICATION FILED NOV. 15, 1921.

1,437,183. Patented Nov. 28, 1922.

2 SHEETS—SHEET 2.

FIG. 4.

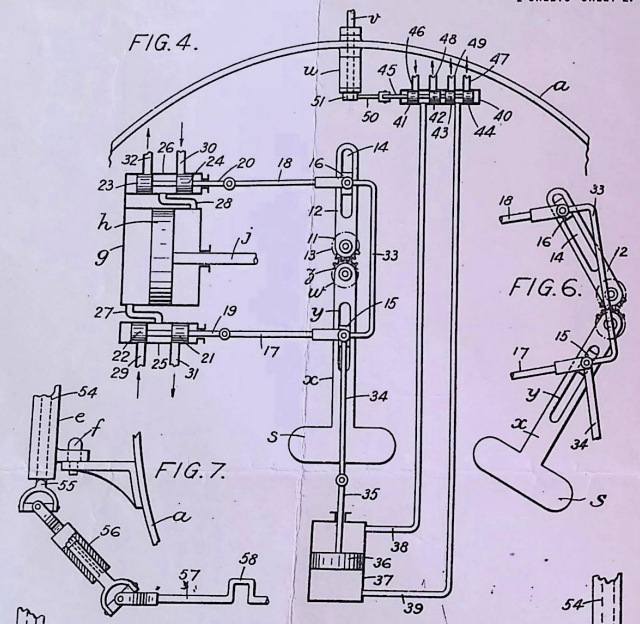
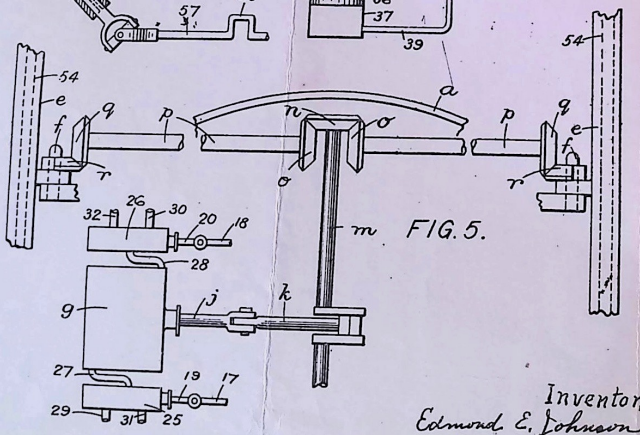


FIG. 6.

FIG. 7.

FIG. 5.



Inventor,
Edmund E. Johnson
by H. H. Lockwood
Attorney.

E. E. JOHNSON.

MEANS FOR STABILIZING MOVING BODIES.

APPLICATION FILED NOV. 15, 1921.

Patented Nov. 28, 1922.

2 SHEETS—SHEET 1.

1,437,183.

FIG. 1.

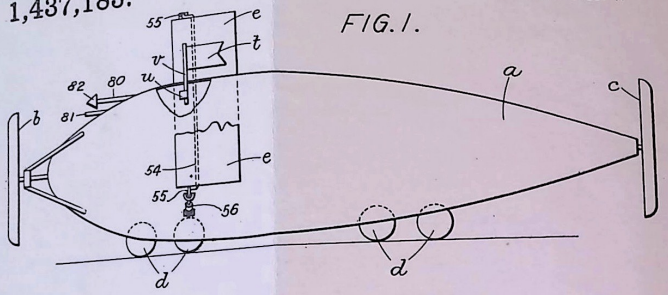


FIG. 2.

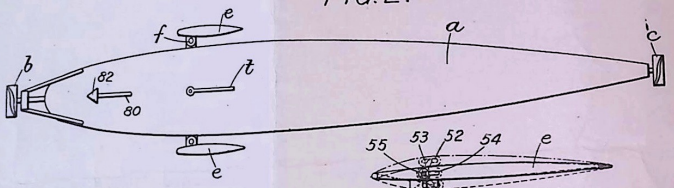
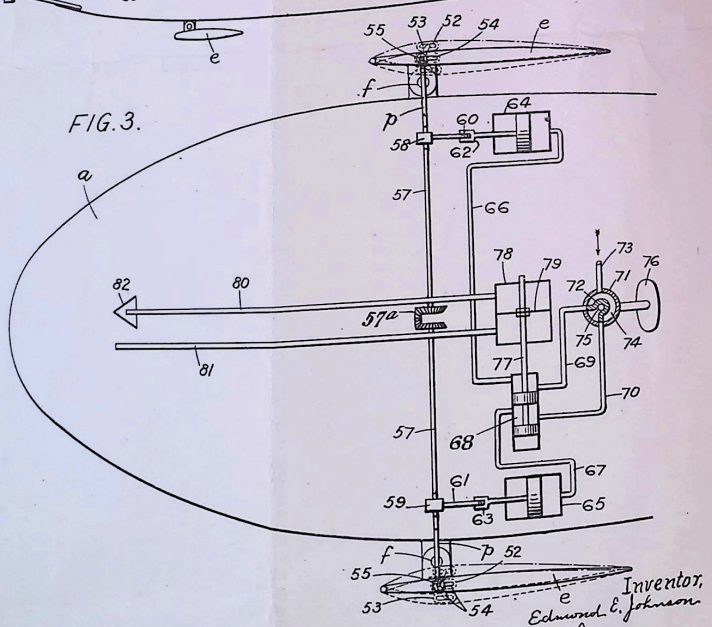


FIG. 3.



Inventor,
Edmond E. Johnson
M. H. Lockwood Attorney.

Patented Nov. 28, 1922.

1,437,183

UNITED STATES PATENT OFFICE.

EDMOND ERNEST JOHNSON, OF MAIDENHEAD, ENGLAND.

MEANS FOR STABILIZING MOVING BODIES.

Application filed November 15, 1921. Serial No. 515,217.

To all whom it may concern:

Be it known that I, EDMOND ERNEST JOHNSON, of Maescourt, Maidenhead, in the county of Berks, England, a British subject, have invented certain new and useful Improved Means for Stabilizing Moving Bodies, of which the following is a specification.

This invention relates to means for neutralizing forces acting laterally in a horizontal plane such, for instance, as centrifugal force or the effects of side winds, on a moving monorail vehicle.

According to this invention a monorail vehicle body is provided on each side with an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

Each aerofoil is adapted to exert, when the monorail vehicle body is in motion through the air, a lateral force adapted to counteract a lateral force such as the centrifugal action set up when rounding a curve or the effect of a side wind, and for the purpose of counteracting such force as closely as possible each aerofoil may be set by hand, both with regard to its angle of incidence and with regard to its camber, but preferably automatically acting means would be provided to attain these ends. For instance, a servo-motor may be employed for varying the angle of incidence of the aerofoils, to the one side or the other, to counteract centrifugal force in rounding a curve the valve chests for permitting the servo-motor to operate, in the one direction or the other, being controlled by a pendulum and a correspondingly moving arm geared thereto, whilst a servo-motor controlled by a pennant may be employed, in conjunction with the pendulum-controlled servo-motor, for a like purpose to counteract the effect of a side wind, and a servo-motor controlled by an aero-static device may be employed for varying the camber of the aerofoils to maintain the latter at their most efficient configuration according to the speed at which the monorail vehicle body is moving. The aerofoils are operated simultaneously and in the same direction so that when their angle of incidence is varied the force acting on the one would tend to push, and the force acting on the other would tend to pull, the vehicle body towards the inner side of the curve.

The aerofoils should be mounted so that their centres of pressure lie in or near the transverse vertical and horizontal planes in which lie the centre of gravity of the vehicle and the means for varying their angle of incidence and camber may be of any known type as used on aeroplanes. By the use of aerofoils as set forth above a component of the resistance presented by each counteracts the laterally acting centrifugal or wind force.

If desired, and for the preservation of balance, when the vehicle body or bodies is or are moving at speed, one or more additional aerofoils may be provided and mounted on each body so that the angle of incidence of each aerofoil is variable about an axis passing through the centre of gravity of the respective body. When more than one additional aerofoil is employed on a body, they may be operated simultaneously but may act in conjunction with each other thereby displacing a volume of air, on each side of the moving vehicle body of sufficient mass to maintain lateral rolling equilibrium. Their controls may also be operated automatically through forces acting from the body at the point or points of contact with the supporting medium.

In addition to the stabilizing effects which may be obtained the aerofoils may also be actuated so as to operate as brakes.

The accompanying drawings illustrate diagrammatically one method of carrying out the invention: Fig. 1 being a side elevation of a monorail vehicle, parts being broken away, and Fig. 2 being a plan thereof. Fig. 3 is a plan on a larger scale of the means for varying automatically the camber of the aerofoils, Fig. 4 is a transverse sectional elevation on a still larger scale of means for varying the angle of incidence of the aerofoils. Fig. 5 is a similar view of another portion of the means shown in Fig. 4, which portion has been omitted from Fig. 4 for the sake of clearness whilst a servo-motor and its valve chests are shown in both Fig. 4 and Fig. 5 to

facilitate comprehension of the relationship of the different parts; Fig. 6 is a detail view showing the pendulum and its associated parts in positions different from those shown in Fig. 4, wh lst Fig. 7 is a sectional elevation on a still larger scale showing a detail of the means illustrated by Fig. 3.

As shown in Figs. 1 and 2, a monorail vehicle has a semi-streamline body *a* and is provided with tractor and pusher propellers *b* and *c* and track wheels *d*. At each side of the body *a* an aerofoil *e* is mounted so that its angle of incidence may be varied about a vertical axis *f* situated near its leading edge, such variation being effected automatically by a servo-motor *g*, which is shown in both Figs. 4 and 5 and the piston *h* of which is connected by its piston rod *j* and a connecting rod *k* with a vertical crank shaft *m* at the top of which is a bevel wheel *n* meshing with bevel wheels *o*. *o*, each on a shaft *p* projecting through the body *a* near its top and at the opposite end of which is a bevel wheel *q* meshing with a bevel quandrant *r* secured to the frame of the aerofoil *e* so that movement of the piston *h* either way from the mid-position shown in Fig. 4 will vary the angle of incidence of the aerofoils *e*. *e*. in the one direction or the other.

The servo-motor *g* is controlled by a pendulum *s* within the body *a* which pendulum is subjected to centrifugal force, whilst the action of the pendulum may be modified by a pennant *t* situated outside and above the body *a*, in the vertical plane of the track wheel *d* . . . and above the widest part of the body *a* which pennant is subjected to the action of side winds and is balanced against centrifugal force by a bob weight *u* mounted on the opposite side of its spindle *v* and within the body *a* and of the requisite mass depending upon the distances of its centre of gravity from the axis of the spindle *v*. In Fig. 1 the upper portion of the nearer aerofoil and part of the body *a* are broken away showing the pennant *t*, its bob-weight *u* and its spindle *v* in full lines.

The pendulum *s* is pivoted at *w* as high as possible and vertically above and parallel with the longitudinal axis of the body *a* and its arm *x* is slotted as at *y* and formed at its upper end with a toothed quadrant *z* meshing with a corresponding toothed quadrant 11 formed at the lower end of an arm 12 pivoted at 13 and slotted as at 14. In the slots *y* and 14 are mounted slide blocks 15 and 16 united by connecting rods 17 and 18 with the piston rods 19 and 20 of piston valves 21, 22 and 23, 24 situated in valve chests 25 and 26 respectively. The valve chests 25 and 26 communicate from the middle of the length of each with opposite ends of the cylinder of the servo-motor *g* by pipes 27 and 28 and the piston valves 22 and 24 normally close the inlet pipes 29 and 30 to, whilst the piston valves 21 and 23 normally close the exhaust pipes 31 and 32 from, the valve chests 25 and 26, it being understood that the inlet pipes 29 and 30 are connected with a suitable supply of fluid under pressure (not shown) whilst the exhaust pipes 31 and 32 are led away to a convenient location.

As the pendulum *s* swings to the one side or the other the arm 12 is moved correspondingly and the connecting rods 17 and 18 and valve rods 19 and 20 are moved in the same direction, so that either the inlet pipe 29 and the outlet pipe 32 or the inlet pipe 30 and the outlet pipe 31 are uncovered and fluid under pressure is admitted to the one side, and exhausted from the other side, of the piston *h*, which is consequently moved in the one direction or the other to vary the angle of incidence of the aerofoils *e*. *e*. as hereinbefore set forth.

The slide blocks 15 and 16 are united by a yoke 33, which is in turn united by a connecting rod 34 with the piston rod 35 of the piston 36 of a servo-motor cylinder 37, the opposite ends of which communicate by pipes 38, 39, with a valve chest 40 in which are disposed four piston valves 41, 42, 43, 44, on a valve rod 45. The piston valves 41 and 44 normally close inlet pipes 46 and 47 to, and the piston valves 42 and 43 normally close exhaust pipes 48 and 49 from, the valve chest 40, and the valve rod 45 is united by a connecting rod 50 with a crank 51 (with which may be combined the bob-weight *u*) on the spindle *v* of the pennant *t*, so that as the spindle *v* turns in the one direction or the other as a result of the action of a side wind on the pennant *t* the valve rod 45 is acted upon to cause the inlet pipe 46 and outlet pipe 49 or the inlet pipe 47 and the outlet pipe 48, to be uncovered thus admitting fluid under pressure by way of the pipe 38 or the pipe 39 to one side of the piston 36 in the servo-motor cylinder 37 and exhausting fluid from the other side of said piston by way of the pipe 39 or the pipe 38, according as the wind acts upon the pennant from the one side or the other.

