E. FALCKE.

GYROSTATIC MECHANISM.

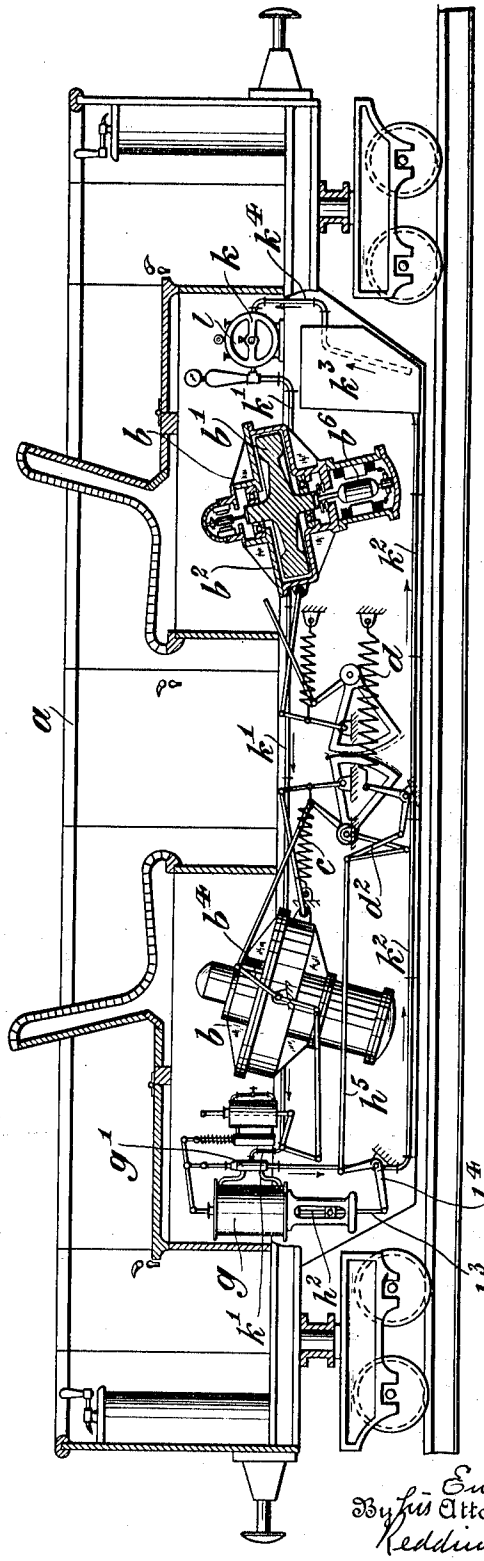
APPLICATION FILED OCT. 26, 1910.

1,048,817.

Patented Dec. 31, 1912.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
Geo. Schmaltz
Sally Rasso

