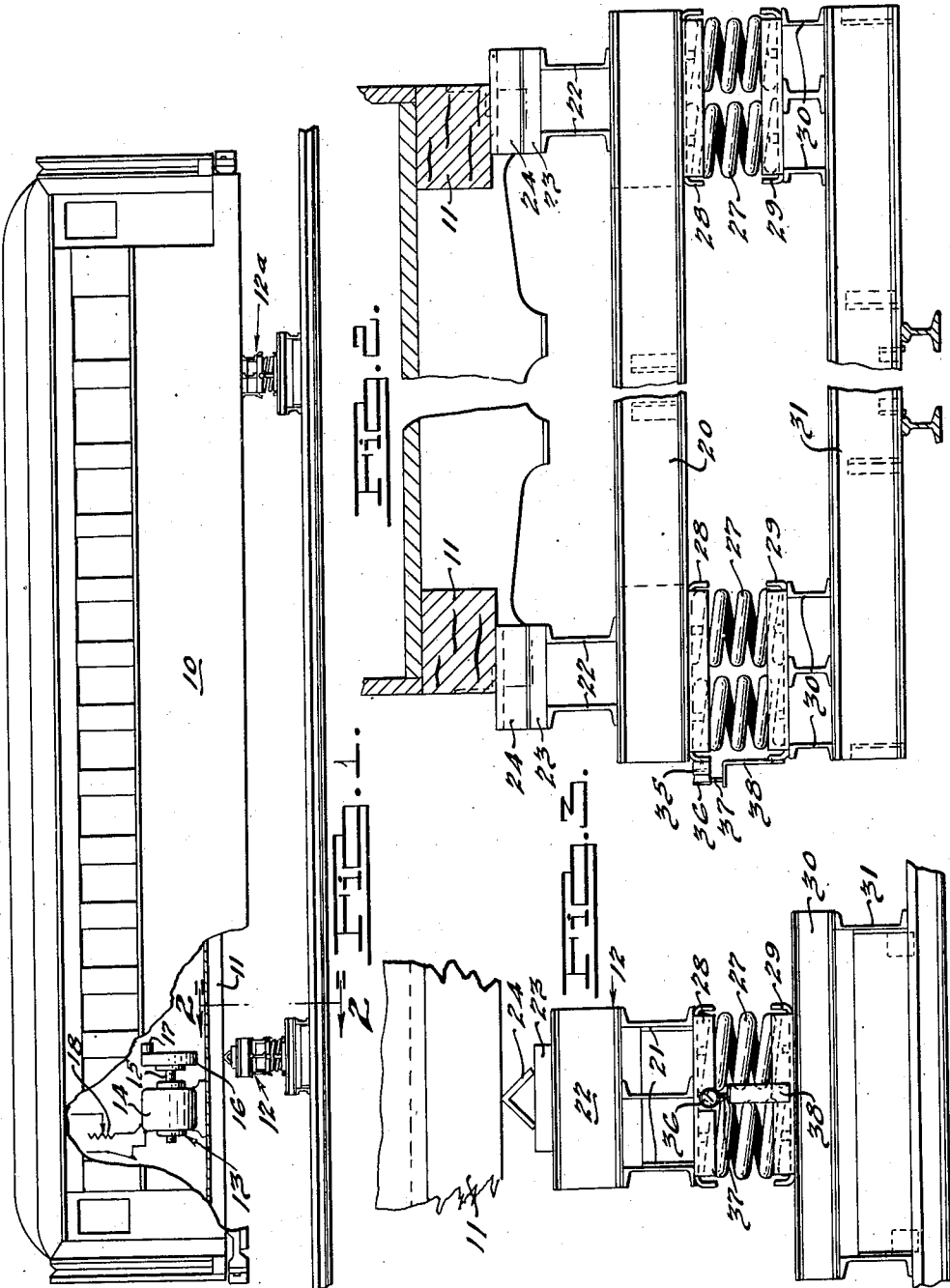


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METHOD OF DETERMINING CONJUGATE CENTERS OF
PERCUSSION OF RAILWAY CARS
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METHOD OF DETERMINING CONJUGATE
CENTERS OF PERCUSSION OF RAILWAY
CARS

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My invention relates to railway equipment and has particular relation to means adapted to be employed for improving the riding qualities of railway vehicles.

The object of my invention is to provide a mechanism for, and a method of, determining the axis of rotation of a railway car with respect to any given center of percussion, which shall be simple to operate, accurate in results, inexpensive to manufacture and durable in operation.