Movement of the piston 36 in the servo-motor cylinder 37 causes the blocks 15 and 16 to be slidden up or down in the slots *y* and 14 thus varying the leverage of the action of the pendulum *s* on the valve rods 19 and 20 as shown in Fig. 6 and modifying the valve opening to correspond with the algebraic sum of the pendulum and pennant movements, *i. e.* the valve opening which should result from a given amount of centrifugal action on the pendulum *s* may be augmented or decreased, as a result of wind action on the pennant *t*. That is to say if the monorail vehicle body *a* be rounding a curve to the right centrifugal action will cause it to lean to the left and the pendulum *s* will consequently swing from its normal upright position to the left as shown in Fig. 6, this will cause the inlet pipe 29 and the outlet pipe 32 to be opened (to an extent corresponding with the extent of swing of the pendulum *s*), and the outlet pipe 31 and the inlet pipe 30 to be closed thus moving the piston *h* and its rod *j* to the right so as to turn the vertical crank shaft *m* and shafts *p*. *p* to incline the aerofoils *e*, *e* towards the right to the required extent, the angles of incidence thus imparted tending to restore the vehicle body *a* to its upright position. If at the same time as the pendulum *s* thus swings to the left the pennant *t* be acted upon by a wind from the left, this will to some extent counteract the effect of centrifugal action, and consequently the angles of incidence imparted to the aerofoils *e*, *e*, should be less. As a result of this wind action on the pennant *t* the inlet pipe 47 and outlet pipe 48 will be opened thus moving the piston 36 piston rod 35, connecting rod 34 yoke 33 and slide blocks 15 and 16 from their normal positions equidistant from the pivotal axes of the pendulum *s* and arm 12 upwards. The positions of the parts resulting from the combined action of a wind from the left and rounding a curve to the right is shown in Fig. 6. This reduces the leverage of the pendulum *s* on the connecting rod 17 and piston rod 19 thus causing the inlet pipe 29 to be opened to a smaller extent while the upward movement of the slide block 16 increases the leverage of the arm 12 on the connecting rod 18 and piston rod 20, thus causing the outlet pipe 32 to be opened to a great extent with the result that the angles of incidence imparted to the aerofoils *e*, *e* are less than would have been the case if there had been no side wind. Had the wind acting on the pennant *t* been from the right it would have augmented the effects of centrifugal action and to counteract this the inlet pipe 46 and outlet pipe 49 would have been opened with the result that the piston 36 and with it the slide blocks 15 and 16 would have been moved downwards from their normal positions equidistant from the pivotal axes of the pendulum *s* and arm 12, thus increasing the leverage of the pendulum *s* and decreasing the leverage of the arm 12 so that the inlet pipe 29 would have been opened to a greater extent and the outlet pipe 32 to a less extent than would have been the case if there had been no side wind, so that greater angles of incidence would be imparted to the aerofoils *e*, *e*. Similarly, if the vehicle be rounding a curve to the left the pendulum *s* would swing to the right and open the inlet pipe 30 and outlet pipe 31 to incline the aerofoils *e*. *e*, to the left. A wind from the left would to some extent augment the effect of centrifugal force and the opening of the inlet pipe 47 and outlet pipe 48 and the consequent upward movement of the slide blocks 16 and 15 from their normal positions equidistant from the pivotal axes of the pendulum *s* and arm 12 would increase the leverage of the arm 12 and decrease the leverage of the pendulum *s* so that the inlet pipe 30 would be opened to a greater extent and the outlet pipe 31 to a less extent than would be the case if there were no side wind thus causing greater angles of incidence to be imparted to the aerofoils *e*, *e*, whilst if the wind be from the right the opening of the inlet pipe 46 and outlet pipe 49 and the consequent lowering of the slide blocks 16 and 15 from their normal mid-positions would decrease the leverage of the arm 12 and increase the leverage of the pendulum *s* so that the inlet pipe 30 would not be opened to so great an extent and the outlet pipe 31 would be opened to a greater extent than would be the case if there were no side wind, thus causing the angles of incidence imparted to the aerofoils *e*, *e* to be decreased according to the strength of the side wind. It would appear that as the pennant *t* is the only controlling element on which side winds act directly and that as the effect of movement of said pennant is to cause an upward or downward movement of the slide blocks 15 and 16 from their normal mid-positions, such movement would be non-effective except when the pendulum *s* and arm 12 are displaced from their normal vertical positions as a result of the effect of centrifugal action on the vehicle body *a* when rounding a curve, but it must be borne in mind that a side wind of sufficient force to be taken into consideration would not only act upon the pennant *t* but would also tend to, and in fact, would, to some extent, cause the body *a* to lean over to one side or the other (to the right if the wind be from the left and vice versa) thus producing obliquity of the pendulum *s* and arm 12 and bringing about a corresponding setting of the aerofoils *e*, *e* to counteract the wind effect and right the body *a*.

It is to be understood that the mechanism shown in Figs. 4 and 5 lie in the same or nearly the same plane and that they are shown separately merely for the sake of clearness.

In order that the camber of the aerofoils *e*, *e* may be adjusted so that their configuration is the most efficient according to the speed at which the vehicle is travelling, and according to centrifugal action on the body *a*, each aerofoil *e* is hollow and has fixedly mounted therein a block or blocks, such as 52 through a slot 53 in each of which passes the crank 54 of a vertical crank shaft 55 adapted to deform the walls of the aerofoil *e* and so adjust its camber. Each crank

shaft 55 is connected by an extensible camber shaft 56 (Fig. 7) with a crank shaft 57 (Figs. 3 and 7) and these crank shafts are disposed transversely of and near the bottom of the body *a* and are interconnected by suitable gearing as at 57^a so as to rotate in opposite directions. The cranks 58 and 59 of the crank shafts 57, 57 are united by connecting rods 60, 61 with the piston rods 62, 63 of servo-motors 64, 65, the cylinders of which are connected through pipes 66—67 with a valve chest 68 similar to the valve chests 25 and 26, except that the valve chest 68 has four ports instead of three. The valve chest 68 has two inlets 69, 70 for fluid under pressure connected with the casing 71 of a cock 72, said casing being connected by a pipe 73 with a source of fluid under pressure (not shown). The cock 72 has an admission port 74 extending through nearly 270° and a centrally escaping exhaust port 75 extending through nearly 90° and is operated by a pendulum 76. The valve rod 77 of the valve in the chest 68 passes slidably through the ends of a chamber 78 in which is centrally disposed a flexible diaphragm 79 to which said valve rod 77 is secured. Opening into the chamber 78 are two pipes 80 and 81, one at each side of the diaphragm 79, said pipes leading forwardly and projecting through the body *a*, the open end of the pipe 80 being covered by a cowl 82. As the vehicle moves forward the rush of air over the cowl 82 creates a partial vacuum in the pipe 80, whilst the air entering the open end of the pipe 81 sets up pressure therein with the result that the diaphragm 79 is deformed, the valve rod 77 is moved and the ends of both pipes 69 and 70 are covered, to an extent depending upon the speed of the vehicle, the greater the speed the more said ends are closed. The pipes 69 and 66 are thus normally in communication with one another, as are also the pipes 70 and 67, and the aerofoils *e e* occupy the mid-position shown in full lines in Fig. 3. The admission port 74 of the cock 72 is adapted, when said cock is turned in the one direction or the other, to establish communication between the pipe 73 and either the pipe 69 and therefore the pipe 66, or the pipe 70, and therefore the pipe 67, thus admitting fluid under pressure to the cylinder of the servo-motor 64 or of the servo-motor 65 whilst the exhaust port 75 communicates with either the pipe 70 and therefore with the pipe 67, or with the pipe 69, and therefore with the pipe 66 and exhausts the cylinder of the servo-motor 65 or of the servo-motor 64.

The pendulum 76 which actuates the cock 72 being subject to centrifugal action serves to determine to which of the servo-motors 64 and 65 fluid under pressure shall be admitted and from which fluid shall be exhausted, and thus determines which shall actuate the crank shafts 57, 57, and 55, 55, according as it becomes necessary to vary the camber of the aerofoils *e e* to, and adjust it on, the one side or the other of the central neutral chords, as indicated in Fig. 3. Normally the pendulum 76 occupies a vertical position so that the inlets to both the pipes 69 and 70 are closed, when, therefore, the diaphragm 79 is deformed (to an extent which depends upon the speed of the vehicle) as a result of the pressure set up in the pipe 81 and of the partial vacuum created in the pipe 80 the valve rod 77 is moved but neither servo-motor 64 nor 65 is operative and each aerofoil *e*, remains symmetrical about its central neutral chord, as shown in full lines in Fig. 3, no matter what may be the speed of the vehicle and the consequent extent of deformation of the diaphragm 79. When, however, the vehicle leans over to one side or the other under wind or centrifugal action, or both, either the inlet 69 or 70 is placed in communication with the pipe 73 according as the body *a* leans to the right or to the left and consequently either the servo-motor 64 or 65 is caused to actuate the crank shafts 57, 57, and 55, 55 so as to vary the camber of the aerofoils *e e* to, and adjust it on, the one side or the other of the central neutral chords, the extent to which such adjustment takes place depending on the extent of deformation of the diaphragm 79 and consequent closure of the pipes 69 and 70, as a result of the speed of the vehicle; the slower the speed the less the deformation of the diaphragm 79, consequently the less the closing of the pipes 69 and 70 and the more the movement of the pistons in the servo-motors 64 and 65, so that the camber of the aerofoils *e*, *e* is greater the less the speed. Thus assuming the cranks 58 and 59 to be in such an angular position in Fig. 3 (vertically upwards from their crank shafts 57, 57) that forward movement of the piston rod 62 will move the crank 58 forwardly and the crank 59 rearwardly, the crank shafts 55 of the aerofoils *e*, *e* will be moved clockwise and the variation of camber of the aerofoils *e*, *e* (and its adjustment) will be towards the left i. e. relatively to the direction of movement of the vehicle, as shown in dotted lines, whilst forward movement of the piston rod 63 will move the crank 59 forwardly and the crank 58 rearwardly and produce counter-clockwise movement of the crank shafts 55, so that the variation of camber of the aerofoils *e*, *e* (and its adjustment) will be towards the right, i. e. relatively to the direction of movement of the vehicle as shown in dot and dash lines.

It is to be understood that the valve mechanism of the various servo-motors may include any known form of hunting gear, where required in order to cut off admission of fluid under pressure to the cylinders of the servo-motors in accordance with the effect to be produced.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising two aerofoils or cambered vanes mounted on vertical axes and arranged on either side of said body with their centers of pressure lying in the transverse vertical and horizontal planes in which lies the center of gravity of said vehicle, and means adapted to vary the angle of incidence of each aerofoil or cambered vane.

2. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising two aerofoils or cambered vanes mounted on vertical axes and arranged on either side of said body with their centers of pressure lying near the transverse vertical and horizontal planes in which lies the center of gravity of said vehicle and means adapted to vary the angle of incidence of each aerofoil or cambered vane.

3. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising a plurality of aerofoils or cambered vanes mounted on vertical axes and arranged in pairs on either side of said body in such positions that the resultant center of pressure lies in the transverse vertical and horizontal planes in which lies the center of gravity of said vehicle, and means adapted to vary the angle of incidence of each aerofoil or cambered vane.

4. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising a plurality of aerofoils or cambered vanes mounted on vertical axes and arranged in pairs on either side of said body in such positions that the resultant center of pressure lies near the transverse vertical and horizontal planes in which lies the center of gravity of said vehicle, and means adapted to vary the angle of incidence of each areofoil or cambered vane.

5. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising two aerofoils or cambered vanes mounted on vertical axes and arranged on either side of said body with their centers of pressure lying in the transverse vertical and horizontal planes in which lies the center of gravity of said vehicle, and means controlled by said lateral forces and adapted to vary the angle of incidence of each aerofoil or cambered vane.

6. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising two aerofoils or cambered vanes mounted on vertical axes and arranged on either side of said body with their centers of pressure lying near the transverse vertical and horizontal planes in which lies the center of gravity of said vehicle, and means controlled by said lateral forces and adapted to vary the angle of incidence of each aerofoil or cambered vane.

7. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising a plurality of aerofoils or cambered vanes mounted on vertical axes and arranged in pairs on either side of said body in such positions that the resultant center of pressures lies in the transverse vertical and horizontal plane in which lies the center of gravity of said vehicle, and means controlled by said lateral forces and adapted to vary the angle of incidence of each aerofoil or cambered vane.

8. In a monorail vehicle the combination with the body thereof of means for neutralizing lateral forces acting on either side of said body when in motion, said means being adapted to exert in a horizontal plane on either side of said body when in motion, forces opposed to said lateral forces, said means comprising a plurality of aerofoils or cambered vanes mounted on vertical axes and arranged in pairs on either side of said body in such positions that the resultant center of pressure lies near the transverse

vertical and horizontal planes in which lies the center of gravity of said vehicle, and means controlled by said lateral forces and adapted to vary the angle of incidence of each aerofoil or cambered vane.

9. In a monorail vehicle the combination with the body thereof of aerofoils or cambered vanes pivotally mounted on said body in substantially vertical planes, and means for varying the degree of camber of said vanes according to the speed of the vehicle, said means being adapted to effect such variation on either side of a neutral plane.

10. In a monorail vehicle the combination with the body thereof of aerofoils or cambered vanes pivotally mounted on said body in substantially vertical planes, means controlled by the speed of the vehicle for varying the degree of the camber of said vanes, and means for determining on which side of a neutral plane the camber of each vane shall be varied, said second mentioned means being controlled by lateral forces.

11. In a monorail vehicle, the combination with the body thereof, of aerofoils or cambered vanes pivotally mounted on said body, the centers of pressure of said vanes lying in the transverse vertical and horizontal planes in which lies the center of gravity of the vehicle, a servo-motor connected with said aerofoils or vanes for effecting a change of incidence thereof, a pendulum adapted under the influence of centrifugal action to control said servo-motor, an auxiliary servo-motor, adapted when operated to modify the action of the first mentioned servo-motor, and a pennant operable under the influence of lateral wind pressure to control said auxiliary servo-motor.

12. In a monorail vehicle, the combination with the body thereof, of aerofoils or cambered vanes pivotally mounted on said body, the centers of pressure of said vanes lying near the transverse vertical and horizontal planes in which lies the center of gravity of the vehicle, a servo-motor connected with said aerofoils or vanes for effecting a change of incidence thereof, a pendulum adapted under the influence of centrifugal action to control said servo-motor, an auxiliary servo-motor, adapted when operated to modify the action of the first mentioned servo-motor, and a pennant operable under the influence of lateral wind pressure to control said auxiliary servo-motor.

13. In a monorail vehicle, the combination with the body thereof, of aerofoils or cambered vanes pivotally mounted thereon, said vanes being so constructed that the camber thereof may be varied to one side or the other of a neutral position, servo-motors for varying the camber of said vanes and a diaphragm chamber for automatically controlling the amount of camber according to the speed of the vehicle, the diaphragm in said chamber being controlled by air pressure exerted thereon, through tubes connected with said chamber on each side of the diaphragm, one of said tubes being provided with a cowl, substantially as described.

14. In a monorail vehicle, the combination with the body portion thereof, of a plurality of aerofoils or cambered vanes, mounted on vertical axes, servo-motors for simultaneously varying the angle of incidence of said vanes, servo-motors for simultaneously varying the camber of said vanes and means for automatically controlling the operation of said servo-motors in accordance with lateral pressures of wind or centrifugal action on said monorail body to counteract the effect thereof.

15. In a monorail vehicle, the combination with the body portion thereof, of a plurality of aerofoils or cambered vanes, means for mounting said vanes for varying the angle of incidence thereof, means for varying the camber of said vanes on either side of a neutral position, servo-motors for controlling the angle of incidence and camber respectively and means automatically controlled by lateral wind pressure and centrifugal action for controlling the action of said servo-motors, said servo-motor for varying the cambers of the vanes being also controlled by the speed of the vehicle.

EDMOND ERNEST JOHNSON.

A. M. & Wm. CLARK,
Chartered Patent Agents,
53 CHANCERY LANE, LONDON, W.C. 2.

PATENTS AND DESIGNS ACTS, 1907 & 1919.

No. 36531/20.

Date 30th Dec.1920.

Complete Specification.

"Improved means for stabilizing moving bodies."

I, EDMOND ERNEST JOHNSON, of Massecourt, Maidenhead, in the County of Berks, a British Subject,

Do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

26/9/21.

This invention relates to the stabilization of moving bodies and has for its object to provide improved means for counteracting forces acting laterally thereof, or thereagainst, such, for instance, as centrifugal force or the effects of side winds.

According to this invention a body is provided on each side with an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

Each aerofoil is adapted to exert, when the body is in motion through a fluid, a lateral force adapted to counteract a lateral force such as the centrifugal action set up when rounding a curve or the effect of a side wind, and for the purpose of counteracting such force as closely as possible each aerofoil may be set by hand, both with regard to its angle of incidence and with regard to its camber, but preferably automatically acting means would be provided to attain these ends. For instance a servo-motor controlled by a pendulum may be employed for varying the angle of incidence of the aerofoils to counteract centrifugal force in rounding a curve, whilst a servo-motor controlled by a pennant may be employed for a like purpose to counteract the effect of a side wind, and a servo-motor controlled by an aero-static device may be employed for varying the camber of the aerofoils to maintain the latter at their most efficient configuration according to the speed at which the body is moving. The aerofoils are operated simultaneously and in the same direction so that when their angle of incidence is varied the force acting on the one would tend to push, and the force acting on the other would tend to pull, the body towards the inner side of the curve.