Inventor
Emil Falcke
By his Attorneys
Redding, Greeley & Austin

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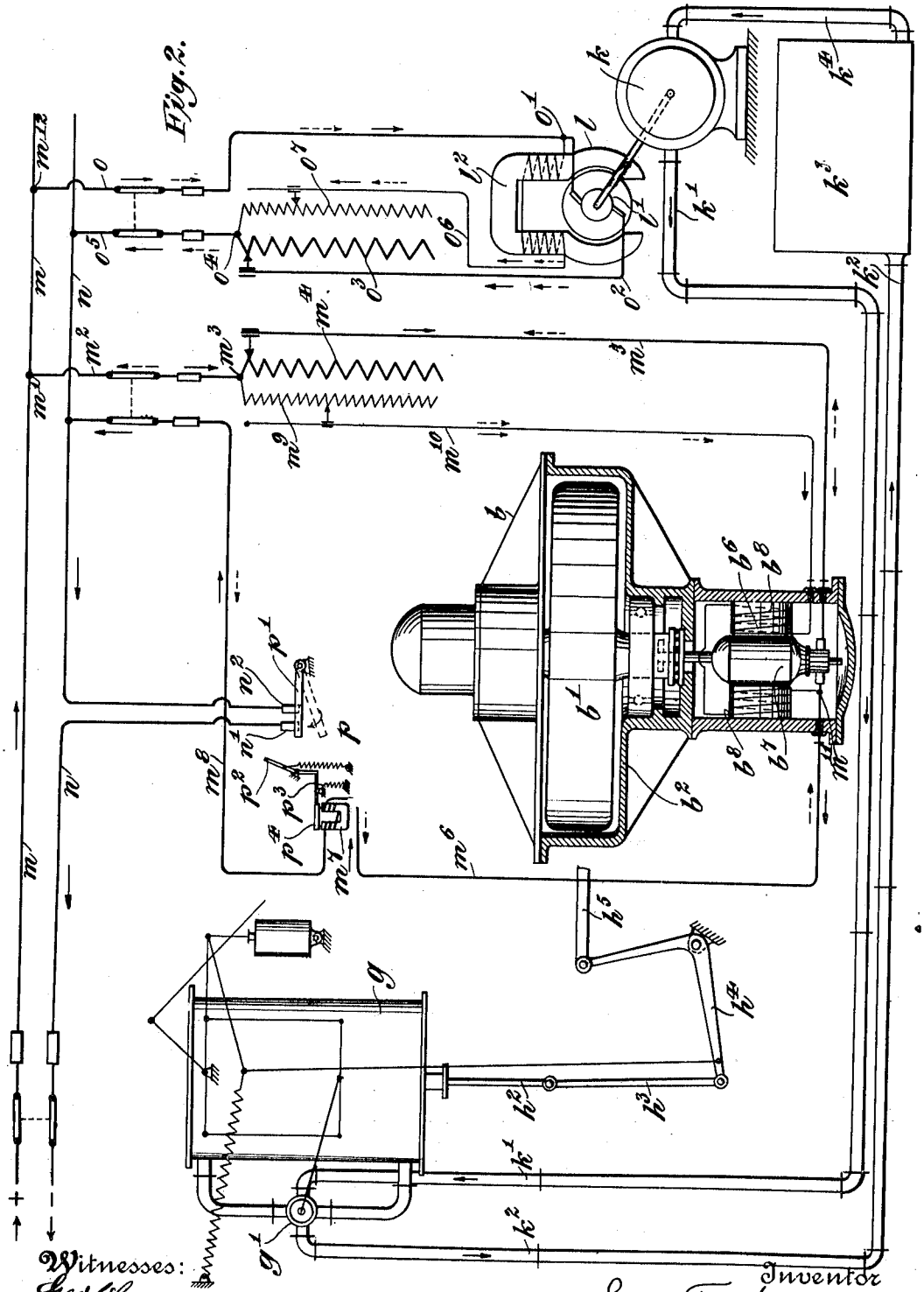
2 SHEETS—SHEET 2.

Fig. 2.



Witnesses:
Geo. Schmarz
Sully Russo.

Inventor
Emil Falcke
By his Attorneys
Redding, Greeley & Austin

UNITED STATES PATENT OFFICE.

EMIL FALCKE, OF DRESDEN, GERMANY, ASSIGNOR TO SCHERL MONORAIL COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

GYROSTATIC MECHANISM.

1,048,817. Specification of Letters Patent. **Patented Dec. 31, 1912.**

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To all whom it may concern:

Be it known that I, EMIL FALCKE, a subject of the Emperor of Germany, residing at Dresden, Germany, have invented certain new and useful Improvements in Gyrostatic Mechanism, of which the following is a specification, reference being had to the accompanying drawing, forming a part hereof.

In the application of the gyrostat to the stabilization of bodies in unstable equilibrium, and particularly of single track, wheeled vehicles or cars in which the heavy, rotating body of the gyrostat is maintained in rotation at a high velocity by an electric motor supplied with current from an external source, the rotating body may continue to rotate at a sufficiently high velocity to maintain the equilibrium of the car for a considerable time after the supply of current is interrupted. In such a car, however, it is necessary that a controlling force shall be applied to the gyrostat within the car and that means shall be provided for controlling such controlling force to meet the varying conditions imposed by various external forces, such as gravity and wind pressure, to which the car is subjected. Devices suitable for such purposes are shown in other applications, Ser. No. 533,462 filed December 15, 1909 and Ser. No. 588,562 filed October 22, 1910, in which it is assumed that the force applied to the rotation of the gyrostat is not interrupted and that, while the controlling force applied to the gyrostat within the car is exerted by a spring, the servomotor, or device by which such controlling force is controlled, is likewise operated from a source of power which is not interrupted. Such servomotor is shown as operated by oil under pressure from an oil pump driven by an electric motor which derives its supply of current from the same external source as that which supplies the current for the rotation of the heavy disk. Obviously, it is a practical necessity that the servomotor, and therefore the operating means, shall continue to operate after the external current supply is interrupted so that the servomotor may continue to act until the operator of the car may bring the car to rest and let down the mechanical supports which may then be relied upon to keep the car upright.

It is the object of this invention to provide means whereby the oil pump or other operating devices of the servomotor shall continue to operate after the external current supply is interrupted.

In accordance with the invention the electric motor of the operating devices is so connected with the feed wires and with the motor of the gyrostat that when the external supply of current is interrupted the kinetic energy of the gyrostat may be utilized to drive its motor as a dynamo to supply current to the motor of the operating devices, provision also being made to guard against interruptions of the current to the motor of the operating devices under such conditions by the burning out of the safety fuses within the car, as might happen in the event of a short circuit outside the car.