For a better understanding of my invention reference may now be had to the accompanying drawing, of which:

Fig. 1 is a side elevational view of a device embodying my invention in its operative position with respect to a railroad car.

Fig. 2 is a transverse sectional view of a portion of the structure illustrated in Fig. 1, the view being taken along line 2—2 thereof.

Fig. 3 is a side elevational view of the structure illustrated in Fig. 2.

In the drawing I have illustrated a typical railroad car body 10 provided with the usual longitudinal body sills 11 and supported upon a pair of flexible or resilient supports 12 and 12^a, which are alike in construction. Mounted directly above one of the supports, in the drawing the support 12, is a device 13 adapted to oscillate the car body 10 upon the support 12. The oscillating mechanism 13 consists of an electric motor 14 provided with a shaft 15 on which is mounted a wheel 16 having an eccentric weight 17 mounted thereon. The motor is controlled by means of a switch and rheostat 18 of any suitable construction which will permit of producing various speeds of the motor 13.

Each of the supports 12 and 12^a comprises a transversely extending bar 20 composed of a plurality of channel-shaped metal members 21 upon each end of which are mounted two short longitudinally extending metal channel members 22 which, in turn, support a member 23 constituting a mounting for an inverted V-shape member 24 the upper edge of which is comparatively sharp so as to produce a substantially knife-edge support for the car body 10 engaging the sills 11.

The bar 20 is mounted at each end upon four coil springs 27 which are symmetrically arranged and which are held in position by means of an upper metal retaining plate 28 and a lower supporting and retaining metal plate 29. The plate 29 is supported upon short longitudinally extending metallic channel section metal supports 30 which in turn rest upon a plurality of trans-

versely arranged metallic channel-shape mem-
bers 31 constituting a main supporting beam. The beam is slightly greater in length than the width of the car and rests upon any suitable supporting surface. Mounted upon the upper retaining plate 28 of the support 30 is an arm 35 upon which is mounted a dial indicator 36 having a stem 37 protruding from the lower side thereof, any vertical movement of which is measured by the indicating gauge 36. Secured to the lower retaining member 29 of the support 30 is an L-shape arm 38 which projects beneath the indicating gauge 36 and is adapted to engage the stem 37.

It is an established fact that, in any freely movable body pivoted at a point on one side of the center of gravity, there is another point on the opposite side of the center of gravity at which application of a force in a direction adapted to produce rotation of that body will produce a pure rotation of that body about the point of pivotal support without subjecting that support to any force reaction parallel to the applied force. If the point about which the body tends to rotate is called the center of rotation the point of impact becomes the center of percussion with respect to that center of rotation, and these two points are conjugate, in that the centers of rotation and impact are mutually interchangeable.

Applied to a railway vehicle this means that, if the centers of suspension of the trucks are located in the vertical transverse planes of the conjugate centers of rotation and percussion, any vertical movement imparted to the car body by one truck, due to vertical irregularities in the track, will produce pivoting of the body about the center of suspension of the other truck. As this center of rotation is directly over the center of suspension of the first truck, such pivoting movement, or oscillation, will cause no compression of the springs of the first truck, which would necessarily occur if the first truck were located at any other point. In the latter case alternate compression and expansion of the springs of both trucks would necessarily take place because the centers of rotation and percussion are always conjugate, causing pitching of the car body and resulting in an unpleasant ride for the passenger.

As the equipment, furnishings, etc. of a car body are not uniformly distributed with respect to the length of the car body it is desirable to be able to determine the location of the conjugate centers of rotation and percussion by fixing the location of one of those centers and determining the other by some simple accurate means. In using this device it is necessary only

to mount the oscillating member 16 within or on the car body in substantially vertical alignment with the assumed location of the effective center of support of one of the trucks. The supporting member 12^a is then mounted beneath the car body in substantially vertical alignment with the location of the center of support of the second truck which becomes the plane of the center of rotation for some center of percussion assumed to be in the vertical transverse plane of the first support.