The invention is especially applicable to rapidly moving bodies, such, for instance, as mono-railway vehicles, which,

in rounding curves and/or when subjected to a strong side wind, transmit the lateral strain or a part thereof to the permanent way.

The aerofoils should be mounted so that their centres of pressure lie in or near the transverse vertical and horizontal planes in which lie the centre of gravity of the vehicle and the means for varying their angle of incidence and camber may be of any known type as used on aeroplanes. By the use of aerofoils as set forth above a component of the resistance presented by each counteracts the laterally acting centrifugal or wind force.

If desired, and for the preservation of balance, when the body or bodies is or are moving at speed, one or more additional aerofoils may be provided and mounted on each body so that the angle of incidence of each aerofoil is variable about an axis passing through the centre of gravity of the respective body. When more than one additional aerofoil is employed on a body, they may be operated simultaneously but may act in conjunction with each other thereby displacing a volume of air, on each side of the moving body, of sufficient mass to maintain lateral rolling equilibrium. Their controls may also be operated automatically through forces acting from the body at the point or points of contact with the supporting medium.

In addition to the stabilizing effects which may be obtained the aerofoils may also be actuated so as to operate as brakes.

The accompanying drawings illustrate diagrammatically one method of carrying out the invention Figure 1 being a side elevation of a monorail vehicle, parts being broken away, and Figure 2 being a plan thereof. Figure 3 is a plan on a larger scale of the means for varying automatically the camber of the aerofoils, Figure 4 is a transverse sectional elevation on

a still larger scale of means for varying the angle of incidence of the aerofoils, Figure 5 is a similar view of another portion of the means shown in Figure 4 which portion has been omitted from Figure 4 for the sake of clearness whilst a servo-motor and its valve chests are shown in both Figure 4 and Figure 5 to facilitate comprehension of the relationship of the different parts, Figure 6 is a detail view showing the pendulum and its associated parts in positions different from those shown in Figure 4, whilst Figure 7 is a sectional elevation on a still larger scale showing a detail of the means illustrated by Figure 3.

As shown in Figures 1 and 2 a monorail vehicle has a ~~fish-~~ semi-streamline ~~like~~ body a and is provided with tractor and pusher propellors b and c and track wheels d. At each side of the body a an aerofoil e is mounted so that its angle of incidence may be varied about a vertical axis f situated near its leading edge, such variation being effected automatically by a servo-motor g which is shown in both Figures 4 and 5 and the piston h of which is connected by its piston rod j and a connecting rod k with a vertical crank shaft m at the top of which is a bevel wheel n meshing with bevel wheels ~~n~~,o each on a shaft p projecting through the body a near its top and at the opposite end of which is a bevel wheel q meshing with a bevel quadrant r secured to frame of the aerofoil e so that movement of the piston h either way from the mid-position shown in Figure 4 will vary the angle of incidence of the aerofoils e e in the one direction or the other.

The servo-motor g is controlled by a pendulum s within the body a which pendulum is subjected to centrifugal force, whilst the action of the pendulum may be modified by a pennant t situated outside and above the body a, in the vertic

26/9/21.

plane of the track wheels d ... and above the widest part of the body a which pennant is subjected to the action of side winds and is balanced against centrifugal force by a bob weight u mounted on the opposite side of its spindle v and within the body a and of the requisite mass depending upon the distance of its centre of gravity from the axis of the spindle v. In Figure 1 the upper portion of the nearer aerofoil and part of the body a are broken away showing the pennant t, its bob-weight u and its spindle v in full lines.

The pendulum s is pivoted at w as high as possible and vertically above and parallel with the longitudinal axis of the body a and its arm x is slotted as at y and formed at its upper end with a toothed quadrant z meshing with a corresponding toothed quadrant 11 formed at the lower end of an arm 12 pivoted at 13 and slotted as at 14. In the slots y and 14 are mounted slide blocks 15 and 16 united by connecting rods 17 and 18 with the piston rods 19 and 20 of piston valves 21,22 and 23,24 situated in valve chests 25 and 26 respectively. The valve chests 25 and 26 communicate from the middle of the length of each with opposite ends of the cylinder of the servo-motor g by pipes 27 and 28 and the piston valves 22 and 24 normally close the inlet pipes 29 and 30 to, whilst the piston valves 21 and 23 normally close the exhaust pipes 31 and 32 from, the valve chests 25 and 26, it being understood that the inlet pipes 29 and 30 are connected with a suitable supply of fluid under pressure (not shown) whilst the exhaust pipes 31 and 32 are lead away to a convenient location.

As the pendulum s swings to the one side or the other the arm 12 is moved correspondingly and the connecting rods 17 and 18 and valve rods 19 and 20 are moved in the same

26/9/21.

direction, so that either the inlet pipe 29 and the outlet pipe 32 or the inlet pipe 30 and the outlet pipe 31 are uncovered and fluid under pressure is admitted to the one side, and exhausted from the other side, of the piston h, which is consequently moved in the one direction or the other to vary the angle of incidence of the aerofoils e,e as hereinbefore set forth.

The slide blocks 15 and 16 are united by a yoke 33, which is in turn united by a connecting rod 34 with the piston rod 35 of the piston 36 of a servo-motor cylinder 37, the opposite ends of which communicate by pipes 38,39,with a valve chest 40 in which are disposed four piston valves 41,42, 43,44, on a valve rod 45. The piston valves 41 and 44 normally close inlet pipes 46 and 47 to, and the piston valves 42 and 43 normally close exhaust pipes 48 and 49 from, the valve chest 40, and the valve rod 45 is united by a connecting rod 50 with a crank 51 on the spindle v of the pennant t, so that as the spindle v turns in the one direction or the other as a result of the action of a side wind on the pennant t the valve rod 45 is acted upon to cause the inlet pipe 46 and outlet pipe 49 or the inlet pipe 47 and the outlet pipe 48, to be uncovered thus admitting fluid under pressure by way of the pipe 38 or the pipe 39 to one side of the piston 36 in the servo-motor cylinder 37 and exhausting fluid from the other side of said piston by way of the pipe 39 or the pipe 38, according as the wind acts upon the pennant from the one side or the other.

Movement of the piston 36 in the servo-motor cylinder 37 causes the blocks 15 and 16 to be slidden up or down in the slots y and 14 thus varying the leverage of the action of the pendulum s on the valve rods 19 and 20 as shown in Figure 6 and modifying the valve opening to correspond with

26/9/21.

the algebraic sum of the pendulum and pennant movements, i.e. the valve opening which should result from a given amount of centrifugal action on the pendulum s may be augmented or decreased, as a result of wind action on the pennant t.

It is to be understood that the mechanisms shown in Figures 4 and 5 lie in the same or nearly the same plane and that they are shown separately merely for the sake of clearness.

In order that the camber of the aerofoils e may be adjusted so that their configuration is the most efficient according to the speed at which the vehicle is travelling, and ventrifugal action on the body a, each aerofoil e is hollow and has fixedly mounted therein a block 52 through a slot 53 in which passes the crank 54 of a vertical crank shaft 55 adapted to deform the walls of the aerofoil e and so adjust its camber. Each crank shaft 55 is connected by an extensible Cardan shaft 56 (Figure 7) with a crank shaft 57 (Figures 3 and 7) disposed transversely of and near the bottom of the body a the cranks 58 and 59 of which are united by connecting rods 60,61, with the piston rods 62,63 of servo-motors 64,65, the cylinders of which are connected through pipes 66, 67, with a valve chest 68 similar to the valve chests 25 and 26. The valve chest 68 has two inlets 69,70 for fluid under pressure connected with the casing 71 of a cock 72, said casing being connected by a pipe 73 with a source of fluid under pressure (not shown). The cock 72 has an admission port 74 extending through nearly 270° and a centrally escaping exhaust port 75 extending through nearly 90° and is operated by a pendulum 76. The valve rod 77 of the valve in the chest 68 passes slidably through the ends of a chamber 78 in which is centrally disposed a flexible diaphragm 79 to which said valve rod 77 is secured. Opening into the chamber 78 are two pipes 80 and 81, one at each side of the diaphragm 79, said pipes leading forwardly and projecting through the body a, the open

29/9/21.

end of the pipe 80 being covered by a cowl 82. As the vehicle moves forwards the rush of air over the cowl 82 creates a partial vacuum in the pipe 80, whilst the air entering the open end of the pipe 81 sets up pressure therein with the result that the diaphragm 79 is deformed, and the valve rod 77 is moved, to an extent depending upon the speed of the vehicle. The admission port 74 of the cock 72 is adapted, when said cock is turned in the one direction or the other, to establish communication between the pipe 73 and either the pipe 69 or the pipe 70 thus admitting fluid under pressure to the cylinder of the servo-motor 64 or of the servo-motor 65 whilst the exhaust port 75 communicates with either the pipe 70 or the pipe 69, and exhausts the cylinder of the servo-motor 65 or of the servo-motor 64.

The pendulum 76 which actuates the cock 77 being subject to centrifugal action serves to determine which of the servo-motors 64 and 65 shall actuate the crank shafts 57, and 55, according as it becomes necessary to vary the camber of the aerofoils e to, and adjust it on, the one side or the other of the central neutral chord, as indicated in Figure 3.

It is to be understood that the valve mechanisms of the various servo-motors may include any known form of hunting gear, where required, in order to cut off admission of fluid under pressure to the cylinders of the servo-motors in accordance with the effect to be produced.

If desired a chamber such as 78, having a diaphragm such as 79, and associated parts as hereinbefore set forth, with a servo-motor having a double acting cylinder and valve mechanism including, if necessary, hunting gear, or with an electric servo-motor, may be employed for varying, on one side only of the neutral chord, the camber of the wings of an aircraft according to its speed or other circumstances.

30/9/21

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:-

1. Improved means for stabilizing moving bodies which consist in providing on each side of a body an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

2. Improved means for stabilizing moving bodies as claimed in Claim 1, wherein the variation of the angle of incidence of the aerofoils or cambered vanes and/or the variation of their camber is effected automatically by means of servo-motors.

3. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein the servo-motor for effecting automatically variation of the angle of incidence of the aerofoils or cambered vanes is controlled by a pendulum adapted to function under centrifugal action.

4. Improved means for stabilizing moving bodies as claimed in Claim 3, wherein the control exercised by the pendulum is modified by means actuated by a servo-motor controlled by a pennant adapted to function under the influence of a side wind.

5. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein servo-motors for effecting automatically variation of the camber of the aerofoils or cambered vanes are controlled by a diaphragm in a chamber into which open on opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is covered by a cowl, substantially as and for the purpose set forth.

6. Improved means for stabilizing moving bodies as claimed in Claim 4, wherein the servo-motor is adapted to vary the leverage of the pendulum action upon the valve rods of the

30/9/21

servo-motor for varying the angle of incidence of the aerofoils or cambered vanes.

7. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein the variation of the angle of incidence of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1, 2, 4, 5 and 6 of the accompanying drawings.

8. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein the variation of the camber of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1,2,3 and 7 of the accompanying drawings.

9. A monorail vehicle constructed and arranged substantially as and for the purposes hereinbefore set forth with reference to the accompanying drawings.

10. Means for varying on one side of the neutral chord the camber of the wing of an aircraft, comprising a crank movable in one or more slotted blocks secured to the walls of a wing, said crank being operated by a servo-motor, which is controlled by movement of a diaphragm in a chamber into which chamber open on opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is covered by a cowl, substantially as set forth.

Dated the 30th day of September, 1921.

A. H. & W. Clark

Chartered Patent Agents,
53 & 54, Chancery Lane,
LONDON, W.C.2.

30/9/21.

PATENT SPECIFICATION

Application Date: Dec. 30, 1920. No. 36,531/20. 177,274

Complete Left Sept. 30, 1921.

Complete Accepted: Mar. 30, 1922.

PROVISIONAL SPECIFICATION.

Improved Means for Neutralizing Lateral Forces Acting on either Side of a Moving Monorail Vehicle.

I, EDMOND ERNEST JOHNSON, of Maescourt, Maidenhead, in the County of Berks., a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to the stabilization of monorail vehicles and has for its object to provide improved means for counteracting forces acting laterally thereof, or thereagainst, such for instance, as centrifugal force or the effects of side winds.

According to this invention a mono-railway vehicle body is provided on each side with an aerofoil mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

Each aerofoil is adapted to exert, when the body is in motion, a lateral force adapted to counteract a lateral force such as the centrifugal action set up when rounding a curve or the effect of a side wind, and for the purpose of counteracting such force as closely as possible each aerofoil may be set by hand, both with regard to its angle of incidence and with regard to its camber, but preferably automatically acting means would be provided to attain these ends. For instance a servo-motor controlled by a pendulum may be employed for varying the angle of incidence of the aerofoils to counteract centrifugal force in rounding a curve, whilst a servo-motor controlled by an aerostatic valve may be employed for varying the camber of the aerofoils to counteract the effects of a side wind. The aerofoils are operated simultaneously and in the same direction so that when their angle of incidence is varied the force acting on the one would tend to push, and the force acting on the other would tend to pull, the body towards the inner side of the curve.

Mono-railway vehicles in rounding curves or when subjected to a strong side wind, transmit the lateral strain or a part thereof to the permanent way.

The aerofoils should be mounted so that their centres of pressure lie in or near the transverse vertical and horizontal planes in which lie the centre of gravity of the vehicle and the means for varying their angle of incidence and camber may be of any known type as used on aeroplanes. By the use of aerofoils as set forth above a component of the resistance presented by each counteracts the laterally acting centrifugal or wind force.

If such vehicles be made of streamline formation an aero-static valve should be arranged at each side at the neutral vertical transverse plane for controlling the servo-motor for varying the camber of the aerofoils whilst the pendular means for controlling the servo-motor for varying their angle of incidence may be arranged within the vehicle itself.

If desired, and for the preservation of balance, when the body or bodies is or are moving at speed, one or more additional aerofoils may be provided and mounted on each body so that the angle of incidence of each aerofoil is variable about an axis passing through the centre of gravity of the respective body. When more than one additional aerofoil is employed on a body, they may be operated simultaneously but may act in conjunction with each other thereby dis-

[*Price* 1/-]

placing a volume of air, on each side of the moving body, of sufficient mass to maintain lateral rolling equilibrium. Their controls may also be automatically operated through forces acting from the body at the point or points of contact with the supporting medium.

In addition to the stabilizing effects which may be obtained the aerofoils may also be actuated so as to operate as brakes.

Dated the 30th day of December, 1920.

A. M. & WM. CLARK,
Chartered Patent Agents,
53/54, Chancery Lane, London, W.C. 2.

COMPLETE SPECIFICATION.

Improved Means for Neutralizing Lateral Forces Acting on either Side of a Moving Monorail Vehicle.

I, Edmond Ernest Johnson, of Maescourt, Maidenhead, in the County of Berks., a British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to means for neutralizing forces acting laterally in a horizontal plane such, for instance, as centrifugal force or the effects of side winds, on a moving monorail vehicle.

According to this invention a monorail vehicle body is provided on each side with an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

Each aerofoil is adapted to exert, when the monorail vehicle body is in motion through the air, a lateral force adapted to counteract a lateral force such as the centrifugal action set up when rounding a curve or the effect of a side wind, and for the purpose of counteracting such force as closely as possible each aerofoil may be set by hand, both with regard to its angle of incidence and with regard to its camber, but preferably automatically acting means would be provided to attain these ends. For instance, a servo-motor may be employed for varying the angle of incidence of the aerofoils, to the one side or the other, to counteract centrifugal force in rounding a curve the valve chests for permitting the servo-motor to operate, in the one direction or the other, being controlled by a pendulum and a correspondingly moving arm geared thereto, whilst a servo-motor controlled by a pennant may be employed, in conjunction with the pendulum-controlled servo-motor, for a like purpose to counteract the effect of a side wind, and a servo-motor controlled by an aero-static device may be employed for varying the camber of the aerofoils to maintain the latter at their most efficient configuration according to the speed at which the monorail vehicle body is moving. The aerofoils are operated simultaneously and in the same direction so that when their angle of incidence is varied the force acting on the one would tend to push, and the force acting on the other would tend to pull, the vehicle body towards the inner side of the curve.