The invention will be more fully explained hereinafter with reference to the accompanying drawings in which a convenient and practical embodiment of the invention is illustrated and in which—

Figure 1 is a general view, partly in elevation and partly in section, illustrating the application of the invention to a car. Fig. 2 is a view partly in outline, partly in section and partly diagrammatic, showing such embodiment of the invention.

It will not be necessary, in the present case, to describe in detail the construction and operation of the gyrostat and the servomotor, but the general arrangement and relation of these parts to each other and to the oil pump, by which the oil is supplied under pressure for the operation of the servomotor, will be described herein so far as may be necessary for an understanding of the present invention.

The gyrostat b may be assumed to comprise a heavy disk b' mounted upon a normally vertical axis, in a suitable casing b^2, from which the air may be exhausted, and rotated by an electric motor b^6. The gyrostat is supposed to be suspended within the car a upon a normally horizontal axis of suspension, transverse to the longitudinal axis of the car and the rail upon which it travels. The gyrostat is supposed to be maintained in a condition of unstable equilibrium as by the connection of a spring c with the casing thereof and to be under the influence of an external controlling force supplied by a spring d connected to the casing of the gyrostat by suitable connections, the force applied being regulated through a force governor controlled by a servomotor g, the force

of the servomotor being delivered through its piston rod h^2, a link h^3, a bell crank lever h^4 and a link h^5, to the force governor, indicated at d^2. The flow of oil to one end or the other of the cylinder of the servomotor is controlled by a valve g' through devices not necessary to be described herein, the action of such devices being in turn controlled through connection with the frame or casing of the gyrostat, as by a link b^4. All of these devices and connections may be constructed and arranged as shown and described in said applications or in any other equivalent or suitable manner, the present invention not being concerned therewith, but only with the driving of the motor of the oil pump, by which oil is supplied to the servomotor under pressure or of the motor of other operating devices from the motor of the gyrostat operating as a dynamo when the external current supply is interrupted.

In the arrangement represented in the drawings oil is supplied under pressure by a pump k through a feed pipe k' to the valve g' and the servomotor g and is returned form the servomotor and the valve through a pipe k^2 to a reservoir k^3 which is connected to the inlet of the pump by a pipe k^4. The pump is shown as driven by an electric motor l comprising as usual an armature l' and a field magnet l^2.

In the arrangement represented in Fig. 2 of the drawings the gyrostat motor and the pump motor are shown as connected to the main wires in multiple and as shunt-wound. The positive wire m is shown as connected to the point m' and thence by the branch m^2 to the point m^3 where the current divides. The current for the armature winding of the gyrostat motor passes over an adjustable resistance m^4 and thence by the path m^5 to the armature b^7 of the motor b^6, and thence by the path m^6 through the coils of a soft iron magnet m^7 and by the path m^8 back to the negative feed wire n. From the point m^3 the current passes over an adjustable resistance m^9 and the path m^{10} to the field windings b^8 and thence to the wire m^6 at the point m^{11}. From the point m^{12} of the positive wire m the current passes by a wire o to a point o' where it divides, passing thence through the armature l' of the pump motor l and by the path o^2, through an adjustable resistance o^3 to the common point o^4, whence it passes by the branch o^5 back to the negative wire n. From the point o' the other part of the current passes through the windings of the field magnet l^2 by the path o^6 and the adjustable resistance o^7 to the common point o^4, returning to the negative wire n by the branch o^5.

One or both of the main wires m, n, is connected to a circuit breaker p controlled by the magnet m^7. In the arrangement shown the negative wire n is thus connected, the terminals n' and n^2 being connected normally by a knife switch p' which is adapted to be opened by a spring-pressed striker p^2 normally held from operation by a spring-pressed latch p^3 which carries the polarized armature p^4 of the magnet m^7.

So long as the current is supplied from an external source the path of the current to the gyrostat motor and the pump motor is as already described and as indicated by the arrows shown in full lines adjacent to the lines which represent the wiring, but should the current supply from the external source be interrupted, the path of the current will then be as described below and as indicated by the arrows shown in broken lines adjacent to the lines representing the wiring. When the external current is thus interrupted the gyrostat continues to rotate for a considerable length of time by its kinetic energy and its motor is then operated as a generator. The current in the field b^8 of the motor continues in the same direction, but the current generated in the armature is reversed, passing from the armature by the wire m^5 and the resistance m^4 to the point m^3 and thence by the branch m^2 to the point m'. From the latter it passes by the intervening portion of the wire m to the point m^{12}, from which it passes through the armature and field of the pump motor in the same manner as before, the pump motor being therefore driven in the same direction as before by the current generated by the gyrostat motor b^6 now operating as a generator.