With the support 12 located under the assumed center of percussion, the eccentric 17 is rotated in synchronism with the natural frequency of the spring support, in my equipment about 170 revolutions per minute, which causes the end of the car body actuated by the eccentric 17 to oscillate about some point within the body at the opposite side of the center of gravity of the body as a center of rotation. If the support 12^a is located in vertical alignment with the natural axis of rotation there will be no vertical movement of the car body at that point and the gauge 36 will indicate no movement. However, if the support 12 and the oscillator 13 are located either forwardly or rearwardly of the center of percussion the car body will move vertically up and down on the springs 27 of the support 12^a and the gauge 36 will indicate such movement. The support 12 and oscillator 13, maintained in vertical alignment, are then moved forwardly or rearwardly as may be desired and the motor 14 again operated. If the movement indicated on the instrument 36 is greater than that previously recorded the support 12 has been moved in the wrong direction, in other words, farther from the center of percussion. On the other hand, if the gauge 36 indicates a smaller amount of movement the direction of movement of the support 12 with respect to the support 12^a is correct.

By means of a series of tests of this character, the number of which will be relatively small after some experience has been obtained with the equipment, a point of location of the support 12 and oscillator 13 on the length of the car can be determined at which no vertical movement of the car body occurs at support 12^a regardless of the vertical movement of the opposite end of the car caused by the rotating eccentric. This point coincides with the location of the center of percussion, for the given amount and arrangement of equipment within the car body for a center of rotation located in vertical alignment with the support 12^a. This point then is most suitable for the center of support of a truck provided that the truck at the opposite end of the car is located in vertical alignment with the opposite support 12^a.

My invention has been described with the support 12^a fixed in position and the support 12 and oscillator 13 is movable owing to the fact that centers of percussion are always determined with respect to a given or determined axis of rotation. As a matter of practice it is easier to consider the center of rotation and center of percussion as two conjugate centers of rotation and percussion, which they necessarily are and to place the oscillator 13 over the support 12 disposed at one assumed center of percussion, and move the support 12^a toward and away from the support 12 to determine the second or conjugate center of rotation.

In instances of the character described the car body pivots about an axis, rather than a

point, but the axis passes through the center of rotation producing, in reality, an axis of rotation.

Although I have illustrated but one form of my invention, and have described in detail but a single application thereof, it will be apparent to those skilled in the art that it is not so limited but that various modifications and changes may be effected therein without departing from the spirit of my invention or from the scope of the appended claims.

I claim:

1. The method of locating the conjugate centers of percussion and thereby the proper relative positions of the supporting trucks of a railway car body with respect to the length thereof which comprises mounting the car body on one fixed and one longitudinally movable resilient support, moving said movable support to various positions at different distances from said fixed support, oscillating said car body vertically by a force applied thereto in substantial vertical alignment with one of said supports in synchronism with the natural frequency rate of the latter support, and determining the position of the movable support at which vertical movement of the body is at a minimum with respect to the support in spaced relation with the point at which the force was applied.

2. The method of locating the conjugate centers of percussion and thereby the proper relative positions of the supporting trucks of a railway car body with respect to the length thereof which comprises mounting the car body on one fixed and one longitudinally movable resilient support, moving said movable support to various positions at different distances from said fixed support, securing to said car body in substantial vertical alignment with said fixed support a means capable of alternately exerting on said car body intermittent vertically upwardly and vertically downwardly directed forces when energized, synchronizing the rate of application of said alternate upward and downward forces with the natural rate of frequency of the fixed resilient support with said movable support in various positions, and determining the position of said movable support at which the vertical movement of the car body with respect to the movable support is at a minimum.

3. The method of locating the conjugate centers of percussion and thereby the proper relative positions of the supporting trucks of a railway car body with respect to the length thereof which comprises mounting the car body on one fixed and one longitudinally movable resilient support, moving said movable support to various positions at different distances from said fixed support, mounting on said car body in substantial vertical alignment with said fixed support a rotatable eccentric, rotating said eccentric and synchronizing the speed thereof with the natural frequency rate of the fixed resilient support with said movable support in various positions, and determining the position of said movable support at which the vertical movement of the body with respect thereto is at a minimum.

4. The method of locating the conjugate centers of percussion and thereby the proper relative positions of the supporting trucks of a railway car body with respect to the length thereof which comprises mounting the car body on one fixed and one longitudinally movable resilient support, securing to said car body in

substantial vertical alignment with said movable support a means capable of producing, when energized, alternate vertically upwardly and vertically downwardly directed forces synchronizing the rate of application of said alternate upward and downward forces with the natural rate of frequency of the movable resilient support, moving said movable support and said force producing means to different distances from said

fixed support, and determining the position of said movable support at which the vertical movement of said body with respect to said fixed support is at a minimum with said force producing means energized and synchronized with the natural frequency rate of the resilient movable support.

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