The aerofoils should be mounted so that their centres of pressure lie in or near the transverse vertical and horizontal planes in which lie the centre of gravity of the vehicle and the means for varying their angle of incidence and camber may be of any known type as used on aeroplanes. By the use of aerofoils as set forth above a component of the resistance presented by each counteracts the laterally acting centrifugal or wind force.

If desired, and for the preservation of balance, when the vehicle body or bodies is or are moving at speed, one or more additional aerofoils may be provided and mounted on each body so that the angle of incidence of each aerofoil is variable about an axis passing through the centre of gravity of the respective body. When more than one additional aerofoil is employed on a body, they may be operated simultaneously but may act in conjunction with each other thereby displacing a volume of air, on each side of the moving vehicle body, of sufficient mass to maintain lateral rolling equilibrium. Their controls may also be operated automatically through forces acting from the body at the point or points of contact with the supporting medium.

In addition to the stabilizing effects which may be obtained the aerofoils may also be actuated so as to operate as brakes.

The accompanying drawings illustrate diagrammatically one method of carrying out the invention Figure 1 being a side elevation of a monorail vehicle, parts being broken away, and Figure 2 being a plan thereof. Figure 3 is a plan on a larger scale of the means for varying automatically the camber of the aerofoils, Figure 4 is a transverse sectional elevation on a still larger scale of means for varying the angle of incidence of the aerofoils. Figure 5 is a similar view of another portion of the means shown in Figure 4 which portion has been omitted from Figure 4 for the sake of clearness whilst a servo-motor and its valve chests are shown in both Figure 4 and Figure 5 to facilitate comprehension of the relationship of the different parts, Figure 6 is a detail view showing the pendulum and its associated parts in positions different from those shown in Figure 4, whilst Figure 7 is a sectional elevation on a still larger scale showing a detail of the means illustrated by Figure 3.

As shown in Figures 1 and 2 a monorail vehicle has a semi-streamline body *a* and is provided with tractor and pusher propellors *b* and *c* and track wheels *d*. At each side of the body *a* an aerofoil *e* is mounted so that its angle of incidence may be varied about a vertical axis *f* situated near its leading edge, such variation being effected automatically by a servo-motor *g* which is shown in both Figures 4 and 5 and the piston *h* of which is connected by its piston rod *j* and a connecting rod *k* with a vertical crank shaft *m* at the top of which is a bevel wheel *n* meshing with bevel wheels *o*, *o* each on a shaft *p* projecting through the body *a* near its top and at the opposite end of which is a bevel wheel *q* meshing with a bevel quadrant *r* secured to the frame of the aerofoil *e* so that movement of the piston *h* either way from the mid-position shown in Figure 4 will vary the angle of incidence of the aerofoils *e e* in the one direction or the other.

The servo-motor *g* is controlled by a pendulum *s* within the body *a* which pendulum is subjected to centrifugal force, whilst the action of the pendulum may be modified by a pennant *t* situated outside and above the body *a*, in the vertical plane of the track wheels *d* . . . and above the widest part of the body *a* which pennant is subjected to the action of side winds and is balanced against centrifugal force by a bob weight *u* mounted on the opposite side of its spindle *v* and within the body *a* and of the requisite mass depending upon the distance of its centre of gravity from the axis of the spindle *v*. In Figure 1 the upper portion of the nearer aerofoil and part of the body *a* are broken away showing the pennant *t*, its bob-weight *u* and its spindle *v* in full lines.

The pendulum *s* is pivoted at *w* as high as possible and vertically above and parallel with the longitudinal axis of the body *a* and its arm *x* is slotted as at *y* and formed at its upper end with a toothed quadrant *z* meshing with a corresponding toothed quadrant 11 formed at the lower end of an arm 12 pivoted at 13 and slotted as at 14. In the slots *y* and 14 are mounted slide blocks 15 and 16 united by connecting rods 17 and 18 with the piston rods 19 and 20 of piston valves 21, 22 and 23, 24 situated in valve chests 25 and 26 respectively. The valve chests 25 and 26 communicate from the middle of the length of each with opposite ends of the cylinder of the servo-motor *g* by pipes 27 and 28 and the piston valves 22 and 24 normally close the inlet pipes 29 and 30 to, whilst the piston valves 21 and 23 normally close the exhaust pipes 31 and 32 from, the valve chests 25 and 26, it being understood that the inlet pipes 29 and 30 are connected with a suitable supply of fluid under pressure (not shown) whilst the exhaust pipes 31 and 32 are led away to a convenient location.

As the pendulum *s* swings to the one side or the other the arm 12 is moved correspondingly and the connecting rods 17 and 18 and valve rods 19 and 20 are moved in the same direction, so that either the inlet pipe 29 and the outlet pipe 32 or the inlet pipe 30 and the outlet pipe 31 are uncovered and fluid under pressure is admitted to the one side, and exhausted from the other side, of the piston *h*, which is consequently moved in the one direction or the other to vary the angle of incidence of the aerofoils *e*, *e* as hereinbefore set forth.

The slide blocks 15 and 16 are united by a yoke 33, which is in turn united by a connecting rod 34 with the piston rod 35 of the piston 36 of a servo-motor cylinder 37, the opposite ends of which communicate by pipes 38, 39, with a valve chest 40 in which are disposed four piston valves 41, 42, 43, 44, on a valve rod 45. The piston valves 41 and 44 normally close inlet pipes 46 and 47 to, and the piston valves 42 and 43 normally close exhaust pipes 48 and 49 from, the valve chest 40, and the valve rod 45 is united

by a connecting rod 50 with a crank 51 on the spindle r of the pennant t, so that as the spindle r turns in the one direction or the other as a result of the action of a side wind on the pennant t the valve rod 45 is acted upon to cause the inlet pipe 46 and outlet pipe 49 or the inlet pipe 47 and the outlet pipe 48, to be uncovered thus admitting fluid under pressure by way of the pipe 38 or the pipe 39 to one side of the piston 36 in the servo-motor cylinder 37 and exhausting fluid from the other side of said piston by way of the pipe 39 or the pipe 38, according as the wind acts upon the pennant from the one side or the other.

Movement of the piston 36 in the servo-motor cylinder 37 causes the blocks 15 and 16 to be slidden up or down in the slots y and 14 thus varying the leverage of the action of the pendulum s on the valve rods 19 and 20 as shown in Figure 6 and modifying the valve opening to correspond with the algebraic sum of the pendulum and pennant movements, *i.e.* the valve opening which should result from a given amount of centrifugal action on the pendulum s may be augmented or decreased, as a result of wind action on the pennant t. That is to say if the monorail vehicle body a be rounding a curve to the right centrifugal action will cause it to lean to the left and the pendulum x will consequently swing from its normal upright position to the left as shown in Figure 6, this will cause the inlet pipe 29 and the outlet pipe 32 to be opened (to an extent corresponding with the extent of swing of the pendulum x), and the outlet pipe 31 and the inlet pipe 30 to be closed thus moving the piston h and its rod j to the right so as to turn the vertical crank shaft m and shafts p, p to incline the aerofoils e, e towards the right to the required extent, the angles of incidence thus imparted tending to restore the vehicle body a to its upright position. If at the same time as the pendulum x thus swings to the left the pennant t be acted upon by a wind from the left, this will to some extent counteract the effect of centrifugal action, and consequently the angles of incidence imparted to the aerofoils e, e should be less. As a result of this wind action on the pennant t the inlet pipe 47 and outlet pipe 48 will be opened thus moving the piston 36 piston rod 35, connecting rod 34 yoke 33 and slide blocks 15 and 16 (from their normal positions equidistant from the pivotal axes of the pendulum x and arm 12) upwards. The positions of the parts resulting from the combined action of a wind from the left and rounding a curve to the right is shewn in Figure 6. This reduces the leverage of the pendulum x on the connecting rod 17 and piston rod 19 thus causing the inlet pipe 29 to be opened to a smaller extent whilst the upward movement of the slide block 16 increases the leverage of the arm 12 on the connecting rod 18 and piston rod 20 thus causing the outlet pipe 32 to be opened to a greater extent with the result that the angles of incidence imparted to the aerofoils e, e are less than would have been the case if there had been no side wind. Had the wind acting on the pennant t been from the right it would have augmented the effects of centrifugal action and to counteract this the inlet pipe 46 and outlet pipe 49 would have been opened with the result that the piston 36 and with it the slide blocks 15 and 16 would have been moved downwards from their normal positions equidistant from the pivotal axes of the pendulum x and arm 12, thus increasing the leverage of the pendulum x and decreasing the leverage of the arm 12 so that the inlet pipe 29 would have been opened to a greater extent and the outlet pipe 32 to a less extent than would have been the case if there had been no side wind, so that greater angles of incidence would be imparted to the aerofoils e, e. Similarly if the vehicle be rounding a curve to the left the pendulum x would swing to the right and open the inlet pipe 30 and outlet pipe 31 to incline the aerofoils e, e, to the left; a wind from the left would to some extent augment the effect of centrifugal force and the opening of the inlet pipe 47 and outlet pipe 48 and the consequent upward movement of the slide blocks 16 and 15 from their normal positions equidistant from the pivotal axes of the pendulum x and arm 12 would increase the leverage of the arm 12 and decrease the leverage of the pendulum x so that the inlet pipe 30 would be opened to a greater extent and the outlet pipe 31 to a less extent than would be the case if there were no side wind thus causing greater angles of incidence to be imparted to the aerofoils e, e whilst if the wind be from the right the opening of the inlet pipe 46 and outlet pipe 49 and the consequent lowering of the slide blocks 16 and 15 from their normal mid-positions would decrease the leverage of the arm 12 and increase the leverage of the pendulum x so that the inlet pipe 30 would not be opened to so great an extent and the outlet pipe 31 would be opened to a greater extent than would be the case if there were no side wind, thus causing the angles of incidence imparted to the aerofoils e, e to be decreased according to the strength of the side wind. It would appear that as the pennant t is the only controlling element on which side winds act directly and that as the effect of movement of said pennant is to cause an upward or downward movement of the slide blocks 15 and 16 from their normal mid-positions, such movement would be non-effective except when the pendulum x and arm 12 are displaced from their normal vertical positions as a result of the effect of centrifugal action on the vehicle body a when rounding a curve, but it must be borne in mind that a side wind of sufficient force to be taken into consideration would not only act upon the pennant t but would also tend to, and in fact, would, to some extent, cause the body a to lean over to one side or the other (to the right if the wind be from the left and *vice versa*) thus producing obliquity of the pendulum x and arm 12 and bringing about a corresponding setting of the aerofoils e, e to counteract the wind effect and right the body a.

It is to be understood that the mechanisms shown in Figures 4 and 5 lie in the same or nearly the same plane and that they are shown separately merely for the sake of clearness.

In order that the camber of the aerofoils e may be adjusted so that their configuration is the most efficient according to the speed at which the vehicle is travelling, and according to centrifugal action on the body a, each aerofoil e is hollow and has fixedly mounted therein a block or blocks, such as 52 through a slot 53 in each of which passes the crank 54 of a vertical crank shaft 55 adapted to deform the walls of the aerofoil e and so adjust its camber. Each crank shaft 55 is connected by an extensible cardan shaft 56 (Figure 7) with a crank shaft 57 (Figures 3 and 7) and these crank shafts are disposed transversely of and near the bottom of the body a and are interconnected by suitable gearing as at 57^a so as to rotate in opposite directions. The cranks, 58 and 59 of the crank shafts 57, 57 are united by connecting rods 60, 61 with the piston rods 62, 63 of servo-motors 64, 65, the cylinders of which are connected through pipes 66, 67 with a valve chest 68 similar to the valve chests 25 and 26, except that the valve chest 68 has four ports instead of three. The valve chest 68 has two inlets 69, 70 for fluid under pressure connected with the casing 71 of a cock 72, said casing being connected by a pipe 73 with a source of fluid under pressure (not shown). The cock 72 has an admission port 74 extending through nearly 270° and a centrally escaping exhaust port 75 extending through nearly 90° and is operated by a pendulum 76. The valve rod 77 of the valve in the chest 68 passes slidably through the ends of a chamber 78 in which is centrally disposed a flexible diaphragm 79 to which said valve rod 77 is secured. Opening into the chamber 78 are two pipes 80 and 81, one at each side of the diaphragm 79, said pipes leading forwardly and projecting through the body a, the open end of the pipe 80 being covered by a cowl 82. As the vehicle moves forwards the rush of air over the cowl 82 creates a partial vacuum in the pipe 80, whilst the air entering the open end of the pipe 81 sets up pressure therein with the result that the diaphragm 79 is deformed, the valve rod 77 is moved and the ends of both pipes 69 and 70 are covered, to an extent depending upon the speed of the vehicle, the greater the speed the more said ends are closed. The pipes 69 and 66 are thus normally in communication with one another, as are also the pipes 70 and 67, and the aerofoils e e occupy the mid-position shown in full lines in Figure 3. The admission port 74 of the cock 72 is adapted, when said cock is turned in the one direction or the other, to establish communication between the pipe 73 and either the pipe 69 and therefore the pipe 66, or the pipe 70, and therefore the pipe 67, thus admitting fluid under pressure to the cylinder of the servo-motor 64 or of the servo-motor 65 whilst the exhaust port 75 communicates with either the pipe 70 and therefore with the pipe 67, or with the pipe 69, and therefore with the pipe 66 and exhausts the cylinder of the servo-motor 65 or of the servo-motor 64.

The pendulum 76 which actuates the cock 72 being subject to centrifugal action serves to determine to which of the servo-motors 64 and 65 fluid under pressure shall be admitted and from which fluid shall be exhausted, and thus determines which shall actuate the crank shafts 57, 57 and 55, 55, according as it becomes necessary to vary the camber of the aerofoils e to, and adjust it on, the one side or the other of the central neutral chord, as indicated in Figure 3. Normally the pendulum 76 occupies a vertical position so that the inlets to both the pipes 69 and 70 are closed, when, therefore, the diaphragm 79 is deformed (to an extent which depends upon the speed of the vehicle) as a result of the pressure set up

in the pipe 81 and of the partial vacuum created in the pipe 80 the valve rod 77 is moved but neither servo-motor 64 nor 65 is operative and each aerofoil *e*, remains symmetrical about its central neutral chord, as shown in full lines in Figure 3, no matter what may be the speed of the vehicle and the consequent extent of deformation of the diaphragm 79. When however, the vehicle leans over to one side or the other under wind or centrifugal action, or both, either the inlet 69 or 70 is placed in communication with the pipe 73 according as the body *a* leans to the right or to the left and consequently either the servo-motor 64 or 65 is caused to actuate the crank shafts 57, 57, and 55, 55 so as to vary the camber of the aerofoils *e* to, and adjust it on, the one side or the other of the central neutral chord, the extent to which such adjustment takes place depending on the extent of deformation of the diaphragm 79 and consequent closure of the pipes 69 and 70, as a result of the speed of the vehicle; the slower the speed the less the deformation of the diaphragm 79, consequently the less the closing of the pipes 69 and 70 and the more the movement of the pistons in the servo-motors 64 and 65, so that the camber of the aerofoils *e*, *e* is greater the less the speed. Thus assuming the cranks 58 and 59 to be in such an angular position in Figure 3 (vertically upwards from their crank shafts 57, 57) that forward movement of the piston rod 62 will move the crank 58 forwardly and the crank 59 rearwardly, the crank shafts 55 of the aerofoils *e*, *e* will be moved clockwise and the variation of camber of the aerofoils *e*, *e* (and its adjustment) will be towards the left *i.e.* relatively to the direction of movement of the vehicle, as shown in dotted lines, whilst forward movement of the piston rod 63 will move the crank 59 forwardly and the crank 58 rearwardly and produce counter-clockwise movement of the crank shafts 55, so that the variation of camber of the aerofoils *e*, *e* (and its adjustment) will be towards the right, *i.e.* relatively to the direction of movement of the vehicle as shown in dot and dash lines.

