April 23, 1940. K. RÖTHLER 2,197,831

MOUNTING OF BOILERS OF MALLET LOCOMOTIVES

Filed June 25, 1938 3 Sheets-Sheet 1

Fig. 1

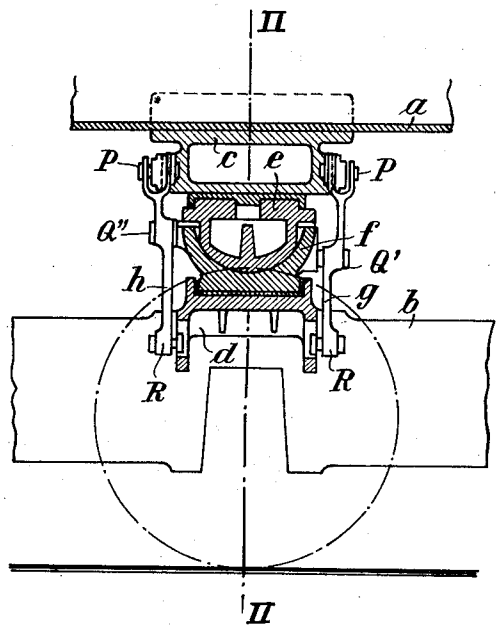
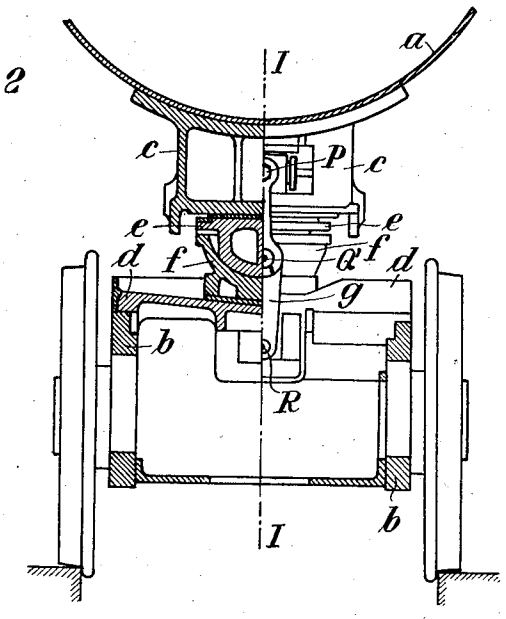


Fig. 2



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MOUNTING OF BOILERS OF MALLET LOCOMOTIVES

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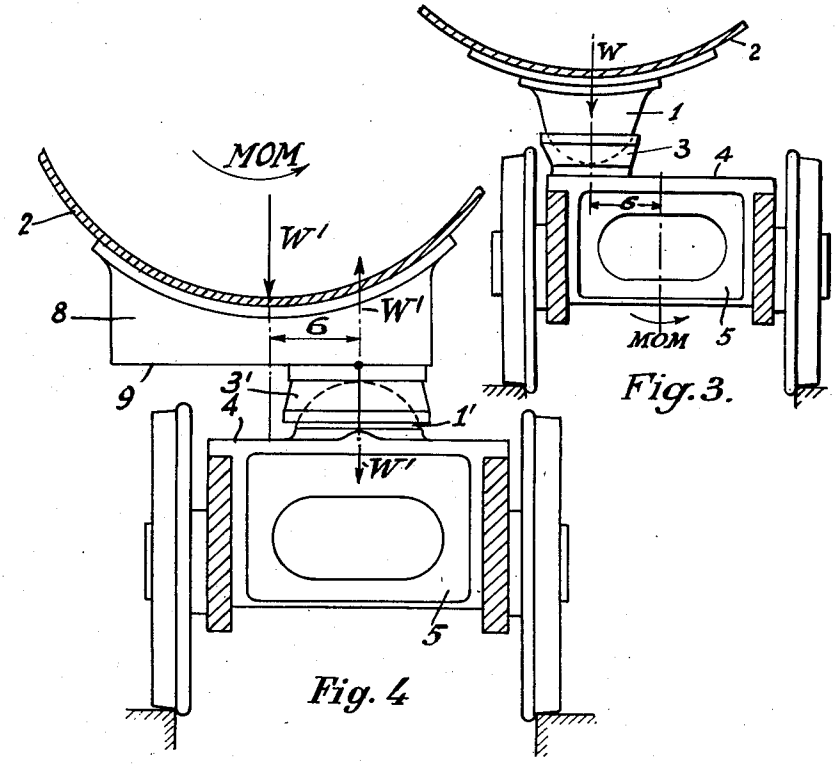


Fig. 3.

