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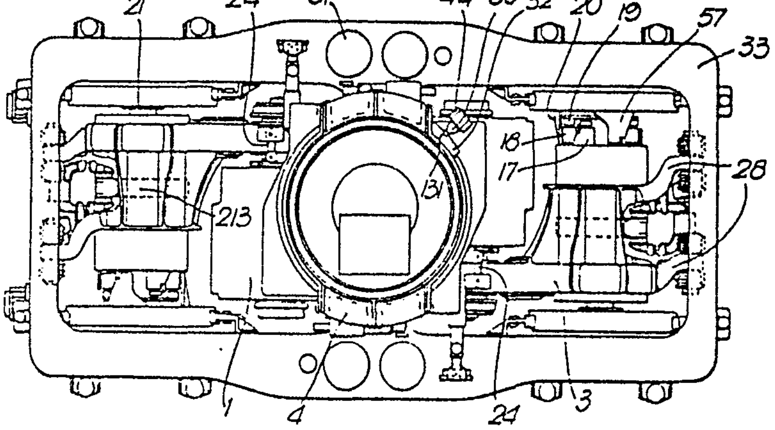
(54) **Bogie mounting.**

(57) A high speed powered railway bogie arrangement comprises a traction motor assembly mounted from the locomotive body so as to be isolated from, but to swivel with, the bogie. The motor drive shafts may be parallel to the axles of the bogie wheelsets. A flexible drive train accommodates relative motion between the traction motor assembly and the bogie wheelsets. A linkage between the bogie and the traction motor assembly allows for some degree of lost motion between swivelling of the bogie and swivelling of the traction motor assembly.

By decoupling the mass of the traction motors from the bogie, "hunting" disturbances of the bogie, which tend to arise at high speeds, are minimised. A Watt linkage between the bogie and the locomotive body allows the bogie lateral freedom of movement with respect to the locomotive body.

Fig.3.



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Bogie Mounting

The present invention relates to railway rolling stock and in particular relates to locomotive bogies.

There exists a continuing need to improve service speed over existing railway routes, particularly through main line curves. At operating speeds above 160 km/hr, conventional railway bogies are subject to instability or "hunting" problems arising from tyre conicity and irregularities in the rail surfaces. To ensure satisfactory running above speeds of 160 km/hr it is necessary to minimise any other unsprung mass e.g. by reducing the diameter of the wheels and by employing a flexible drive between the axles and the gearboxes.

At speeds above 200 km/hr, the mass of the traction motors can cause unstable oscillations of the bogies to build up. Furthermore, where very high speed operation through large radius curves is contemplated, since the primary suspension of a bogie affords no significant degree of lateral springing, small irregularities of curvature at the rails are liable to generate large dynamic lateral forces on the bogie. For these reasons it is highly desirable to transfer the traction motors from the bogie to the body of the vehicle, so that the body and motors move laterally only at the low natural frequency of the body on its secondary suspension rather than in response to sudden shocks which arise at the wheelset and bogie.

Known high speed locomotives have employed traction motors mounted on the body but have required large cardan shafts. Right-angle i.e. bevel gear drives, usually suspended from the wheelsets themselves and employing cardan shafts have been canvassed for high speed, but known arrangements utilising such right angle drives have not been successful at high powers and have been considered to be unsuitable for high speed use.

It has recently been proposed to mount the motors from the body in such a way as to occupy nearly the same location as when mounted from the bogie, the motor drive shafts being parallel to the wheelset axles. However the essential movements of the bogie relative to the body on curves and turnouts, in sidings, cross-overs and depot yards, place a stringent geometric restriction on the dimensions of the traction motors and the drives which can be accommodated and therefore on the power transmitted to each wheelset. Thus it is an object of the present invention to provide an improved powered bogie mounting arrangement which is suitable for high-speed use and which is capable of developing high motive power.

According to the present invention a powered railway bogie arrangement comprises a traction motor assembly including at least one traction motor, and a drive train coupled between the bogie wheelsets and the traction motor assembly and arranged to accommodate relative motion between the traction motor assembly and said wheelsets, the traction motor assembly being mounted so as to have limited freedom of movement with respect to the bogie.