It is to be understood that the valve mechanisms of the various servo-motors may include any known form of hunting gear, where required, in order to cut off admission of fluid under pressure to the cylinders of the servo-motors in accordance with the effect to be produced.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Means for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body which consist in providing on each side of said body an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

2. Means, as claimed in Claim 1, for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body, wherein the variation of the angle of incidence of the aerofoils or cambered vanes and/or the variation of their camber is effected by means of automatically controlled servo-motors.

3. Means, as claimed in Claim 2 for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body wherein the aerofoils or vanes are so mounted that their centres of pressure lie in or near the transverse vertical and horizontal planes in which lies the centre of gravity of the vehicle and wherein the valve chests of the servo-motor for effecting automatically variation of the angle of incidence of the aerofoils or cambered vanes to the one side or the other are controlled by a pendulum adapted to function under centrifugal action and a correspondingly-moving arm geared thereto, in combination with a servo motor controlled by a pennant adapted to function under substantial lateral wind pressure, the control exercised by the pendulum and the arm geared thereto being modified by the action of the servo-motor controlled by the pennant, substantially as hereinbefore set forth.

4. Means, as claimed in Claim 2 for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body, wherein servo-motors for effecting variation of the camber of the aerofoils or cambered vanes are regulated automatically by a diaphragm in a chamber into which open on opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is covered by a cowl, substantially as and for the purpose set forth.

5. Means, as claimed in Claim 3, for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body wherein the servo-motor controlled by the pennant is adapted to vary the leverage of the pendulum action upon the valve rods of the servo-motor for varying the angle of incidence of the aerofoils or cambered vanes.

6. Means for varying on one or other side of the neutral chord the camber of each of the aerofoils set forth in Claim 1, comprising a crank movable in one or more slotted blocks secured to the walls of an aerofoil, said cranks being operated by a servo-motor, which is controlled by movement of a diaphragm in a chamber into which chamber open on opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is covered by a cowl, substantially as set forth.

7. Means, as claimed in Claim 2 for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body, wherein the variation of the angle of incidence of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1, 2, 4, 5 and 6 of the accompanying drawings.

8. Means, as claimed in Claim 2, for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body, wherein the variation of the chamber of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1, 2, 3, and 7 of the accompanying drawings.

9. A monorail vehicle constructed and arranged substantially as and for the purposes hereinbefore set forth with reference to the accompanying drawings.

Dated the 30th day of September, 1921.

A. M. & WM. CLARK,
Chartered Patent Agents,
53 & 54, Chancery Lane, London, W.C. 2.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1922.

Fig. 1.

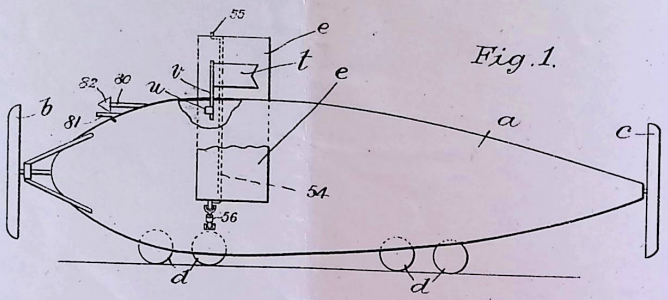


Fig. 2.

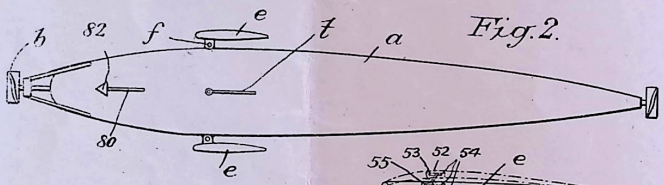


Fig. 3

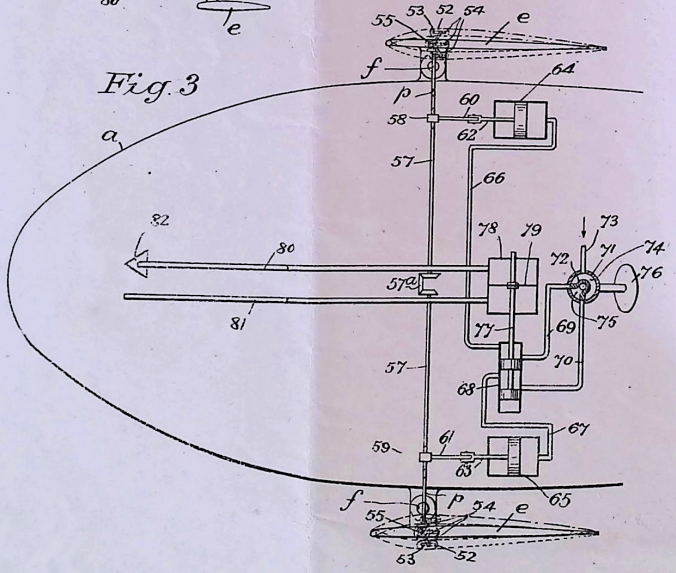


Fig. 4.

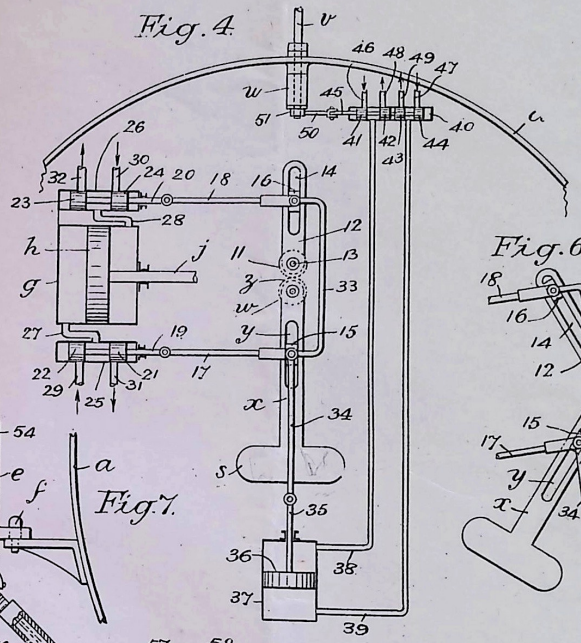
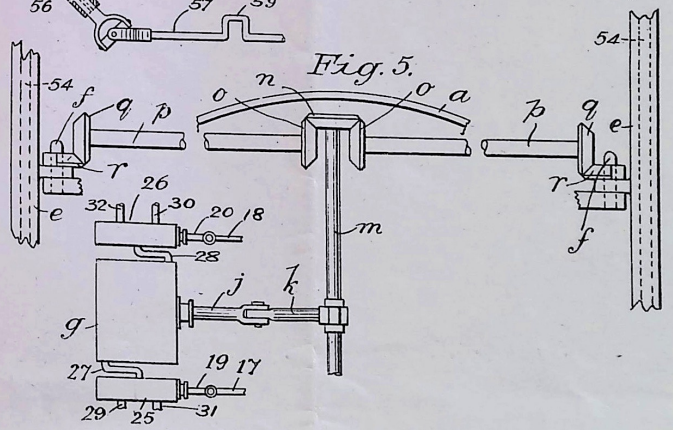


Fig. 6.

Fig. 7.

Fig. 5.



Malby&Sons, Photo-Litho

[Second Edition.]

N° 29,579 A.D. 1909

Date of Application, 17th Dec., 1909

Complete Specification Left, 8th June, 1910—Accepted, 19th Dec., 1910

PROVISIONAL SPECIFICATION.

Improvements in and relating to the Suspension and Running Gear of Single Track Vehicles.

I, Louis Brennan, C.B., of Woodlands, Gillingham, in the County of Kent, Civil and Mechanical Engineer, do hereby declare the nature of this invention to be as follows:—

This invention relates to the suspension and running gear of vehicles.

In monorail vehicles kept in equilibrium either by gyroscopic control or by effecting shifts of the centre of gravity of the vehicle with respect to its supporting wheels it is essential that the structure or parts of the same should be unstable apart from the stability imparted artificially by the gyrostats or by the shifts of the centre of gravity.

In a straight length of rail with the wheels in line it is advisable or necessary to provide means for transferring the restoring torque to the wheels so that the whole structure can turn about the rail head. With certain dispositions of the wheels on curves, however, it may happen that the points of contact of the wheels with the rail define an arc instead of a straight line, and in this case rigid connection between the vehicle body and the wheels must give place to a semi-rigid or free connection according to the conditions to be met. Moreover, in monorail vehicles since the dead weight of the vehicle is borne on a single line of rail a comparatively large number of wheels are often necessary in order to keep down the load per wheel, and it is then important to secure a fair distribution of the load.

Further, in monorail vehicles kept in equilibrium by either of the means before stated, during the transmission of the righting torque to the vehicle the distribution of load on each journal of the road wheel axles of such vehicles is subject to variation according to the magnitude and direction of the said torque.

In monorail vehicles having a plurality of supporting wheels it is essential to effect the braking of the wheels in such a manner that an equal braking effect is produced on each wheel braked. Further, owing to the fact that monorail vehicles are run upon a single line it is desirable in order to obtain adequate retarding effect to brake all the wheels. The problem therefore arises of applying an equal braking effect to all the wheels of a monorail vehicle.

The object of the present invention is to provide an improved construction of under-carriage for monorail vehicles in which a proper distribution of the load over, in some cases, a large number of wheels is effected and in which under all conditions the vehicle may remain unstable apart from the stability imparted artificially to it.

A further object of the present invention is to effect the proper distribution of the load on each journal of the road wheel axles on monorail vehicles according to the magnitude and direction of the righting torque.

A further object of the invention is to provide improved means for applying a braking effect to all the wheels on a monorail vehicle.

The invention consists broadly in a vehicle, the body of which is supported

[*Price 8d.*]

PRICE 1/-

at two points disposed respectively at suitable intermediate points at corresponding equalising or distributing frames or levers, the ends of each of these frames being supported at intermediate points of certain sub-frames, this system being repeated if desired while the last set of frames are provided with suitable bearings for the vehicle wheels.

The invention further consists in an arrangement of under carriages substantially as indicated in the preceding paragraph and having at each and all of the points of support connections such as to permit relative motion between the parts in planes mutually at right angles to one another.

The invention also consists in an arrangement of under carriages, substantially as indicated in the two preceding paragraphs and having axle boxes so constructed and mounted that they are free to move vertically in the horn plates and are free to swivel in a plan perpendicular to the rail.

The invention further consists in an arrangement of braking devices for use with the under carriages of mono-rail vehicles constructed substantially in accordance with the preceding paragraphs in which an equal braking effect is applied to each of two or more road wheels.

The invention further consists in the improved equalising under carriages, trunnion axle boxes, and equalising brake mechanism hereinafter described.

I will now describe a method of carrying this invention into effect in the case where the weight of the vehicle is supported by two bogies. For the convenience of description I will describe the parts appertaining to one bogey, it being understood that the second bogey may be similar in all respect.

Upon the underframe of the car there is bolted or otherwise secured a hollow pivot perpendicular to the base of the car and about which a trunnioned frame can rotate in a plane parallel to the floor of the vehicle. The load of the vehicle is transmitted from the hollow pivot to the trunnioned frame by a suitable thrust bearing, for instance, a ring of balls concentric with the pivot. The trunnion frame has projecting journals constituting an axis intersecting the axis of the hollow pivot at right angles and about which the bogey is within certain limits free to rotate about a horizontal axis perpendicular to the plane containing the road wheels and rail. The journals of this trunnion frame rest in bearings secured to the side frames of the under-carriage or bogey. It will thus be seen that the bogey frame is free to move within certain limits either about the substantially vertical axis of the hollow pivot or to rock in a fore-and-aft direction about the trunnions whose axis is thwartways of the vehicle. The journals of the road wheel axles are carried in trunnioned axle boxes formed by bearings provided with trunnions which fit in corresponding holes in guide plates sliding vertically in horn plates secured to the bogey, sufficient endwise freedom being allowed in the journals to permit such tipping of the axle in a vertical plane perpendicular to the rail as is permitted by the restraints to the vertical motion of the axle boxes. By these means the axle boxes of the road wheels are free to move vertically in the horn plates whilst restrained in a fore-and-aft direction and free to swivel in a plane perpendicular to the rail. The load is transmitted from the bogey frame to the axle journals as follows:—

Bearing washers seated upon suitable abutments secured to the bogey frames are provided on each side of the axle box so as to transmit the load from the bogey frame through springs, preferably helical, by means of suitable washers and nuts to tension rods. These tension rods are connected by pin connections to yoke levers carrying a pillow block provided with a spherical seating for a spherical-ended strut or the like which transmits the load shared between the springs to the top of the axle box bearings. Freedom for movement of the spherical-ended strut or the like in a plane perpendicular to the rail is provided for so as to allow tilting of the axle within the limits required. It is generally preferable to situate the yoke levers, tension rods, springs and abutments within the side members of the bogey frame when the latter are hollow, as for instance, when they are composed of plates connected together. It will be understood that the

bogey frame is composed of two side members one on each side of the road wheels, the side members being connected by suitable cross pieces.

In cases where electric motors are used to propel the vehicle I prefer to mount the motor rigidly to the frame of the under-carriage or bogey, as in this manner the whole of the weight of the motor is spring-borne. In such cases I find it convenient to mount an intermediate cranked shaft in bearings on the motor and to drive this shaft by means of a pinion of the motor armature shaft which meshes with a gear wheel on the intermediate shaft. The intermediate shaft carries cranks and crank pins at each end, these cranks being connected to similar cranks and crank pins upon the ends of the road wheel axle or axles. All coupling rods connecting cranks are preferably provided with spherical brasses at their ends in order to compensate for the freedom of the road wheel axles. In some cases further coupling rods may be employed to couple up the other wheel of the two-wheeled bogey, and again in some cases a second motor may be provided at the opposite end of the bogey frame, each motor then driving one wheel, which wheels may or may not be coupled together. When only one motor is provided the effect of its overhung weight at the end of the bogey frame is preferably compensated for by situating the bearings of the trunnion frame swivelling about the vertical pivot hereinbefore described as far as possible from the motor end of the bogey frame.

It is to be understood that in the simplest case a vehicle is provided with two bogies of the kind just described, in which case two hollow vertical pivots will be secured to the under-frame of the vehicle. In cases when it is desired to employ more than four road-wheels, say for instance, eight wheels, four bogies and their accompanying parts, similar to the bogie already described, are provided. Instead, however, of the trunnion frames of each of these bogies connecting directly on to the framing of the vehicle, they are connected on to vertical hollow pivots, carried upon equalising frames or levers. In the case under consideration there will be two of these equalising levers, one connected to two of the bogies, that is, to four of the wheels, and the other to the other two bogies.