Fig. 4

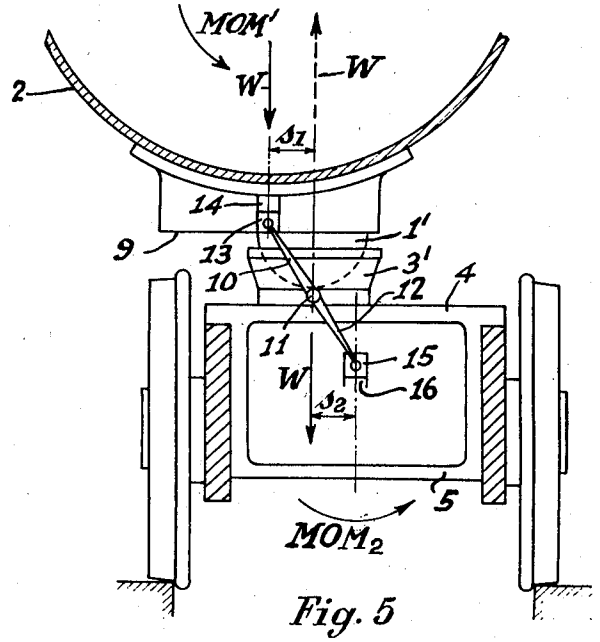


Fig. 5

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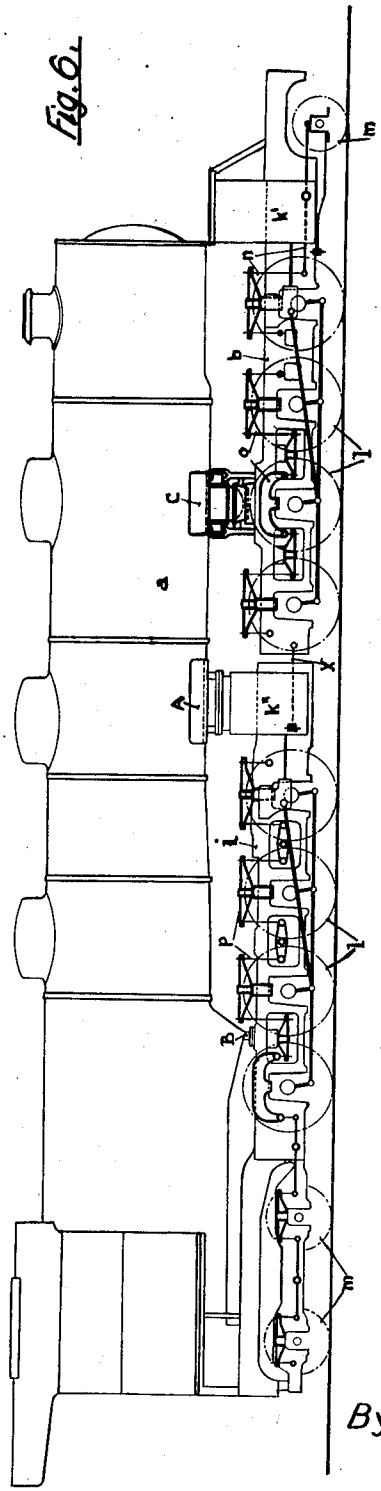
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MOUNTING OF BOILERS OF MALLET LOCOMOTIVES

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Fig. 6.