Preferably the or each traction motor is mounted with its drive shaft substantially parallel to the axles of the bogie wheelsets. However it may be feasible in some cases to mount the motors with the drive shafts transverse to the bogie wheelsets and to employ a right-angle drive between the motors and wheelsets.

The traction motor assembly is preferably mounted on a swivel mounting which is coaxial with the swivel mounting of the bogie. A linkage between the bogie and the traction motor assembly may be arranged to allow for some degree of lost motion between swivelling of the bogie and swivelling of the traction motor assembly. In this manner the moment of inertia of the traciton motor assembly about the swivel axis is decoupled from slight swivelling oscillations of the bogie which tend to arise at high speeds as a result of uneveness in the rail surfaces. When the traction motors are decoupled in this manner, such oscillations can be damped much more easily and high speeds can be reached before the onset of instability.

Preferably the traction motor assembly is mounted from the body of the locomotive to which the bogie is attached so as to translate with the locomotive body but to swivel with the botie. Thus a locomotive incorporating a bogie of this type at each end will effectively carry one or more traction motors at each end which will increase its moment of inertia and correspondingly reduce its tendency to sway or "nose" on its secondary suspension.

Preferably the arrangement incorporates stabiliser means for inhibiting swivelling oscillations of the traction motor assembly relative to the locomotive body. The stabiliser means may for example comprise a spring-loaded roller which engages a depression or projection in a member attached to the traction motor assembly or the locomotive body when the bogie is aligned with the body, but rides out of the depression or over the projection when the locomotive enters a curve and the bogie swivels with respect to the body. In this manner, parasitic oscillatiosn of the traction motor assembly which would otherwise tend to occur during running on straight track can be avoided.

Preferably the traction motor assembly is coupled to one or both bogie wheelsets by a flexible drive train. The driving end of the drive train may be supported from the bogie by a linear bearing and preferably includes a flexible torque coupling (of the type comprising a floating ring element connected by respective pairs of parallel pivoted links to arms on the driving and driven shafts for example) which is able to accommodate vertical mvoement of the wheelset on its primary suspension. Lateral movement of the drive train wth respect to the wheelset (resulting from swivelling oscillations of the bogie or "nosing" of the locomotive body with its associated motor assemblies) may suitably be accommodated by linear bearings in the torque coupling.

The bogie may be connected to the locomotive body by a Watt linkage which locates the bogie in the longitudinal direction but allows the bogie lateral freedom of movement with respect to the locomotive body.

The Watt linkage may be connected between a pivot on the bogie and the traction motor assembly, the connection at said pivot preferably being near rail level, i.e. below the level of the bogie. This ensures that weight transfer between the wheelsets (arising from the reaction to driving and braking torque) is minimised.

Alternatively however the Watt linkage may be in the form of a bridge member which is mounted from the locomotive body for rotation about the bogie swivel axis, the bridge member incorporating a pair of downwardly extending legs, the lower ends of which are connected by resective substantially parallel pivoted links to the bogie frame.

Two embodiments of the invention will now be described by way of example only, with reference to Figures 1 to 8 of the accompanying drawings, of which:

Figure 1 is a side elevation of a railway bogie in accordance with the invention,

Figure 2 is a section, partially cut away, showing the bogie of Figure 1,

Figure 3 is a plan view of the bogie of Figure 1,

Figure 3a is a plan view of a railway bogie having alternative stabilising means,

Figure 4 is a section on IV-IV of Figure 4a showing in detail one drive train of the bogie shown in Figures 1 or 3a,

Figure 4a is a side elevation of the motor and drive train shown in Figure 4,

Figure 5 is a partial plan view of the underside of the bogie shown in Figure 1, showing a Watt linkage connection,

Figure 6 is a partial axial section showing the Watt linkage of Figure 5,

Figure 7 is a side elevation, partially cut away, of a short wheel-base similar to that shown in Figure 2,

Figure 8 is a sketch perspective view of the Watt linkage utilised in the bogie of Figure 7, and

Figure 9 shows one alternative drive train of the bogie shown in Figures 1 or 3a.