At some intermediate point in its length, preferably at the centre of each of the yoke beams or frames, a trunnion member, similar to that already described, is provided, this trunnion member connecting to two vertical hollow pivots secured to the underside of the frame of the vehicle. It will thus be seen that each yoke or frame can swivel round the vertical pivots on the frame of the vehicle and that the bogies can swivel independently of one another round the vertical pivots carried upon the ends of the equalising beams or frames. Further that the equalising beams or frames can oscillate in a fore and aft direction about the trunnions connecting with the pivots on the vehicle frame, and each of the bogies can oscillate or rock in a fore and aft direction about the trunnions connecting with the vertical pivots carried by the equalising beams.

In the case when sixteen road wheels are employed all the parts described with reference to the eight wheel modification will be duplicated, but instead of the equalising bars engaging the pivots on the vehicle frame as they do in the eight wheel modification two further equalising bars are provided pivoted at or about their mid points to the vehicle frame and carrying at their extremities pivots engaging the beforementioned equalising bars.

In the case when eight or more wheels are employed similar swivelling axle boxes to those described in the first modification may be used for each of the road wheel axles, and, if desired, one or two motors may be mounted upon each bogie and any number of wheels connected by coupling rods.

I will now describe the braking devices which I prefer to employ with compound under-carriages of the type hereinbefore described.

Upon the framing of the vehicle I mount a standard or the like, carrying a wheel and screw shaft so arranged that rotation of the screwed shaft will pull a nut or cross-head along a slide, this cross-head or nut being connected by a suitable link to a bell-crank or the like. This bell-crank is connected by a

torque to the wheels so that the whole structure can turn about this rail head. With certain dispositions of the wheels on curves, however, it may happen that the points of contact of the wheels with the rail define an arc instead of a straight line, and in this case rigid connection between the vehicle body and the wheels must give place to a semi-rigid or free connection according to the conditions to be met. Moreover, in monorail vehicles since the dead weight of the vehicle is borne on a single line of rail a comparatively large number of wheels are often necessary in order to keep down the load per wheel, and it is then important to secure a fair distribution of the load.

Further, in single track vehicles kept in equilibrium by either of the means before stated, during the transmission of the righting torque to the vehicle the distribution of load on each journal of the road wheel axles of such vehicles is subject to variation according to the magnitude and direction of the said torque.

In the monorail vehicles having a plurality of supporting wheels it is essential to effect the braking of the wheels in such a manner that an equal braking effect is produced on each wheel braked. Further, owing to the fact that monorail vehicles are run upon a single line it is desirable in order to obtain adequate retarding effect to brake all the wheels. The problem therefore arises of applying an equal braking effect to all the wheels of a monorail vehicle.

The object of the present invention is to provide an improved construction of under-carriage for single track vehicles in which a proper distribution of the load over, in some cases, a large number of wheels is effected and in which under all conditions the vehicle may remain unstable apart from the stability imparted artificially to it.

A further object of the present invention is to effect the proper distribution of the load on each journal of the road wheel axles of single track vehicles according to the magnitude and direction of the righting torque.

A further object of the invention is to provide improved means for applying a braking effect to all the wheels on a single track vehicle.

The invention consists broadly in a vehicle, the body of which is supported at two points disposed respectively at suitable intermediate points of corresponding equalising or distributing frames or levers, the ends of each of these frames being supported at intermediate points of certain sub-frames, this system being repeated if desirable while the last set of frames are provided with suitable bearings for the vehicle wheels.

The invention further consists in an arrangement of under carriages substantially as indicated in the preceding paragraph and having at each and all of the points of support connections such as to permit relative motion between the parts in planes mutually at right angles to one another.

The invention also consists in an arrangement of under carriages, substantially as indicated in the two preceding paragraphs and having axle boxes so constructed and mounted that they are free to move vertically in the horn plates and are free to swivel in a plane perpendicular to the rail.

The invention further consists in an arrangement of braking devices for use with the under carriages of single track vehicles constructed substantially in accordance with the preceding paragraphs in which an equal braking effect is applied to each of two or more road wheels.

The invention further consists in the improved equalising under carriages, trunnion axle boxes, and equalising brake mechanism hereinafter described.

Referring now to the accompanying drawings:—

Figure 1 is a part sectional elevation showing a bogey and part of the vehicle frame and brake mechanism of a vehicle embodying the present invention.

Figure 2 is a plan of Figure 1.

Figure 3 is a cross sectional view through the hollow vertical pivots seen in Figures 1 and 2.

Figure 4 is a diagrammatic elevation showing the arrangement of wheels at one end of the vehicle when eight road wheels are employed to support the vehicle.

Figure 5 is an elevation view of the brake standard and equalising rock shaft.

Figure 6 is a plan of Figure 5.

Figure 7 is a detail, showing the cross head and connecting bell crank employed at the hollow pivot.

Figure 8 is a plan of Figure 7.

I will now describe a method of carrying my invention into effect in the case where the weight of the single track vehicle is supported by two bogies. For convenience of description I will describe the parts appertaining to one bogey, it being understood that the second bogey may be similar in all respects.

Upon the under frame, 94, of the car there is secured a hollow pivot, 95, perpendicular to the base of the car and about which a trunnioned frame, 96, can rotate in a plane parallel to the floor of the vehicle. The load of the vehicle is transmitted by a thrust bearing, for instance, a ball bearing, 97. The frame, 96, has projecting journals, 98, constituting an axis intersecting the axis of hollow pivot, 95, at right angles and about which the bogey is within certain limits free to rotate about a horizontal axis perpendicular to the plane containing the road wheels and rail. The journals, 98, rest in bearings, 99, secured to the side frames, 100, of the under carriage or bogey. The bogey frame is thus free to move within certain limits either about the substantially vertical axis of the hollow pivot, 95, or to rock in a fore-and-aft direction about the trunnions, 98, whose axis is thwartways of the vehicle. The journals, 101, of the road wheel axles, 102, are carried in trunnioned axle boxes formed by bearings 103, provided with trunnions, 104, fitting corresponding holes in guide plates, 105, sliding vertically in horn plates, 106, secured to the bogey, sufficient endwise freedom being allowed the journals 101, to permit such tipping of the axle in a vertical plane perpendicular to the rail as is permitted by the restraints to the vertical motion of the axle boxes. The axle boxes of the road wheels can thus move vertically in the horn plates, 106, whilst restrained in a fore-and-aft direction and free to swivel in a plane perpendicular to the rail, 107. The load is transmitted from the bogey frame, 100, to the axle journals, 101, as follows:—

Bearing washers, 108, seated upon suitable abutments, 109, secured to the bogey frame, 100, on each side of the axle box transmit the load from the bogey frame through springs, 110, preferably helical, by means of suitable washers, 111, and nuts, 112, to tension rods, 113. Tension rods, 113, are connected by pin connections, 114, to yoke levers, 115, carrying a pillow block, 116, provided with a spherical seating, 117, for a spherical-ended strut or the like, 118, which transmits the load shared between springs, 110, to the top of the axle box bearings, 103. Freedom for movement of the spherical-ended strut or the like, 118, in a plane perpendicular to the rail is provided so as to allow tilting of the axle, 102, within the limits required. It is preferable to situate yoke levers, tension rods, springs and abutments within the side members 100, of the bogey frame when the latter are hollow, as for instance, when composed of plates connected together as shown in the drawings. It will be understood that the bogey frame is composed of two side members, 100, one on each side of the road wheels, 119, the side members, 100, being connected by suitable cross pieces, 120.

In cases where electric motors are used to propel the vehicle I prefer to mount the motor, 121, rigidly to the frame of undercarriage or bogey, as in this manner the weight of the motor is spring-borne. In such cases I find it convenient to mount an intermediate cranked shaft, 122, in bearings, 123, on the motor and to drive this shaft by means of a pinion on the motor armature shaft which meshes with a gear wheel on the intermediate shaft, 122. The intermediate shaft, 122, carries cranks, 124, and crank pins, 125, at each end, these crank pins, 125, connecting by rods, 128, to similar cranks, 127, and crank pins, 126,

upon the ends of the road wheel axle or axles, 102. All coupling rods, 128, connecting cranks are preferably provided with spherical brasses in order to compensate for freedom of the road wheel axles. In some cases further coupling rods may be employed to couple up the other wheel of the two-wheeled bogey and again in some cases a second motor may be provided at the opposite end of the bogey frame, each motor then driving one wheel which wheels may or may not be coupled together. When only one motor is provided the effect of its overhung weight at the end of the bogey frame is preferably compensated for by situating the bearings, 99, of the trunnion frame, 96, swivelling about the vertical pivot, 95, as far as possible from motor end of the bogey frame.

It is to be understood that in the simplest case a vehicle has two bogies of the kind described, in which case two hollow vertical pivots are secured to under-frame of the vehicle. In cases when it is desired to employ more than four road-wheels, say for instance, eight wheels, four bogies and their accompanying parts, similar to the bogey already described, are provided. Instead, however, of the trunnion frames 95, of each of these bogies connecting directly on to the framing, 94, of the vehicle, they are connected on to the vertical hollow pivots, carried upon equalising frames or levers, 129. In the case under consideration there will be two of these equalising levers, 129, one connected to two of the bogies, that is, to the four of the wheels, and the other two bogies.

At some intermediate point in its length, preferably at the centre of each of the yoke beams or frames, 129, a trunnion member, 130, similar to that already described, is provided, this trunnion member connecting to a vertical hollow pivot secured to the underside of the frame, 94, of the vehicle. It will thus be seen that each yoke or frame, 129, can swivel round the vertical pivots on the frame, 94, of the vehicle and that the bogies can swivel independently of one another round the vertical pivots carried upon the ends of the equalising beams or frames, 129. Further that the equalising beams or frames can oscillate in a fore and aft direction about the trunnions, 130, connecting with the pivots on the vehicle frame, and each of the bogies can oscillate or rock in a fore and aft direction about the trunnions, 96, connecting with the vertical pivots carried by the equalising beams.

In the case when sixteen road wheels are employed all parts described with reference to the eight wheel modification are duplicated, but instead of the equalising bars, 129, engaging the pivots on the vehicle frame as in the eight wheel modification two further equalising bars are provided pivoted at or about their mid points to the vehicle frame and carrying at their extremities pivots engaging the before mentioned equalising bars, 129, by means of the trunnion members, 130.

In the case when eight or more wheels are employed similar swivelling axle boxes to those described in the first modification may be used for each of the road wheel axles, and, if desired, one or two motors may be mounted upon each bogey and the wheels connected by coupling rods.

I will now describe the braking devices which I prefer to employ with compound under carriages of the type hereinbefore described.

Upon the framing, 94, of the vehicle I mount a standard or the like, 131, carrying a hand operated brake actuating wheel or handle, 132, and screw shaft, 133, arranged to pull a nut or cross-head, 134, along a slide, this cross-head or nut being connected by links, 135, to a bell-crank or the like, 136. This bell-crank connects by a connecting-rod, 137, to an arm, 138, carried by a shaft, 139, carried in suitable bearings 140. At the opposite end of this shaft, 139, to that carrying the first mentioned arm, 138, is another similar arm, 141, this arm being connected to any suitable mechanical brake-operating device or to the piston of a fluid-pressure braking device, 142, such as the Westinghouse or like brake. The braking effect of such device being additional to the effect produced by the hand operated wheel or handle, 132. The shaft, 139, carrying these arms is situated substantially over one of the hollow vertical

pivots, 95, secured to the bottom of the vehicle. Upon the shaft there is mounted a third arm, 143, substantially at right angles to the two above mentioned arms, the end of which is arranged to oscillate in an up-and-down direction over the hole in the vertical hollow pivot. This arm, 143, carries a link, 144, upon the end of which is secured an equalising link, 145; one end of this equalising link, 145, is situated directly over the centre of the opening in the vertical hollow pivot, 95, and carries a link, 148, depending into this opening; the other end of the equalising link, 145, is connected by bell crank, 146 and rod, 147, to a bell crank, 149, situated near the other vertical hollow pivot secured to the bottom of the vehicle and arranged with one arm immediately over the opening in that hollow pivot.

The link, 148, depending from the equalising lever, 145, is pivotally attached to a cross-head, piece, 150, secured by a grub screw or otherwise in a member, 151, contained within and sliding in the hollow vertical pivot, 95, secured to the underside of the vehicle. This cross-head, 150, has attached to it by a swivel, 152, a second cross-head 153, which is also within the member, 151. The swivel 152, may conveniently be composed of a series of buttress like rings, turned on one member and engaging buttress like grooves turned in the other member, the member containing the grooves being made in halves in order that the parts may be assembled. A feather may be provided to prevent rotation of the member, 151, within the pivot, 95. The cross head, 153, connected by a swivel to cross-head, 150, has depending from it a link, 155, which engages one arm of a bell crank, 156, the other arm of which carries a brake shoe, 157. The pivot, 158, upon which bell crank, 156, is mounted is carried by floating pendulum levers, 159, depending from yoke, 160, crossways of bogey frame, connection to this yoke being by a pin, 161. Also connecting to the pin, 158, is another link or frame, 162, carrying at its end a second brake shoe, 163, the weight and braking strains of this second brake shoe being taken by a further system of pendulum levers, 164. It will thus be seen that upon pulling on one arm of the bell crank, the brake shoes are forced apart and against the bogey wheels, suitable adjusting means 163, are provided in the link, 162, and on bell crank, and on pendulum levers for adjusting the angle of the brake shoes.

All the mechanism just described is repeated on each of the bogies, the connection between each group of bogies being effected through equalising means according to the foregoing description.

It is to be understood that in some cases the equalising beams or frames, 129, to which the bogies are pivoted when more than four road wheels are employed may be disposed alongside the road wheels instead of above them. Further, the axis of the trunnions of the frames, 96 and 130, which pivot about the vertical hollow pivots may be arranged in the same or below the plane of the road wheels axles.

Suitable lubricating devices may be provided for the road wheel axle journals and all moving parts.

Although spiral springs have been described laminated springs may be employed and arranged to bear either directly upon the pillow block, 116, before mentioned or upon the tension rods, 113.

The intermediate cranked shaft bearings, 123, may be secured directly to the bogey frame when desired.

Balance weights, 166, upon the cranks or road wheels may be provided. In the case when buffers and couplings are required they are preferably arranged upon the end of the bogey frames adjacent to the ends of the single track vehicle. When buffing and traction strains are thus taken by the bogies it is preferable to arrange the axis of the trunnions, 98, in the plane of the road wheel axles, 102.

It will be understood of course that the road wheels, 119, are preferably double flanged and their peripheries formed of a contour suitable to engage the rail head. Like-wise the brake blocks are preferably formed with a contour

the counterpart of the wheel tyre so as to fit the same. Moreover each brake block is free to rotate upon the pin connecting it to its supporting lever, about an axis parallel to the rail so that lateral oscillation of the wheel is not impeded such lateral oscillations occurring during recovery of the vehicle under external upsetting forces or when inequalities in the track are encountered.

Any suitable motive power may be employed provided provision is made for conveying the drive to the road wheels so as to compensate for relative movement between the parts.

In some cases I may provide brake cylinders operated by fluid pressure upon the bogey frames themselves to operate the brake blocks by suitable means and convey fluid pressure to these cylinders by flexible piping from the vehicle body.

When desired suitable sanding mechanism is applied to the bogey frames and operated by mechanical means or by fluid pressure from the vehicle body.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a single track vehicle, supporting the body of the vehicle at two points disposed respectively at suitable intermediate points of corresponding equalising or distributing frames or levers, the ends of each of these frames being supported at intermediate points of certain sub-frames, this system being repeated if desirable while the last set of frames are provided with suitable bearings for the vehicle wheels substantially as described.