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UNITED STATES PATENT OFFICE

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MOUNTING OF BOILERS OF MALLET LOCOMOTIVES

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Application June 25, 1938, Serial No. 215,865
In Germany June 26, 1937

7 Claims. (Cl. 105—171)

The present invention relates to an improved mounting of the boiler of a Mallet locomotive. In connection with Mallet locomotives, it is necessary to provide on each side of the locomotive two or more independent groups of springs in in which the springs are connected by compensating levers, each group of springs with compensating levers forming a complete unit. In most constructions of the Mallet locomotive, the boiler is supported upon the front bogie by means of one or two plane table supports and consequently the front and the rear truck or frames are always guided parallel to one another. Lateral displacement of the plane supports must in this construction be avoided. The front bogie and the rear frames of the locomotive cannot in this construction adapt themselves independently to an uneven track, and unevenness of the track must be taken up by variations in the elongations of the various groups of springs, these variations being substantially equal to the variations which would occur if all the groups of axles were mounted in a common frame.

With a very long wheel base of a Mallet locomotive having a considerable number of driven wheels and with sharp curves in the line of the track, very considerable relative inclinations of the axles of the front bogie with regard to the axles of the rear frame will occur, apart from inclinations due to accidental unevenness of the track. These relative inclinations lead to very considerable over-loading or under-loading of the springs and the wheels at one or the other side of the locomotives, and have to be taken care of by special devices.

Another very disturbing influence is the fact that on passing sharp curves of the track the front part of the boiler will move very considerably laterally with regard to its front bogie, which again influences in a very unfavourable manner the distribution of the load upon the spring groups at the left and at the right side of the locomotive, either the one or the other group becoming overloaded.

These two main influences and the influence of the unevenness of the track frequently have a cumulative effect and they produce very considerable variations in the individual spring and wheel loads, which may lead to derailment of the locomotive and fracture of springs.

In view of the above-mentioned unfavourable influences, it is advisable to aim in connection with a Mallet locomotive having a very long wheel base, at the obtention of a three-point support. In order to obtain such a support in connection with a Mallet locomotive, it is important to support the front part of the boiler by means of a spherical or ball bearing in the middle plane of the frame of the front bogie and to arrange for all the driven and running axles of the rear frame to be connected on either side by a left hand and a right hand group of springs, the springs of each group being connected by compensating levers. Independently of this arrangement the front bogie must again have a three-point support, for instance by connecting the leading running axles and the first driven axles by means of longitudinal and transverse levers and by two lateral groups of springs of the following three driven axles. Curves in the track and accidental unevenness will then not lead to any substantial variation of the spring tension and the wheel loads. There will, however, still remain the unfavourable influence of the lateral displacement of the front part of the boiler with regard to its bogie occurring in curved portions of the track, and it is necessary to compensate or avoid the effect of this lateral displacement upon the load distribution by additional means.

Fig. 1 is a section on line I—I of Fig. 2,

Fig. 2 is a cross section on line II—II of Fig. 1,

Figs. 3 to 5 are diagrams of boiler mountings, and

Fig. 6 is a general view of the whole locomotive.

Theoretically there are three possible ways of reducing the overstressing of the springs. These ways are diagrammatically indicated in Figs. 3, 4 and 5, Figs. 3 and 4 showing diagrammatically known manners of mounting the boiler upon the front bogie, and Fig. 5 showing diagrammatically the improved manner according to the present invention.

Referring first to Fig. 3, it will be seen that the boiler **2** is provided upon its under side with a semispherical pivot **1** which rests in a correspondingly shaped socket **3**. The socket **3** is slidable upon a horizontal surface **4** of the front bogie **5**. Assuming the maximum displacement of the socket **3** to be indicated by the distance **6** and the portion of the weight of the boiler transmitted by the pivot **1** to be indicated by the letter W, then it will be seen that at the maximum lateral displacement of the boiler with regard to the front bogie, the weight W will no longer be distributed uniformly upon the wheels at the left hand side and those at the right hand side, but will be taken up chiefly by those at the left hand side. Consequently the springs interposed between the wheels and the frame of the bogie at the left hand side will be over-stressed and

those at the right hand side will be under-stressed, whilst the distribution of the load upon the axles of the rear frame will remain unaltered. The turning moment MOM increasing the stressing at the outer side of the curve in the track will be represented by $MOM=W\times 6$.