Similar parts are indicated by corresponding reference numerals throughout the drawings.

Referring to Figure 1 to 3, the bogie shown comprises a generally rectangular bogie frame 33 supported on primary suspension springs 50 (Figure 1) from axle boxes 49 which carry wheelsets consisting of wheels 47 mounted on axles 21 (Figure 3). The primary suspension is thus conventional form and typically allows only a very slight lateral freedom of movement between the wheelsets and bogie frame 33. The bogie is powered by a traction motor assembly comprising two traction motors 1 (Figure 3) bolted to a bolster 4 (Figure 2, Figure 3) which is in turn mounted from the locomotive body 45 for rotation about the bogie swivel axis 59 on a rotational bearing 2 (Figure 2). As will subsequently be described in more detail, the locomotive body is coupled to the bogie frame 33 by a Watt linkage connected between bolster 4 and a pivot 38 extending from bogie frame 33 (Figure 2), and is supported from the bogie frame on a secondary suspension consisting of four flexi-coil springs 31. As best seen in Figure 3, the traction motor assembly lies in the space envelope of the bogie and each traction motor 1 is coupled to a gearbox 3 which incorporates a drive train to a torque coupling indicated generally at 57. The torque couplings 57 (which will subsequently be described in detail) drive the wheelsets and accommodate vertical displacements of the axles 21 on their primary suspension and also lateral displacements caused by swivelling of the traction motor assembly. Rotation of the traction motor assemblies on bearing 2 is transmitted to the remote end of each gearbox 3 by short links 24 between bolster 4 and gearbox 3. Arms 28 are each supported by a linear bearing 8 which is attached beneath the headstock of the bogie frame 33. For the sake of clarity, only one linear bearing 8 is shown but in fact each gearbox 3 is supported by its own linear bearing and in general the two traction motors 1 are supported and coupled to their associated wheelsets by identical components in an antisymmetrical arrangement. Therefore only one set is described specifically.

As described thus far, the traction motors 1, gearboxes 3 and associated torque couplings 57 are free to swivel about axis 59 relative to the lcoomotive body, whilst transmitting driving or braking torque to the wheelsets. Consequently the moment of inertia of this assembly about swivel axis 59 is isolated from any rotational oscilations of the bogie frame 33 about this axis. Such oscillations tend to arise in practice as a result of uneveness in the rail surfaces and rail spacing can cause problems at high speeds. In the present arrangement however, the traction motors are isolated from these disturbances and the oscillations can therefore be damped much more easily. A further advantage of the arrangement as described thus far is that the centre of mass of the traction motor assembly and associated gearboxes and torque couplings is fixed with respect to the locomotive body, thus reducing the tendency of the body to sway or "nose" on the bogies and, more importantly, increasing the speed at which the bogie can operate without reaching the onset of instability.

In order to swivel the motors 1 and gearboxes 3 with the bogie frame 33 when entering curved sections of track, whilst maintaining their isolation from oscillations of the bogie on straight track, a link 22 is connected between one of the motors 1 and the transom of bogie frame 33 as shown in Figure 5. Link 22 allows approximately 4 mm of lost motion between rotation of bogie frame 33 and the motor assembly and thus only has effect on curved sections of track. In order to suppress "hunting" disturbances of the motor assembly which would otherwise be allowed by this lost motion, a stabiliser comprising a spring-loaded stabiliser 30, is mounted on a support 44 from the locomotive body and engages a notch in a projection 60 from bolster 4 to inhibit oscillation of the bolster on its swivel mounting. When the locomotive enters a curved section of track the wheelsets swivel the bogie frame 33 about its swivel axes 59 until the lost motion in link 22 is fully taken up, and then projection 60 rolls past its associated rollers 131 (which thus ride out of their depressions), and causes the traction motor assembly gear-boxes 3 and torque couplings 57 to swivel bodily with the bogie frame to follow the track curvature. On curved track, "hunting" of the bogie 33 is not a serious problem because the flexicoil suspension springs 31 resist swivelling of the bogie and thereby hold the flanges of wheels 47 against the rails.