2. In an arrangement of under-carriages for single track vehicles as claimed in Claim 1, joints for connecting the several frames to one another and to the vehicle body comprising hollow pivots attached to one of the frame members or to the under side of the vehicle, trunnion carrying members adapted to swivel round the said pivots, and bearings carried by another of the frames and engaging the said trunnions, substantially as and for the purposes described.

3. In an arrangement of under-carriages for single track vehicles, axle boxes so constructed and mounted that they are free to move vertically in the horn plates, and are free to swivel in a plane perpendicular to the rail substantially as described.

4. In a single track vehicle, driving devices comprising a motor carried on the body of the under-carriage or bogey, driving an intermediate shaft from which the road wheels are driven by connecting rods, substantially as described.

5. In an arrangement of under-carriages, as claimed in Claim 1, braking devices in which an equal braking effect is applied to each of two or more road wheels, said devices comprising swivelling cross heads working within the hollow pivots, attached to the vehicle body, links connecting said cross heads with bell cranks adapted to operate links carrying brake shoes, said cross heads being connected together by bell cranks and connecting rods, substantially as described.

6. The improved equalising under-carriages, trunnion axle boxes and equalising brake mechanism, substantially as described with reference to the accompanying drawings.

Dated this 8th day of June, 1910.

MARKS & CLERK,
57 & 58, Lincoln's Inn Fields, London, W.C.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 25—50/6/1912.]

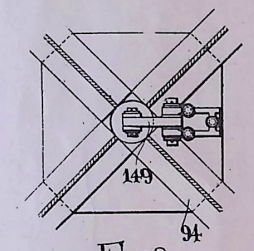


Fig 8

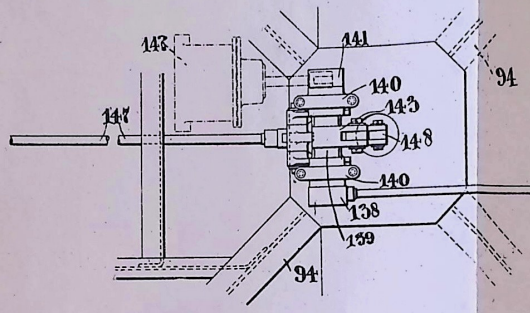


Fig.6.

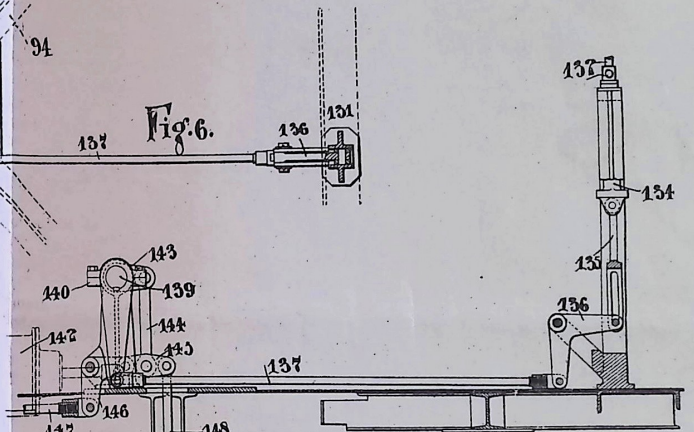


Fig.7.

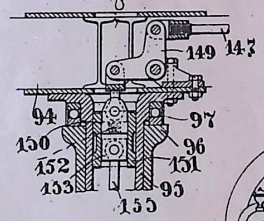
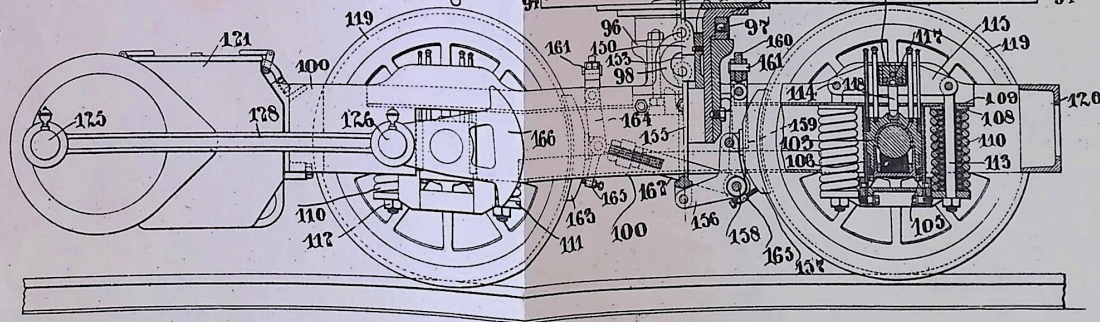


Fig.1.



Malby & Sons, Photo-Litho.

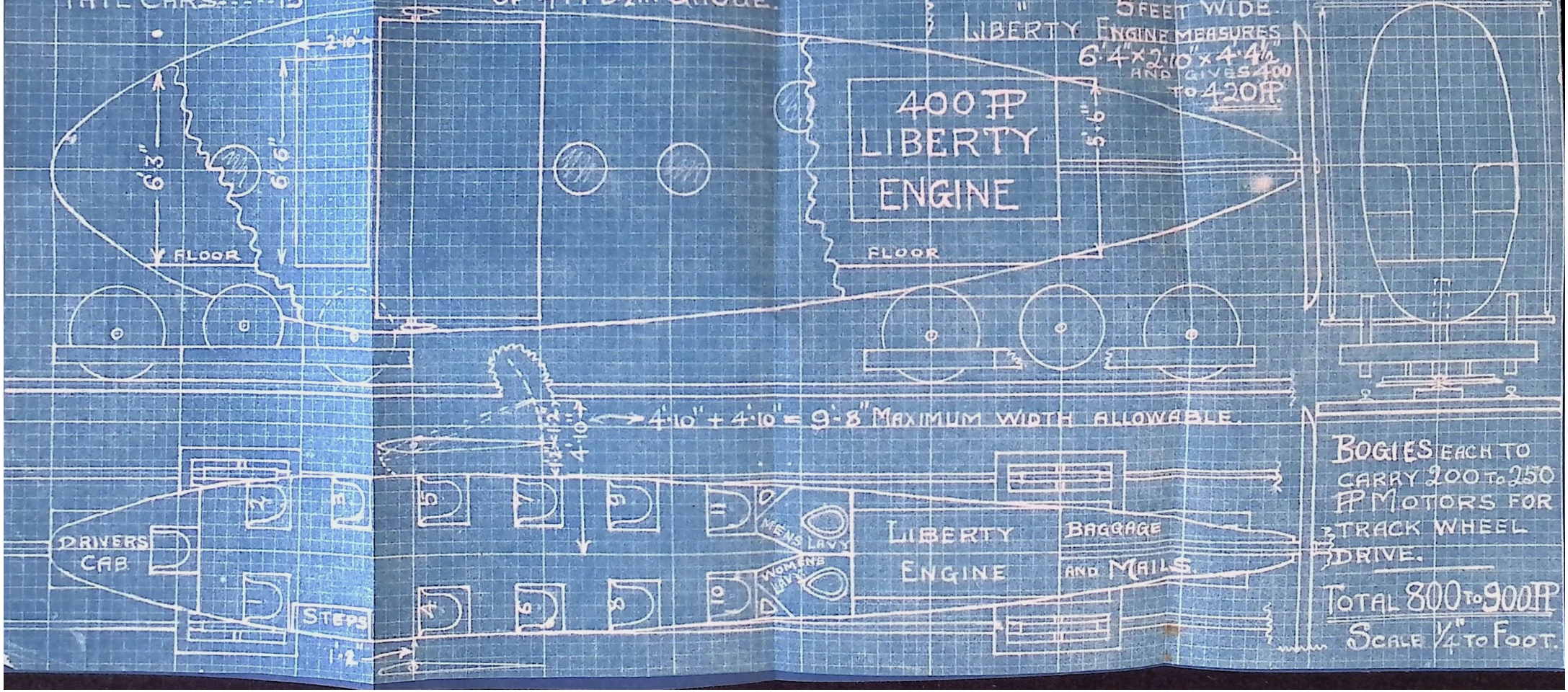
J.C.M. MONO-RAILWAY.

DEMONSTRATION CAR.

SINGLE CAR----11 PASSENGERS
NOSE CAR-----17 "
CENTER CARS---25 "
TAIL CARS-----13 "

THESE CARS ADAPTED TO RUN UPON MONO-RAIL MOUNTED BETWEEN TWIN RAIL SYSTEM OF 4FT 8½IN GAUGE.

ELEVATION 4 TO 1 STREAMLINE.
PLAN 8 TO 1 STREAMLINE.
LENGTH 40 FEET.
MAXIMUM HEIGHT 10 FEET (BODY)
MAXIMUM WIDTH OF BODY 5 FEET
MAXIMUM WIDTH (AT MAXIMUM ANGLE OF INCIDENCE) OVER AEROFOILS 9FT 8IN.
AEROFOILS 9 FEET HIGH.
" 5 FEET WIDE.
LIBERTY ENGINE MEASURES 6'4"×2'10"×4'4½" AND GIVES 400 TO 420HP.



BOGIES EACH TO CARRY 200 TO 250 HP MOTORS FOR TRACK WHEEL DRIVE.

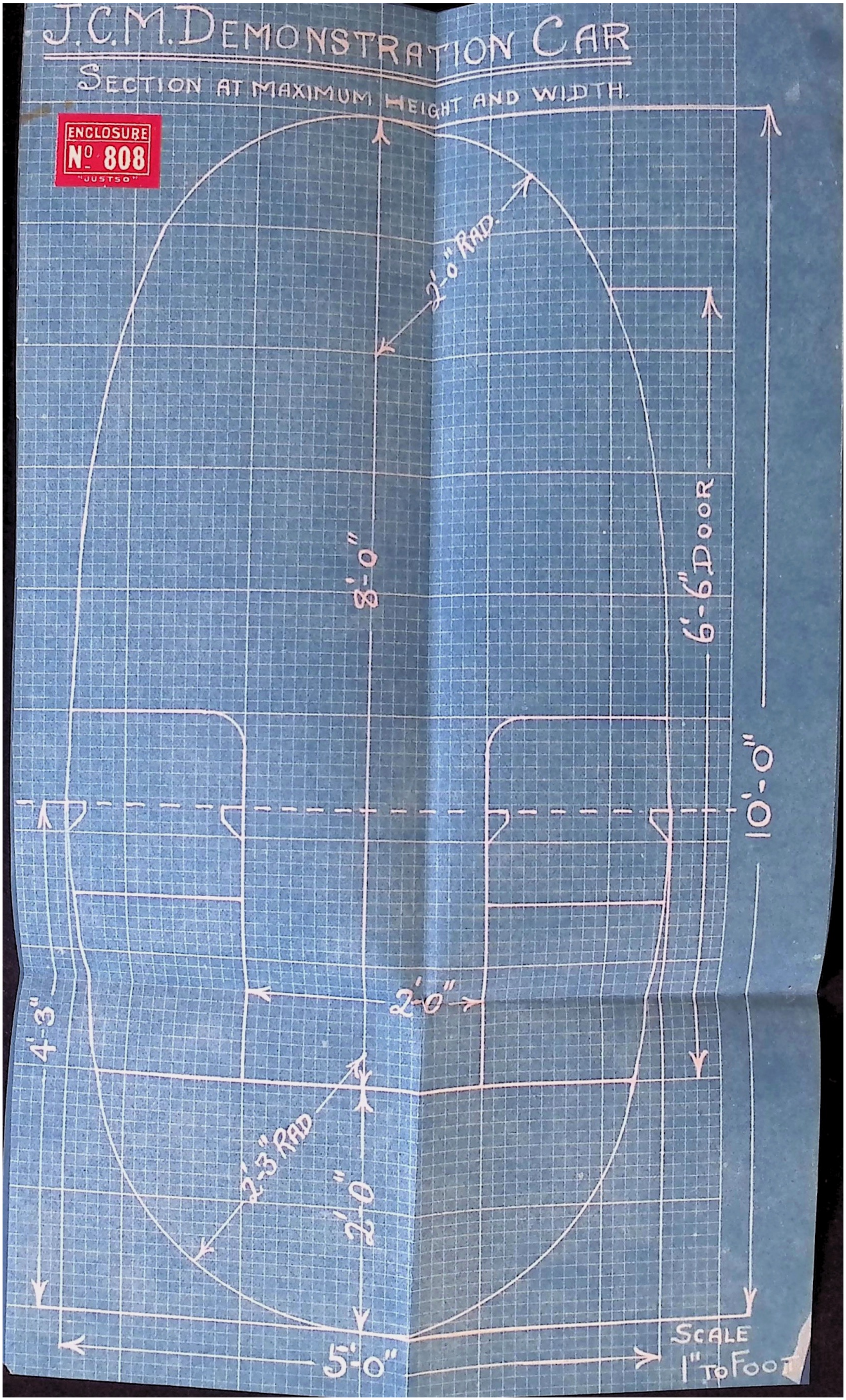
TOTAL 800 TO 900HP

SCALE ¼" TO FOOT.

J.C.M. Demonstration Car

Section at Maximum Height and Width.

ENCLOSURE
No. 808
"JUSTSO"



HEADS OF SYNDICATE AGREEMENT
or
EXPLORATION PARENT COMPANY.

A N A G R E E M E N T made B E T W E E N EDMOND ERNEST JOHNSON of Maescourt Maidenhead Berks England (hereinafter called "the Vendor)of the one part and

(hereinafter called "the Syndicate")of the other part WHEREAS the Patentee is the originator of the J.C. M. High Speed Mono-Railway and the patentee of an invention which is the subject of letters patent granted or about to be granted in the United States of America whereof the Serial No.is 515217 AND WHEREAS the Syndicate has agreed to purchase an option to acquire such interest in the said patent invention and on such terms as hereinafter appear and to pay for the demonstration in the United States of America of the said railway and invention in manner hereinafter appearing and further to use their best endeavours to cause the same to be adopted and used and to do such other acts and things as are hereinafter mentioned NOW it is hereby agreed as follows - between the parties hereto

1. The syndicate shall at its own expense in all things obtain from the Vendor and import into the United States of America and demonstrate the working of a model car provided with a 75/100 H.P.Rolls-Royce engine and fitted with Tractor Propeller ~~or such other engines previously~~ (excluding Carburetter) ~~as may in writing be approved of by the parties hereto~~ The model car shall be according to the attached specification or as may be mutually agreed in writing by the parties hereto.

2. An order for the model car together with a deposit of ~~£ 3,750~~ $5,000 on account ofthe cost thereof shall be lodged with the Vendor within 7 days from the date hereof. $5,000

3. It shall be competent for the Vendor to have the under carriage Radiator, Carburetter aerofoils and ancillary gear manufactured in the U.S. A.if deemed advisable .

3. The vendor will cause the model car to be delivered or manufactured and assembled at New York as soon as practicable and the Syndicate will pay the vendor the balance of the cost of the same including under carriage aerofoils and ancillary gear, such balance not exceeding the sum of £ 5,000 within 7 days after arrival or assembly in New York. The said cost is exclusive of packing freight customs and handling which shall be paid or reimbursed by the Syndicate in addition.

4. The syndicate will at its own expense cause to be provided erected and equipped or will arrange for the exclusive use for the demonstration of the car of a Twin Rail Track 4' 8½" gauge with a central Mono-Rail with a run of not less than 4 English miles Together with suitable housing for the model car. Such track shall be provided finished andequipped fit and ready for the use of the model car within three months after the arrival of the same in New York. The locality of the track and the gradient thereof and the disposition of the same as to being straight or curved and in all other respects and all other details of the construction thereof shall be to the satisfaction of the Vendor or someone nominated by him for the purpose .