In the construction shown in Fig. 4, the positions of the semispherical pivot and the slidable socket are reversed, the pivot 1' being fixed to the horizontal surface 4 of the bogie frame 5 and the boiler 2 being provided upon its under surface with a fixed support 8 having a horizontal surface 9 which slides upon the top of the socket 3' co-operating with the semispherical pivot 1'. In this construction the weight W1 of the front part of the boiler taken up by the front bogie will always act in the middle plane of the front bogie and therefore, even when the front part of the boiler is displaced with regard to the front bogie by the maximum distance 6, the load will be distributed equally upon the left hand and right hand side springs and wheels. On the other hand, there will be a turning moment

$$MOM=W'\times 6$$

which tends to turn the front part of the boiler to the outer side of the track. This turning moment is taken up by the springs of the rear frame, the outer springs and wheels of the rear frame being over-stressed and the inner springs and wheels being under-stressed.

To avoid the disadvantages of the construction diagrammatically illustrated in Figs. 3 and 4, the invention provides a construction diagrammatically indicated in Fig. 5.

In this construction, both the boiler 2 and the frame 5 of the front bogie are provided with substantially horizontal slide surfaces 9 and 4 respectively and between these surfaces there is slidably mounted a ball joint consisting of a spherical pin 1' and a corresponding socket 3'. The movement of the ball joint 1', 3' relatively to the horizontal guideways 9 and 4 is controlled by a double-armed lever 10, 12, pivotally mounted at 11 upon the socket 3'. The upper end of the lever arm 10 is vertically guided by means of a slide 13 in a guideway 14 of the boiler support 9, whilst the lower end of the lever arm 12 is vertically guided by means of a slide block 15 in a vertical guideway 16 of the bogie frame 5. The effective arms of the lever 10, 12 are preferably so chosen that upon lateral displacement of the boiler with regard to the front bogie, the distances of the middle plane of the ball joint from the middle plane of the bogie and the middle plane of the boiler will be about equal. Therefore, the maximum displacement of the boiler will be equal to $s1+s2$ and the disturbing moments due to the displacement will be about halved, the moment MOM1 being equal to $W\times s1$ and the moment MOM2 being equal to $W\times s2$. These moments are taken up by the springs of the front frame and by the springs of the rear bogie respectively.

It will thus be seen that by the improved arrangement there will be reduced over-stressing or overloading at the outer side of the curve and also reduced under-stressing at the inner side of the curve as compared with those occurring in the construction indicated in Figs. 3 and 4.

Assuming the load of the boiler taken up by the front bogie to be say 23,500 kg. calculations and tests have shown that in the construction according to Fig. 3 there will be over-stressing of the wheels amounting to about 28% and over-stressing of the springs amounting to about 52%. With the same load and in the case of the construction shown in Fig. 4, the over-stressing and under-stressing respectively of the wheels of the rear frame will amount to about 16% and over-stressing and under-stressing respectively of the springs will amount to 22%.

In the construction according to the invention shown in Fig. 5 there will be stress variations both in the front bogie and in the rear frame, and those in the front bogie will amount to about 15.3% as regards the wheels and about 28.4% of the springs. In the rear frame, stress variation of the wheels will be 7.3% and that of the springs 10%. It will thus be seen that by the improved constructions, the stress variations are maintained within permissible limits and will avoid any possibility of accidents when passing over sharp curves.

Another feature of the invention consists in providing very simple means for returning automatically the boiler to its normal position when the locomotive has passed a curve. This is, according to the invention, attained by suitably shaping the surface upon which the ball joint slides upon the front bogie.

A constructional example of the invention is indicated in the drawings in Figs. 1, 2 and 6.

Referring first to Fig. 6, *a* indicates the boiler which is in manner known per se supported upon a front bogie *b* and a rear frame *i*, which are coupled together as usual by a rod X. The front bogie has four driven wheel pairs *l* driven by an engine *k* and a running wheel pair *m* which is not driven, whilst the rear frame has four driven wheel pairs *l* and two pairs of non-driven running wheels *m*. The spring suspension of the front bogie is indicated by the letters *n* and *o* whilst the spring suspension of the rear frame is indicated by the letter *p*. In both the bogie and the frame the individual springs are connected by levers to form a complete unit on either side of the frame. The boiler *a* rests upon the rear bogie *i* at three points A, B, B, the point A being in the middle plane of the boiler and the points B being on either side of the middle plane. The front part of the boiler rests at C upon the front bogie, this support being the subject of the invention and shown in details in Figs. 1, 2 and 5.

