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Applegate

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[54] **LIFT CONTROL FOR RAIL CAR**

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[52] **U.S. Cl.**.....**104/23 R,** 104/134, 180/1 FV

[51] **Int. Cl.**.....**B64f 3/00**

[58] **Field of Search**.....104/23 FS, 134, 135, 136; 105/2 A; 180/116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 1 FV

[56] **References Cited**

UNITED STATES PATENTS

2,864,318	12/1958	Toulmin, Jr.	104/134 X
2,976,820	3/1961	Schaar	105/2 A
3,155,050	11/1964	Hafner	104/134 X
3,181,638	5/1965	Cockerell	180/122 X

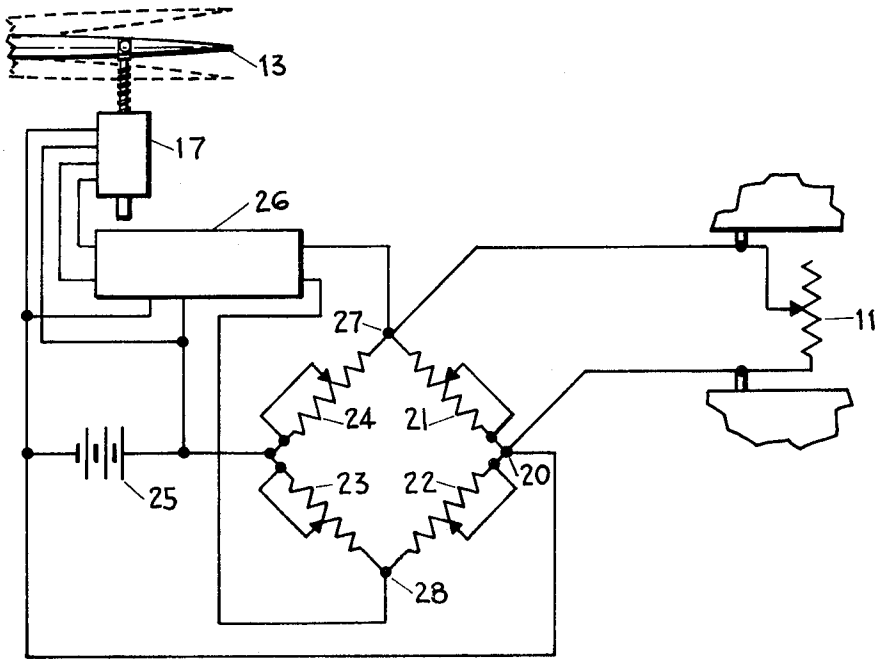
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[57] **ABSTRACT**

Method and means for controlling an air foil for regulating the weight carried by slippers supporting a rail car at high speeds travelling on conventional rails.