The force needed to overcome the stabiliser springs is relatively small since rotation of the motor and gearcase takes place on roller and ball bearings. It will be appreciated that the action of the spring loaded notched stabiliser does not hinder the lateral movement of the superstructure traction motors and their gearcases on the secondary suspension 31 when the superstructure sways or noses in a lateral direction relative to the bogie on straight or curved track, since the notched stabiliser 30 is connected across elements which control rotational movements of the rotational bolster 4 and therefore motors 1, whilst the links 24 copy the lateral motion of the superstructure and thus restrain the gearwheel end of the gearcase from describing small oscillatory movements in unison with the bogie should sporadic hunting occur on straght track. The amount of this movement is that matching the wheel flange to rail lateral track clearance which is plus or minus 7 or 8 mm generally. Thus the notched stabiliser together with the small clearances at the end of the bolster rotational link 22 ensure that on straight track, the rotational inertia of the motor and gearcase remain de-coupled from the rotational movements of the bogie.

Figure 3A shows an alternative embodiment in which two dampers, 200 and 201 replace the spring loaded notched stabiliser 30 illustrated in Figure 3. These dampers are attached between the bogie frame and the rotating bolster 4 and act across the small mvoement allowed by the bolster rotational link 22 (see Figure 5). For slow rotational movements of the bogie, such as those occurring when traversing a curve, they have no discernible effect. For more rapid oscillation, such as occurs when the bogie starts to 'hunt', i.e. to oscillate sinusoidally about the vertical axis 59 through its centre, the dampers act to restrain such movement.

Figures 4 and 4a show in detail the drive train from one of the traction motors 1 to one of the wheelsets; the drive train from the other motor 1 shown in Figure 3 is of course precisely similar. Referring to Figures 1, 2 and 4a, it can be seen that each motor 1 is supported from bolster 4 by a curved link 6 pivoted on spherical bearings 7 at top and bottom. The linear roller bearings 8 provide for relative lateral movement between bogie frame 33 and the locomotive body whether on curved or straight track.

Referring to Figure 4, the gearbox 3 contains a pinion 9 at the end adjacent to the traction motor, a large idler gear 10 and the driving gearwheel 11 which also serves as the hollow quill tube. Bolted inside the driving gear wheel 11 is an annular drive element 12, which is manufactured in two halves for assembly purposes. The annular drive element on one side and the quill stub extension on the driving gearwheel on the opposite side form the mounting points for gearwheel roller bearings 13. The annular driving element 12 receives driving or electric braking torque at lugs 14 inside the gearwheel and to which it is attached by means of bolts fitted with ring dowel bushes.

Referring to part section A-A, the linear recirculating roller bearings 218 are loaded via spring pads 202 which themselves are pre-loaded by partial compression of circular dished springs, generally known as "Belleville" washers. The spring pads can typically accept movement of about 0.4 to 0.5 mm, and they serve to minimise the accuracy necessary to ensure load sharing between the bearings.

Surfaces 203 and 204 accept drive respectively in each direction of travel, whilst surfaces 205 and 206 drive respectively in each direction of travel. Spring pads 202, pre-loaded to a half or two-thirds maximum tractive effort, act in conjunction with re-circulating linear roller bearings and hardened steel raceways 208, thus providing a plunge bearing. The mutual angles of these linear bearings also act to support the weight of the drive tube assembly 209 together with the relatively minor eccentric loads which occur when the floating ring of the flexible drive 210 runs off-centre, i.e. when the bogie frame and therefore the driving quill tube 209 rises and falls relative to the axle as the suspension responds to normally encountered track irregularities.

The plunge bearing allows the driving quill tube and gearbox assembly to translate laterally on the secondary suspension of the body in a manner which is linearly free in either direction whether exerting tractive effort, braking or coasting.

The gearcase at the headstock end moves laterally at the same time on the two side-by-side linear bearings 8 mounted on the bogie headstock. The driving member is supported at each end by linear re-circulating roller bearings 207 218. The plunge bearing so formed allows the driving member 17 to remain in the same position laterally in relation to the axle and flexible drive, whilst motors 1 and gearcase 3 can move laterally by plus or minus 65 mm on their linear bearings as the superstructure sways or noses on the secondary suspension and on curved or straight track.