Referring to Figs. 1 and 2 which show in detail the front support of the boiler, *a* indicates the boiler and *b* the frame of the front bogie. To the under side of the boiler is fixed a support *c* having a plane under surface. The bogie frame *b* is provided with an upper surface *d*, and between the under surface of the support *c* and the surface *d* of the bogie there is slidably mounted a ball joint consisting of an upper pivoted member *e* having a semispherical bearing surface resting in a corresponding semispherical surface of a socket member *f*. To the socket member *f* are pivoted at intermediate points Q' and Q'' two armed levers *g* and *h* respectively which in the normal position of the boiler are located in the middle plane of the boiler and the bogie. The upper end of each lever is forked, the forked portions being pivotally connected at P to blocks slidably mounted in vertical guideways formed in the boiler support *c*. The lower ends of the levers are also pivotally connected at R in any suitable manner to similar blocks slidably mounted in vertical guideways formed in the bogie frame *b*. The positions of the pivots of the levers and the lengths of the arms are so chosen that during lateral displacement of the boiler with regard to

the front bogie, the middle plane of the ball joint remains approximately at equal distances from the middle plane of the bogie frame and the middle plane of the boiler. In some cases, however, the dimensions of the lever arms and the positions of the pivots may be chosen in such a manner as to obtain a different proportion between the said distances.

In a track curve, the direction of the longitudinal middle axis of the front bogie is displaced with respect to that of the boiler, the two axes forming an angle between them. Now, it is obvious that the further a particular point on one axis or limb of the displacement angle is from the apex point of this angle, the greater is also its distance from a point on the other limb or axis located at an equal distance from the said apex point.

The levers *g* and *h* are located at different distances from the apex of the angle formed by the relative displacement of the middle axes of the front bogie and the boiler. Consequently, when the vehicle traverses a curve, each lever is displaced to a different extent. The lever *h* located closer to the apex point has a shorter path and thus the smaller displacement, whilst the lever *g*, located further forwardly of the vehicle, undergoes the greater displacement. On the other hand, however, the intermediate pivot points Q' and Q'' of the levers *g* and *h*, should, on account of the parallel guiding of the ball joint, constantly carry out displacements of equal sizes. The axes of rotation of the levers *g* and *h* always lie parallel to the axis of the front bogie *b*. In order, therefore, that the ball socket *f* shall be guided parallel to itself and to the centre of the bogie *b*, different lever transmissions are necessary. As can be seen from Figure 1, this is achieved in the example described, by making the two levers *g* and *h* of the same overall length, but locating the intermediate points Q' and Q'' in such positions therealong that the proportion of the lengths of the arms PQ'; Q'R and PQ''; Q''R are different. In order to provide for automatic return of the parts *c*, *e*, *f*, *d* into the initial position after the train has passed over a curve in the track, the bearing surfaces of the socket *f* are made wedge shaped. This construction is extremely compact, which is a very considerable advantage in view of the small available space.

It will be understood that other means may be provided for positively controlling the relative movement of the parts. For instance, instead of guiding the upper ends of the levers in vertical guideways, links might be used, and the levers might, for instance, be replaced by toothed racks and wheels.

I claim:

1. In a Mallet locomotive of the type wherein the boiler is supported upon a front bogie and a rear frame the combination of: a boiler; a front bogie; means for supporting said boiler on said front bogie, said means comprising a guideway fixed to the under side of the boiler; a guideway upon the bogie; and a ball joint located between said two guideways; said ball-joint comprising a socket member slidable upon one of said guideways and a ball, in said socket, and slidable upon the other guideway; and means for controlling the movement of said ball joint due to lateral displacement of the boiler with regard to the bogie to maintain a definite proportion between the distances of said ball joint from the middle plane of the boiler and the bogie.