7 Claims, 2 Drawing Figures



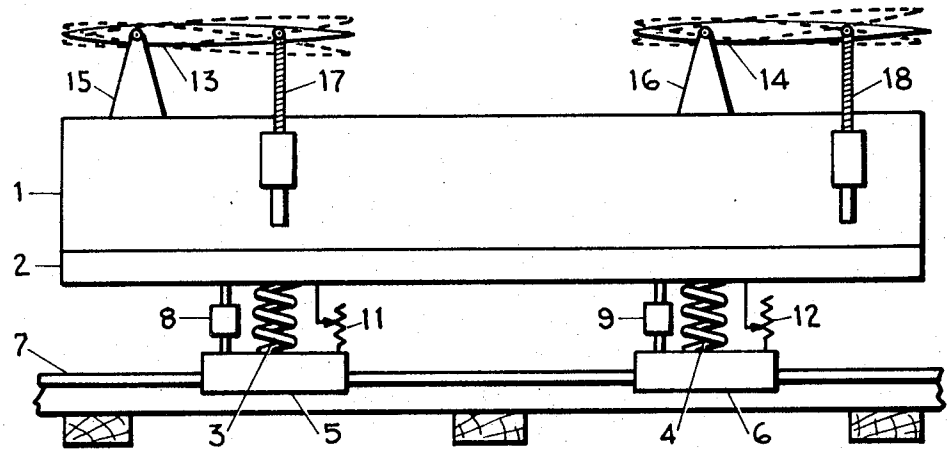


Fig 1

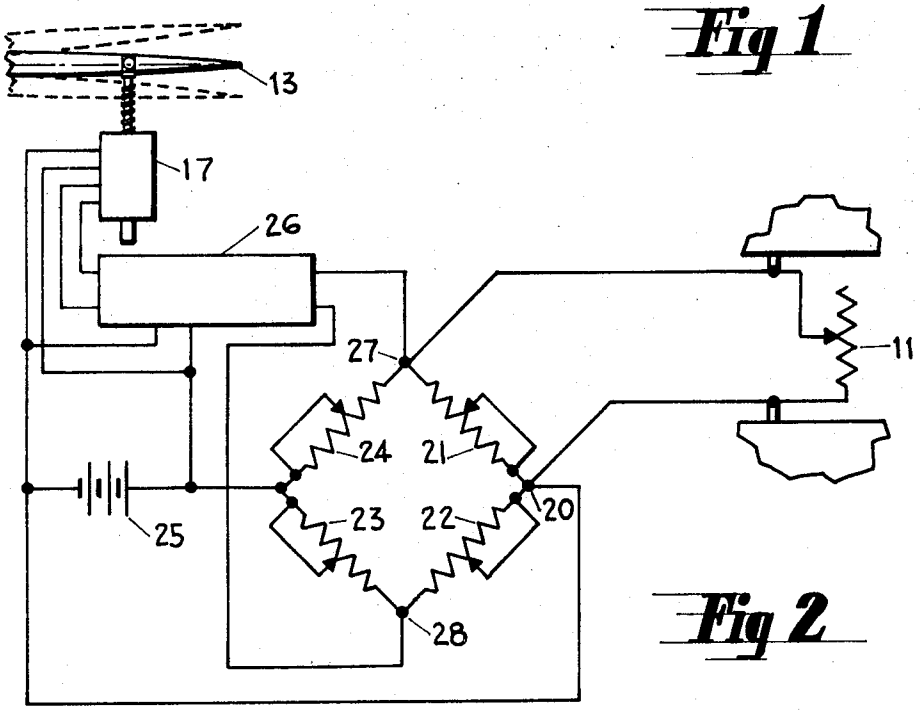


Fig 2

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LIFT CONTROL FOR RAIL CAR

This invention is concerned with the operation and control of cars traveling on rails. Conventional cars use wheels in contact with the rails, but others use sliding shoes on the rails to avoid the objections to wheels. This invention is concerned especially with cars with sliding contact with rails, although applicable to any high speed vehicle with or without wheels traveling on rails or on any other solid surface such as a common road.

The principal object of this invention is to regulate the aerodynamic lift on the vehicle. Another object is to adjust the lift automatically to maintain as nearly as possible lifts on the forward and rearward bearings respectively of the vehicle to conform to lift and load values represented by adjustments made manually in the lift control apparatus. A third object is to be able to use the lift control mechanism to operate the car so that the resultant downward load on the bearing surface is just enough to assure stable operation with minimum wear on the wheels or sliding shoes.

What constitutes my present invention is shown in the accompanying drawing, described in the following specification and defined in the appended claims.

In the drawing,

FIG. 1 is a side view of a car 1, supported by a frame 2. Frame 2 is supported by a forward spring 3, and a rearward spring 4, which are connected respectively to shoes referred to as slippers 5 and 6 which slide on rail 7. Dashpots (vibration dampers) 8 and 9 are in parallel with springs 3 and 4 respectively to minimize spring oscillation and to stabilize spring support. Variable resistors 11 and 12 are connected mechanically in parallel with springs 3 and 4 respectively so that the resistance of each resistor responds to variation in vertical dimension of the respective spring deflection. These resistors can be arranged so that their resistances vary directly or inversely with spring length as may be desired in the operation of circuits to which they are to be connected. Inasmuch as FIG. 1 shows a single side view of the car assemblage, it will be understood that identical elements corresponding to elements 2 to 12 inclusive will exist on the other side of the car, although resistors 11 and 12 may, in practice, be used alone to control the lift assuming that the car will be approximately level transversely in operation, omitting their counterparts on the other side. Resistors 11 and 12 can be made responsive to both sides of the car by placing them on appropriate structural elements at the centerline of the car support system.

Attached to the car in a location subject to relative car movement in the surrounding air, shown for convenience in FIG. 1 on top of car 1, there are airfoils 13 and 14 supported movably on brackets 15 and 16. Airfoils 13 and 14 are made in conventional forms for regulating lift by varying the angle of attack. The angle of attack of airfoil 13 is changed by motor 17 and of airfoil 14 by motor 18.

FIG. 2 is an electric circuit diagram showing the principal operational control connections for one airfoil. The principles of operation for the other are similar. Resistor 11 is connected into a bridge circuit 20 comprising 4 resistors, 21, 22, 23, and 24. Resistor 11 is shown connected to resistor 24 which can be omitted under some conditions. Power is provided to bridge 20 by a source 25 illustrated here as a DC battery. A power amplifier 26 receiving power from battery 25 is connected between bridge 23 and motor 17.