If it be assumed that the interruption of the external current be caused by an external short circuit it is obvious that the safety fuses in the feed wire will be burned out. Unless provisions were made to prevent it, it is probable that the safety fuses within the car would also be burned out and that the pump motor would cease to operate, in which event the servomotor would cease to perform its functions and the car might upset. To guard against such catastrophe the safety devices already referred to are provided. As soon as the current through the wires m^6 and m^8 and the coils of the magnet m^7 becomes zero or negative, the magnetism of the magnet m^7 becomes zero or its polarity is reversed and the armature p^4 is instantly released or repelled thereby releasing the striker p^2 and permitting it to break the circuit at p through one or both of the main wires as the case may be. Everything external to the circuit of the motor-dynamo b^6 and the pump motor l is therefore cut off and there is no longer danger of burning out the fuses or other parts of such circuit. Obviously when the motor b^6 commences to operate as a generator the return of the current from the point o^6 of the pump motor circuit is by the point o^7 and

wire m^8, m^6 to the armature b^7 of the motor b^6.

It will be obvious that various changes in details of construction and arrangement may be made to suit different conditions of use and that the invention, therefore, is not restricted to the precise construction and arrangement shown.

I claim as my invention:

1. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means for controlling the application of an external force to the gyrostat, and an electric motor for operating said controlling means, said motors being connected with a common external source of current, whereby, when the external source of current supply is interrupted, the gyrostat motor is driven as a generator by the kinetic energy of the gyrostat and the motor of the controlling means is operated by the current generated by the gyrostat motor.

2. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means for controlling the application of an external force to the gyrostat, and an electric motor for operating said controlling means, said motors being connected in multiple with a common external source of current, whereby, when the external source of current supply is interrupted, the gyrostat motor is driven as a generator by the kinetic energy of the gyrostat and the motor of the controlling means is operated by the current generated by the gyrostat motor.

3. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means for controlling the application of an external force to the gyrostat, an electric motor for said controlling means, said motors being connected with a common external source of current, a circuit breaker included in the main feed connections, and means operated by a reversal or cessation of current in the connections of the gyrostat motor to open said circuit breaker.

4. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means for controlling the application of an external force to the gyrostat, an electric motor for said controlling means, said motors being connected in multiple with a common external source of current, a circuit breaker included in the main feed connections, and means operated by a reversal or cessation of current in the connection of the gyrostat motor to open said circuit breaker.

5. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means for controlling the application of an external force to the gyrostat, an electric motor for said controlling means, said motors being connected with a common external source of current, a circuit breaker included in the main feed connections, a magnet with a polarized armature included in the connections of the gyrostat motor and means operated by a reversal or cessation of current through the coils of said magnet to open said circuit breaker.

6. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means to apply an external force to the gyrostat, a servomotor and connections to control said means, and an electric motor and intermediate devices to operate the servomotor, both of said motors being connected with a common external source of current, whereby, when the external source of current supply is interrupted the gyrostat motor is driven as a generator by the kinetic energy of the gyrostat and the second named motor is driven by the current generated by the gyrostat motor.

7. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means to apply an external force to the gyrostat, a servomotor and connections to control said means, and an electric motor and intermediate devices to operate the servomotor, both of said motors being connected in multiple with a common external source of current, whereby, when the external source of current supply is interrupted the gyrostat motor is driven as a generator by the kinetic energy of the gyrostat and the second named motor is driven by the current generated by the gyrostat motor.

8. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, a circuit breaker included in the main feed connections, means operated by a reversal or cessation of current in the connections of the gyrostat motor to open said circuit breaker, means to apply an external force to the gyrostat, a servomotor and connections to control said means, and an electric motor and intermediate devices to operate the servomotor, both of said motors being connected with a common external source of current, whereby, when the external source of current supply is interrupted the gyrostat motor is driven as a generator by the kinetic energy of the gyrostat and the second named motor is driven by the current generated by the gyrostat motor.

9. In an apparatus of the character described, the combination of a gyrostat, an electric motor therefor, means to apply an external force to the gyrostat, a servomotor and connections to control said means, said servomotor comprising a cylinder and pis-

ton, a pump to supply fluid under pressure to said cylinder, and an electric motor for said pump, said motors being connected with a common external source of current, whereby, when the external source of current supply is interrupted the gyrostat motor is driven as a generator by the kinetic energy of the gyrostat and the pump motor is driven by the current generated by the gyrostat motor.

This specification signed and witnessed this 11th day of October A. D., 1910.

EMIL FALCKE.

Signed in the presence of—

PAUL ARRAS,

PAUL VOLMER.