The driving member 17 transmits driving or electric brake torque to the axle by means of a flexible coupling which forms the subject of our U.K. patent application No. 8507720 (which is hereby incorporated by reference) but in this case is designed for a small overall diameter so that the parts are strung out along the axis of the axle, rather than around each other which increases diameter.

Briefly, driving member 17 transmits torque at rubber bushings 55 driving parallel links 18, (Figure 2) one pushing and one pulling. These links are connected by through pins (not shown) to twin 'floating' rings 19, one on each side of the two driving arms of the driving member 17. From the floating rings 19 two further links 61 (Figure 2) drive bushes 56 which in turn drive the driving member 20 which is bolted to the wheel.

Other forms of flexible drive could be used with the invention. A type of floating ring drive (Alsthom) which is well known employs twin links to pull or push the floating ring and twin links to correspondingly push or pull the axle, but each according to direction of travel. Again some form of cardan shaft drive could connect the drive member to the opposite wheel.

The flexible drive can alternatively be located at the centre line of the axle 21 so that differing types of primary wheelset yaw suspension, or yaw control of wheelsets can be accommodated, including self steered, cross braced, or fully steered types, which have a connection between body and bogie linkages. In this case, the transmission disc brake 213 is omitted.

Thus the axle 21 driven at its centre line by means of a pure torque from the driven member 20, and flexible drive elements, which are rubber bushed and of minimal unsprung weight, can rise, fall, or tilt in end view of the vehicle and within the design confines of the flexible drive, its driving member 17 and driven member 20, whilst the whole gearcase 3 and gears can translate laterally relative to the axle as the superstructure sways or noses on the secondary suspension, moving sideways by plus or minus 65 mm on the re-circulating roller bearings 207, 218 inside the hollow driving gearwheel and at the headstock of the bogie frame 33. The axle 21 can thus yaw in plan view, and the execution of such motion places no significant additional load on the system vertically, on the wheelset in yaw, or on the wheelset yaw suspension or control, and therefore it follows, on the contact zones between wheel and rail, either as a result of the movements of the axle relative to the quill drive axis, or due to changes in reaction loads arising from change in the state of traction, electric brake, or mechanical transmission brake (if fitted) or coasting. (The transmission disc brake need not be fitted in the location shown on Figure 3.)

These advantages also increase the accuracy of calculated predictions concerning stability at speed and damping forces when required for very advanced types of bogie.

There is differential movement of the gearcase 3 relative to the hollow motor armature shaft 34 in end view in the vertical plane, which arises because the two gearbox bearing supports 8 at the headstock, which are side by side, maintain the gearbox in the same horizontal plane as the bogie frame whenever the superstructure rolls on its secondary suspension. Again in side elevation, whenever the superstructure bounces on the secondary suspension 31 the link 6, suspended from the rotating bolster, which supports the pinion end of the gearcase, causes a small differential movement at the pinion end of the gearbox, between the pinion axis and the axis of the hollow motor armature shaft 34 since the pinion end of the gearbox is superstructure mounted by means of the link 6, whereas the gearwheel end of the gearbox is located, as well as supported by, the linear bearings 8 at the headstock of the bogie and is thus mounted on the primary suspension for vertical movements.

These small differential movements between the pinion and hollow armature shaft 34 are catered for by utilising the existing GEC hollow armature shaft drive which has been in use at 110 mph on BR for more than 10 years and has given very good service.

In this drive a geartooth coupling 35 able to accept small angular change of alignment as to its axis, transmits driving torque from the hollow armature shaft 34 of the traction motor at the end of the motor remote from the gearcase pinion 9. Transmission of the drive is then by means of a solid shaft 36 contained within the hollow armature shaft 34 to a rubber bushed two part coupling 37 at the opposite end and which drives the pinion.