2. In a Mallet locomotive of the type wherein the boiler is supported upon a front bogie and a rear frame, the combination of; a boiler; a front bogie; a guideway fixed to the under side of the boiler; a guideway upon the bogie; a ball joint slidable between said two guideways; and means for controlling the movement of said ball joint due to lateral displacement of the boiler with regard to the bogie to maintain a definite proportion between the distances of said ball joint from the middle plane of the boiler and the bogie, said ball joint comprising a semispherical socket member and a semispherical pivot member, said socket member being slidable upon the guideway upon the bogie and said pivot member being slidable upon the guideway fixed to the boiler.

3. In a Mallet locomotive of the type wherein the boiler is supported upon a front bogie and a rear frame, the combination of: a boiler; a front bogie; means for supporting said boiler on said front bogie, said means comprising a guideway fixed to the under side of the boiler; a guideway upon the bogie; and a ball joint located between said two guideways; said ball-joint comprising a socket member slidable upon one of said guideways and a ball, in said socket, and slidable upon the other guideway; and means for controlling the movement of said ball joint due to lateral displacement of the boiler with regard to the bogie to maintain a definite proportion between the distances of said ball joint from the middle plane of the boiler and the bogie, said guideway upon the bogie rising laterally from its centre to its ends.

4. In a Mallet locomotive of the type wherein the boiler is supported upon a front bogie and a rear frame, the combination of: a boiler; a front bogie; means for supporting said boiler on said front bogie, said means comprising a guideway fixed to the under side of the boiler; a guideway upon the bogie; and a ball joint located between said two guideways; said ball-joint comprising a socket member slidable upon one of said guideways and a ball, in said socket, and slidable upon the other guideway; and means for controlling the movement of said ball joint due to lateral displacement of the boiler with regard to the bogie to maintain a definite proportion between the distances of said ball joint from the middle plane of the boiler and the bogie, said means for controlling the movement of the ball joint comprising levers each pivoted at an intermediate point along the length thereof to the ball joint and operatively connected at the ends thereof to the boiler and the bogie respectively.

5. In a Mallet locomotive of the type wherein the boiler is supported upon a front bogie and a rear frame the combination of: a boiler; a front bogie; means for supporting said boiler on said front bogie, said means comprising a guideway fixed to the under side of the boiler; a guideway upon the bogie; and a ball joint located between said two guideways; said ball-joint comprising a socket member slidable upon one of said guideways and a ball, in said socket, and slidable upon the other guideway; and means for controlling the movement of said ball joint due to lateral displacement of the boiler with regard to the bogie to maintain a definite proportion between the distances of said ball joint from the middle plane of the boiler and the bogie, said controlling means comprising levers each pivoted at an intermediate point along the length thereof to the ball joint; vertical guideways for the ends of said le-

vers provided upon the boiler and the bogie, and slide blocks pivoted to the upper ends of the lever, said blocks sliding in the vertical guideways on the boiler and slide blocks pivoted to the lower ends of said levers, said blocks sliding in the guideways on the bogie.

6. In a Mallet locomotive of the type wherein the boiler is supported upon a front bogie and a rear frame, the combination of: a boiler; a front bogie; means for supporting said boiler on said front bogie, said means comprising a guideway fixed to the under side of the boiler; a guideway upon the bogie; and a ball joint located between said two guideways; said ball-joint comprising a socket member slidable upon one of said guideways and a ball, in said socket, and slidable upon the other guideway; and means for controlling the movement of said ball joint due to lateral displacement of the boiler with regard to the bogie to maintain a definite proportion between the distances of said ball joint from the middle plane of the boiler and the bogie, said proportion being substantially 1:1.

7. In a Mallet locomotive of the type wherein the boiler is supported upon a front bogie and a rear frame, the combination of: a boiler; a front bogie; means for supporting said boiler on said front bogie, said means comprising a guideway fixed to the under side of the boiler; a guideway upon the bogie; and a ball joint located between said two guideways; said ball-joint comprising a socket member slidable upon one of said guideways and a ball, in said socket, and slidable upon the other guideway; and means for controlling the movement of said ball joint due to lateral displacement of the boiler with regard to the bogie to maintain a definite proportion between the distances of said ball joint from the middle plane of the boiler and the bogie, said means for controlling the movement of the ball joint comprising levers, each pivoted at an intermediate point along the length thereof to the ball joint and operatively connected at the ends thereof to the boiler and the bogie respectively, the ratio of the effective arm lengths of the levers being different.

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