In the operation of this system, for example, forward airfoil 13 and the associated operational elements, resistor 11 takes a known position with a known resistance when spring 3 is loaded to a specified load producing a known spring vertical dimension. Resistors 21, 22, 23, and 24 of bridge 20 are adjusted so that the potential difference (voltage) between points 27 and 28 are zero or some other predetermined value that will cause power amplifier 26 to decrease it's output voltage to zero stopping motor (linear actuator) 17. The output voltage of amplifier 26 is responsive to changes in the resistance of resistor 11. An increase of resistance in resistor 11 beyond that at which, with the appropriate adjustments of bridge 20 provides zero output voltage of amplifier 26 will cause amplifier 26 to produce a voltage in one direction. A decrease of resistance of resistor 11 to less than that of zero output at amplifier 26 will cause amplifier 26 to produce a voltage in the other direction. Thus with motor 17 separately excited, changes in the resistance of resistor 11 will cause motor 17 to run in one direction or the other in accordance with the respective polarities of the circuit components. It will be obvious then that the polarities can be arranged so that when spring 3 is compressed by a load in car 1, resistor 11 will change, increasing or decreasing as arranged causing motor 17 to increase the angle of attack of airfoil 13, thereby increasing lift and decreasing the load on spring 3. Resistor 11 correspondingly will revert to a position of equilibrium stopping motor 17. The similar action at the rearward spring 4 and the associated elements will adjust airfoil 14 to maintain a prescribed load on spring 4.

Control of airfoils 13 and 14 as described will maintain prescribed loads on springs 3 and 4 through varying conditions of car loading, speed of car, altitude and other terrestrial conditions. The usually preferred condition of operation of springs 3 and 4 is to maintain spring loads less than the weight of the car but with some downward loads on slippers 5 and 6, and to avoid uplift on the springs and slippers.

I claim:

1. The method of controlling a resultant vertical load on a resilient member in a sliding bearing, said load comprising a gravitational component and an opposing aerodynamic lift component wherein a variable electrical potential difference is produced in response to variation in the vertical dimension of said resilient member from variation in said resultant load, combining said variable potential difference with adjustable potential differences to produce a reversible potential difference whose zero value corresponds to a selected loading on said resilient member, causing said reversible potential difference to control said aerodynamic lift, and combining said lift mechanically with said gravitational component and thereby controlling said resultant load to maintain said selected loading on said resilient member and said sliding bearing.

2. Means for controlling a resultant vehicular load on a resilient member in a sliding bearing, said load comprising a gravitational component and an opposing aerodynamic lift component, means for producing a variable electrical potential difference in response to

variation in the vertical dimension of said resilient member from variation in said resultant load, means for combining said variable potential difference with adjustable potential differences to produce a reversible potential difference whose zero value corresponds to a selected loading on said resilient member, means for causing said reversible potential difference to control said aerodynamic lift, means for combining said lift mechanically with said gravitational component and thereby controlling said resultant load to maintain selected loading on said resilient member and said sliding bearing.

3. In a rail car including slippers for carrying the car on rails, a spring between the car proper and each of said slippers, and a controllable airfoil supported on said car arranged to provide variable aerodynamic lift opposing gravitational load on said car to control vertical resultant load on said springs and slippers, the combination of a variable resistor with said spring arranged so the resistance of said variable resistor is responsive to the said resultant load on said spring, an adjustable network of a plurality of resistors including said variable resistor delivering a reversible potential difference whose zero value corresponds to a specific value of resistance of said variable resistor and to a specific value of resultant load on said spring, power amplifying means controlled by said reversible potential difference, and actuating means whereby said airfoil is controlled to produce an aerodynamic lift which combined with said gravitational load of said car controls the said resultant load on said spring.

4. The method as in claim 1 in which said resilient member is hydraulically damped whereby said variable potential difference and said aerodynamic lift are restrained in amplitude and frequency of variation.

5. Means as in claim 2 and means for hydraulically damping variation in said vertical dimension of said resilient member whereby the frequency and amplitude of variations in said potential differences and said aerodynamic lift are minimized.

6. In a rail car as in claim 3, hydraulic dampers mechanically paralleling said springs whereby the operation of said variable resistor and said airfoil is subject to less frequent and less extensive variation.

7. In a rail car as in claim 3, wherein said adjustable network of a plurality of resistors is in the form of a bridge circuit of four adjustable resistors one of which is electrically in parallel with said variable resistor.

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