Traction reaction occurs at the wheel tread, and traction forces, arising from this reaction and derived from the pure torque exerted by the driving member 20, are exerted on the bogie frame 33 at the centre line of the axleboxes 49 and the primary suspension 50. Referring to Figures 5 and 6,traction and braking forces are transmitted from the bogie frame 33 to the superstructure by means of a downwardly pointing bogie pivot 38 attached to the transom of the bogie frame 33 and a Watt linkage to the rotating bolster 4. The Watt linkage consists of a short traction beam 39 bushed 40 at the bogie pivot, and disposed to lie across the bogie frame and supported by two straps 41 having wearing faces and attached to the motorframe at one end and the rotational bolster at the other end. At the outer extremities of the traction beam 39 short rubber bushed traction links 42 on either side connect to the rotational bolster 4 at a low height, thus transmitting traction and braking forces to the locomotive superstructure, since except for the ability to rotate in plan view with the bogie, the traction bolster 4 and motors 1 are in all other respects a part of the superstructure. Each traction link has a rubber spherical bush 142 at its connection to the traction beam 39 and a plain rubber bush 43 at the connection to the rotational bolster 4.

The large diameter ball or roller bearing used as the rotational bearing 2 is well able to accept the longitudinal traction load and the couple arising from the traction link loads multiplied by the height between the rotational bearing and the traction links 42 and bogie pivot 38.

The bogie pivot point illustrated as to its height above rail is typical of that for optimum weight transfer with the drive discussed and illustrated. Due to the removal of the motor frame to become effectively a part of the superstructure, the frame reaction is removed from the bogie frame to the superstructure. Mounted on the superstructure the reaction of the motors, which is adverse, is divided by the distance apart of the pivot points rather than the bogie's relatively short wheelbase. Thus the removal of the reaction from the bogie frame enables equal axle loads to be obtained in each bogie with a virtual pivot above rail level and the increase in change of pivot load due to the motor reaction is only small.

The net result is a small but definite improvement in weight transfer.

It will be appreciated that all the relative motions between the locomotive body 45 (Figure 2) bogie frame 33, and bolster 4 should be damped, and accordingly hydraulic dampers of conventional type are provided. Two of these are indicated at 48 in Figure 1.

Figures 7 and 8 show a bogie with a shorter wheelbase than that shown in Figures 1 to 5. The shorter wheelbase (typically 3.00m as opposed to 3.35m) is achieved by dispensing with the central transom of the bogie frame - the bogie frame 33' of Figure 7 incorporates two bridging members 65 instead. Accordingly the motors 1 are mounted closely adjacent one another beneath the rotatable bolster 4.

As in the embodiment of Figures 1 to 5, a Watt linkage transfers drive from the bogie frame to the superstructure 45 whilst allowing lateral freedom of the superstructure relative to the bogie frame on its secondary suspension. As shown in Figures 7 and 8, a bridge member 60 is mounted from superstructure 45 for rotation about bogie swivel axis 59 on a roller bearing 2'. As best seen in Figure 8 the bridge member 60 comprises two diagonally opposite legs 61 which embrace the bolster 4 and motors 1. However bolster 4 swivels independently of bridge member 60 and is allowed limited rotational freedom of movement with respect to the bogie frame 33' by a rubber-bushed link 66 (Figure 7) which connects it to one bridge portion 65 of botie frame 33'. Referring to Figure 8, bridge member 60 is connected to extensions 67 from bogie frame 33' by two parallel links 64 which are pivoted at horizontal axes 62 from legs 61 and are pivoted at their opposite ends about vertical axes 63, these vertical axes being fixed with respect to the bogie frame. consequently bridge member 60 and the associated superstructure 45 can move laterally on the bogie but is fixed to the bogie in the longitudinal direction. The links 64 incorporate rubber bushings (not shown) which allow limited twisting of axes 62 with respect to axes 63, so that bridge member 60 and superstructure 45 can move vertically and laterally (i.e. side to side) on its secondary suspension (not shown in Figs. 7 and 8).

The shorter bogie wheelbase allowed by the Watt-linkage bridge of Figures 7 and 8 is highly desirable and frequently a necessity on high speed trains because it reduces undesirable quasi-static lateral forces which act on the bogie during running in curved track, and also reduces the instantaneously generated forces which arise as a result of kinks and irregularities in straight track.