5. The Vendor will provide a demonstrator of the model car for a period of three months after the completion of the car and track in all respects to the satisfaction of the Vendor and the Syndicate will at its own expense use its best endeavours to exhibit the car and commend its adoption in all desirable quarters and before all persons likely to be interested in its practical and remunerative adoption and public use.

6. The necessary labour fuel oil and other supplies for operating the model car and all necessary advertisements and notices shall be provided by and at the expense of the Syndicate who shall cause the car to be insured in the name

and for the benefit of the Vendor and to his satisfaction in the sum of £ 10000 at least against risks of fire burglary Larceny and all other insurable risks The Car shall be redelivered to New York at the completion of the demonstrations by and at the cost of the Syndicate unless the option hereinafter mentioned is exercised.

7. Upon the arrival of the said Car in New York & the completion of the same and of the track the Syndicate will use its best endeavours to form a Company to acquire a licence to work the patent rights either exclusively or otherwise in the various states of the Republic covered by the U. S. patent and the syndicate shall be deemed to have Licence for the period of months from the date of its arrival or completion in the United States to operate the same but for the purposes of demonstration only but not of working for profit.

8. Upon payment to the vendor of the sum of £ 35,000 the syndicate shall have an Option to be exercised by notice in writing to be given to the Vendor at in the United States of America within months from the date hereof to acquire an exclusive non-assignable Licence to work the said Patent invention in the United States of America to be granted to any Corporation or Company to be approved of by the Vendor formed to work the same upon the terms following that is to say

(A) The Vendor to receive a royalty of £ 1,000 per car fitted with the patent invention manufactured within the United States of America or imported into the United States of America or in respect of each pair of aerofoils so manufactured or imported as the case may be whether applied to a mono rail vehicle or not.

(B) The Vendor shall receive one third of the cash and of the shares or stock allotted and of all other consideration whatsoever payable for the rights

conferred under this Option by any transferee of the said License approved of by the Vendor and a like proportion of the shares of all subsidiary Corporations to be formed by the parent corporation(with the Vendors consent) for working the said patent invention. The constitution of every such Corporation or Company whether subsidiary or ⊙

Otherwise and the salaries or share of profits of all officials thereof shall be subject to the approval of the Vendor.

(C) The aforesaid and all other Licences to work the said Patent invention shall be conditional uponthe same being worked to the uotmost capacity of the Licensee with a minimum of 25 new cars turned out per ~~annum~~ and of 250 miles being run per ~~annum~~ by cars so fitted with the patent invention and in default of compliance with this clause all licences affected shall be revocable at the option of the Vendor or ~~other the~~ owners of the Patent.for the time being.

(D) The Vendor shall also receive during the continuance of his Patent a payment of £ 100 per annum per English mile of track used by cars fitted as aforesaid within the United states of America and in the reckoning of such mileage each way up and down shall be separately reckoned together with (in addition) the length of all bays passing places sidings and the like.

9. The Patentee and his successors in title shall have the right to nominate two members of the Board of the parent and of any subsidiary Corporations as aforesaid including the right for the patentee or such successors to nominate himself or themselves.

~~10.~~

This invention relates to the stabilization of moving bodies and has for its object to provide improved means for counteracting forces acting laterally thereof, or thereagainst, such, for instance, as centrifugal force or the effects of side winds.

According to this invention a body is provided on each side with an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

Each aerofoil is adapted to exert, when the body is in motion through a fluid, a lateral force adapted to counteract a lateral force such as the centrifugal action set up when rounding a curve or the effect of a side wind, and for the purpose of counteracting such force as closely as possible each aerofoil may be set by hand, both with regard to its angle of incidence and with regard to its camber, but preferably automatically acting means would be provided to attain these ends. For instance a servo-motor controlled by a pendulum may be employed for varying the angle of incidence of the aerofoils to counteract centrifugal force in rounding a curve, whilst a servo-motor controlled by a pennant may be employed for a like purpose to counteract the effect of a side wind, and a servo-motor controlled by an aero-static device may be employed for varying the camber of the aerofoils to maintain the latter at their most efficient configuration according to the speed at which the body is moving. The aerofoils are mounted simultaneously and in the same direction so that when their angle of incidence is varied the force acting on the one would tend to push, and the force acting on the other would tend to pull, the body towards the inner side of the curve.

The invention is especially applicable to rapidly moving bodies, such, for instance, as mono-railway vehicles, which,

in rounding curves and or when subjected to a strong side wind, transmit the lateral strain or a part thereof to the permanent way.

The aerofoils should be mounted so that their centres of pressure lie in or near the transverse vertical and horizontal planes in which lie the centre of gravity of the vehicle and the means for varying their angle of incidence and camber may be of any known type as used on aeroplanes. By the use of aerofoils as set forth above a component of the resistance presented by each counteracts the laterally acting centrifugal or wind force.

If desired, and for the preservation of balance, when the body or bodies is or are moving at speed, one or more additional aerofoils may be provided and mounted on each body so that the angle of incidence of each aerofoil is variable about an axis passing through the centre of gravity of the respective body. When more than one additional aerofoil is employed on a body, they may be operated simultaneously but may act in conjunction with each other thereby displacing a volume of air, on each side of the moving body, of sufficient mass to maintain lateral rolling equilibrium. Their controls may also be operated automatically through forces acting from the body at the point or points of contact with the supporting medium.

In addition to the stabilizing effects which may be obtained the aerofoils may also be actuated so as to operate

The accompanying drawings illustrate diagrammatically one method of carrying out the invention Figure 1 being a side elevation of a monorail vehicle, parts being broken away, and Figure 2 being a plan thereof. Figure 3 is a plan on a larger scale of the means for varying automatically the camber of the aerofoils, Figure 4 is a transverse sectional elevation on

the algebraic sum of the pendulum and pennant movements, i.e. the valve opening which should result from a given amount of centrifugal action on the pendulum s may be augmented or decreased, as a result of wind action on the pennant t.

It is to be understood that the mechanisms shown in Figures 4 and 5 lie in the same or nearly the same plane and that they are shown separately merely for the sake of clearness.

In order that the camber of the aerofoils e may be adjusted so that their configuration is the most efficient according to the speed at which the vehicle is travelling, and ventrifugal action on the body a, each aerofoil e is hollow and has fixedly mounted therein a block 52 through a slot 53 in which passes the crank 54 of a vertical crank shaft 55 adapted to deform the walls of the aerofoil e and so adjust its camber. Each crank shaft 55 is connected by an extensible Cardan shaft 56 (Figure 7) with a crank shaft 57 (Figures 3 and 7) disposed transversely of and near the bottom of the body a the cranks 58 and 59 of which are united by connecting rods 60,61, with the piston rods 62,63 of servo-motors 64,65, the cylinders of which are connected through pipes 66, 67, with a valve chest 68 similar to the valve chests 25 and 26. The valve chest 68 has two inlets 69,70 for fluid under pressure connected with the casing 71 of a cock 72, said casing being connected by a pipe 73 with a source of fluid under pressure (not shown). The cock 72 has an admission port 74 extending through nearly 270° and a centrally escaping exhaust port 75 and is operated by a pendulum 76. The valve rod 77 of the valve in the chest 68 passes slidably through the ends of a chamber 78 in which is centrally disposed a flexible diaphragm 79 to which said valve rod 77 is secured. Opening into the chamber 78 are two pipes 80 and 81, one at each side of the diaphragm 79, said pipes leading forwardly and projecting through the body a, the open

29/9/21.

end of the pipe 80 being covered by a cowl 82. As the vehicle moves forwards the rush of air over the cowl 82 creates a partial vacuum in the pipe 80, whilst the air entering the open end of the pipe 81 sets up pressure therein with the result that the diaphragm 79 is deformed, and the valve rod 77 is moved, to an extent depending upon the speed of the vehicle. The admission port 74 of the cock 72 is adapted, when said cock is turned in the one direction or the other, to establish communication between the pipe 73 and either the pipe 69 or the pipe 70 thus admitting fluid under pressure to the cylinder of the servo-motor 64 or of the servo-motor 65 whilst the exhaust port 75 communicates with either the pipe 70 or the pipe 69, and exhausts the cylinder of the servo-motor 65 or of the servo-motor 64.

The pendulum 76 which actuates the cock 72 being subject to centrifugal action serves to determine which of the servo-motors 64 and 65 shall actuate the crank shafts 57, and 55, 55, according as it becomes necessary to vary the camber of the aerofoils to, and adjust it on, the one side or the other of the central neutral chord, as indicated in Figure 3.

It is to be understood that the valve mechanisms of the various servo-motors may include any known form of hunting gear, where required, in order to cut off admission of fluid under pressure to the cylinders of the servo-motors in accordance with the effect to be produced.

If desired a chamber such as 78, having a diaphragm such as 79, and associated parts as hereinbefore set forth, with a servo-motor having a double acting cylinder and valve mechanism including, if necessary, hunting gear, or with an electric servo-motor, may be employed for varying, on one side only of the neutral chord, the camber of the wings of an aircraft according to its speed or other circumstances.

30/9/21

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:-

1. Improved means for stabilizing moving bodies which consists in providing on each side of a body an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

2. Improved means for stabilizing moving bodies as claimed in Claim 1, wherein the variation of the angle of incidence of the aerofoils or cambered vanes and/or the variation of their camber is effected automatically by means of servo-motors.

3. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein the servo-motor for effecting automatically variation of the angle of incidence of the aerofoils or cambered vanes is controlled by a pendulum adapted to function under centrifugal action.

4. Improved means for stabilizing moving bodies as claimed in Claim 3, wherein the control exercised by the pendulum is modified by means actuated by a servo-motor controlled by a pennant adapted to function under the influence of a side wind.

5. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein servo-motors for effecting automatically variation of the camber of the aerofoils or cambered vanes are controlled by a diaphragm in a chamber into which open on opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is covered by a cowl, substantially as and for the purpose set forth.

6. Improved means for stabilizing moving bodies as claimed in Claim 4, wherein the servo-motor is adapted to vary the leverage of the pendulum action upon the valve rods of the

30/9/21

servo-motor for varying the angle of incidence of the aerofoils or cambered vanes.

(7) 7. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein the variation of the angle of incidence of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1, 2, 4, 5 and 6 of the accompanying drawings.

(8.) 8. Improved means for stabilizing moving bodies as claimed in Claim 2, wherein the variation of the camber of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1,2,3 and 7 of the accompanying drawings.

(9.) 9. A monorail vehicle constructed and arranged substantially as and for the purposes hereinbefore set forth with reference to the accompanying drawings.

(16) ~~10~~ Means for varying on one side of the neutral chord the camber of the wing of an aircraft, comprising a crank movable in one or more slotted blocks secured to the walls of a wing, said crank being operated by a servo-motor, which is controlled by movement of a diaphragm in a chamber into which chamber open on opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is covered by a cowl, substantially as set forth.

Dated the 30th day of September, 1921.

A. A. Hill & Clark

Chartered Patent Agents,

53 & 54, Chancery Lane,

LONDON, W.C.2.

REVISED CLAIMS

(C O P Y)

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:-

1. Means for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body which consist in providing on each side of said body an aerofoil or cambered vane mounted so that its angle of incidence may be varied about a vertical axis and constructed so that its camber may be varied towards either side of a neutral plane.

2. Means, as claimed in Claim 1, for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body, wherein the variation of the angle of incidence of the aerofoils or cambered vanes and/or the variation of their camber is effected by means of automatically controlled servo-motors.

3. Means, as claimed in Claim 2 for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body wherein the aerofoils or vanes are so mounted that their centres of pressure lie in or near the transverse vertical and horizontal planes in which lies the centre of gravity of the vehicle and wherein the valve chests of the servo-motor for effecting automatically variation of the angle of incidence of the aerofoils or cambered vanes to the one side or the other are controlled by a pendulum adapted to function under centrifugal action and a correspondingly-moving arm geared thereto, in combination

7/1/22

with a servo motor controlled by a pennant adapted to function under substantial lateral wind pressure, the control exercised by the pendulum and the arm geared thereto being modified by the action of the servo-motor controlled by the pennant, substantially as hereinbefore set forth.

4. Means, as claimed in Claim 2 for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body, wherein servo-motors for effecting variation of the camber of the aerofoils or cambered vanes are regulated automatically by a diaphragm in a chamber into which open on opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is covered by a cowl, substantially as and for the purpose set forth.

5. Means, as claimed in Claim 3, for neutralizing lateral fordes acting in a horizontal plane on either side of a moving monorail vehicle body wherein the servo-motor controlled by the pennant is adapted to vary the leverage of the pendulum action upon the valve rods of the servo-motor for varying the angle of incidence of the aerofoils or cambered vanes.

6. Means for varying on one or other side of the neutral chord the camber of each of the aerofoils set forth in Claim 1, comprising a crank movable in one or more slotted blocks secured to the walls of an aerofoil, said cranks being operated by a servo-motor, which is controlled by movement of a diaphragm in a chamber into which chamber open on

opposite sides of the diaphragm two forwardly projecting tubes the open end of one of which is cover ed by a cowl, substantially as set forth.

7. Means, as claimed in Claim 2 for neutralizing lateral forces acting in a horizontal plane on either side of a moving monorail vehicle body, wherein the variation of the angle of incidence of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1, 2, 4, 5 and 6 of the accompanying drawings.

8. Means, as claimed in Claim 2, for neutralizing lateral forces acting in a horizontal plane on either side of a moving mono-rail body, wherein the variation of the camber of the aerofoils or cambered vanes is effected by means constructed, arranged, and adapted to operate substantially as hereinbefore set forth with reference to Figures 1, 2, 3, and 7 of the accompanying drawings.

9. A monorail vehicle constructed and arranged substantially as and for the purposes hereinbefore set forth with reference to the accompanying drawings.

Dated the 30th day of September, 1921.

(sgd) A.M. & Wm. Clark,
Chartered Patent Agents,
53 & 54, Chancery Lane,
London, W.C.2

HEADS OF AGREEMENT between E.E. Johnson Esq. and Captain Crossley Meates.

Date.

Parties.

Recite.

E.E. Johnson Inventor of the Highspeed Mono Rail and sole Patentee thereof in England U.S.A. and France and that Captain Crossley Meates has contributed certain services ~~and~~/ de/ de/ ~~funds~~/in the development of the invention.

de/ E.E. Johnson has ~~also~~/expended considerable sums in such development and in the invention and experiments prior and subsequent thereto.

E.E. Johnson about to proceed to U.S.A. with the object of developing and exploiting the invention there.

1. E.E. Johnson's contribution ~~to-date~~ as at Oct. 31st, 1922 to be reckoned at the sum of £ 314. 11. 0. and the account to be continued on the same basis

2. Captain Crossley-Meates ~~contribution~~ to receive Credit to date to be reckoned at the sum of £ 626. 13. 2.

3. The future exploitation and development of the invention in all parts of the world to be under the direction of E.E. Johnson who is about to proceed to U.S.A. for the purpose of such development and exploitation.

4. E.E. Johnson under this agreement is to have a free hand as to the terms on which the invention is disposed of or dealt with in the U.S.A. and elsewhere.

5. All proceeds from the development of the invention in all parts of the world are to be divided between the parties

hereto in the proportion of 60% for E.E. Johnson and 40% for Captain Crossley Meates subject nevertheless to the next clause.

6. The present expenditure to date is to be repaid to the parties out of the first return received or so far as such return shall permit (before any division pursuant to Clause 5) and proportioned according to the respective amounts due to the parties.

7. The costs of the trip to U.S.A. of E.E. Johnson including inter alia all travelling and all living expenses