Figure 9 shows the drive train of an embodiment of the invention in which the traction motor assembly is carried from the underframe at one end and from the bogie frame at the other end, with a gearbox 3 and the frame of a motor 1 rigidly connected by bolts 211. This arrangement dispenses with the through shaft inside the motor armature but retains the plunge bearing on the quill tube. It also dispenses with the notched stabiliser and slewing ring (Figure 3).

CLAIMS

1. A powered railway bogie arrangement comprising a traction motor assembly including at least one traction motor (1), and a drive train coupled between the bogie wheelsets (47, 21) and said traction motor assembly and characterised in that said drive train is arranged to accommodate relative motion between said traction motor assembly and said wheelsets, said traction motor assembly being mounted so as to have limited freedom of movement with respect to the bogie (33).

2. A powered railway bogie arrangement according to Claim 1 wherein each said traction motor (1) is mounted with its drive shaft (36) substantially parallel to the axles (21) of said bogie wheelsets.

3. A powered railway bogie arrangement according to Claim 1 wherein each said traction motor (1) is mounted with its drive shaft (36) transverse to said bogie wheelsets and a right-angle drive is employed between said motor and said wheelsets.

4. A powered railway bogie arrangement according to Claim 2 or 3 wherein said traction motor assembly is mounted on a swivel mounting (2, 4) which is coaxial with the swivel mounting (38) of the bogie.

5. A powered railway bogie arrangement according to any preceding claim further comprising a linkage (22) between said bogie and said traction motor assembly and arranged to allow for some degree of lost motion between swivelling of said bogie and swivelling of said traction motor assembly.

6. A powered railway bogie arrangement according to any preceding claim wherein said traction motor assembly is mounted from the body (45) of the locomotive to which said bogie is attached so as to translate with the locomotive body but to swivel with the bogie.

7. A powered railway bogie arrangement according to Claim 6 further comprising stabiliser means for inhibiting swivelling oscillations of said traction motor assembly relative to the locomotive body.

8. A powered railway bogie arrangement according to Claim 7 wherein said stabiliser means comprises a spring-loaded roller (131) which engages a depression or projection in a member (60) attached to said traction motor assembly or said locomotive body when the bogie is aligned with the body, but rides out of said depression or over said projection when the locomotive enters a curve and the bogie swivels with respect to the body.

9. A powered railway bogie arrangement according to Claim 7 wherein said stabiliser means comprises a pair of hydraulic dampers (200, 201).

10. A powered railway bogie arrangement according to any preceding claim wherein said traction motor assembly is coupled to said bogie wheelsets by a flexible drive train.

11. A powered railway bogie arrangement according to Claim 10 wherein said drive train is supported from said bogie by a linear bearing, (8).

12. A powered railway bogie arrangement according to Claim 10 wherein said drive train includes a flexible torque coupling to accommodate vertical movement of the wheelset on its primary suspension.

13. A powered railway bogie arrangement according to Claim 12 wherein said flexible torque coupling comprises a floating ring element (19) connected by respective pairs of parallel links (18, 61) to arms on the driving and the driven shafts (17, 20).

14. A powered railway bogie arrangement according to Claim 12 or 13 wherein said flexible torque coupling includes linear bearings (207, 218) to accommodate lateral movement of said drive train with respect to said wheelset.

15. A powered railway bogie arrangement according to any preceding claim wherein said bogie is connected to the locomotive body by a Watt linkage which locates said bogie in the longitudinal direction but allows the bogie lateral freedom of movement with respect to the locomotive body.

16. A powered railway bogie arrangement according to Claim 15 wherein said Watt linkage is connected between a pivot (35) on said bogie and said traction motor assembly, the connection at said pivot being below the level of the bogie.

17. A powered railway bogie arrangement according to Claim 15 wherein said Watt linkage is in the form of a bridge member (60) which is mounted from the locomotive body for rotation about the bogie swivel axis, said bridge member incorporating a pair of downwardly extending legs, (61) the lower ends of which are connected by respective substantially parallel pivoted links (64) to the bogie frame.

18. A powered railway bogie arrangement according to any preceding claim comprising a gearbox (3) rigidly fixed to the frame of said traction motor (1).

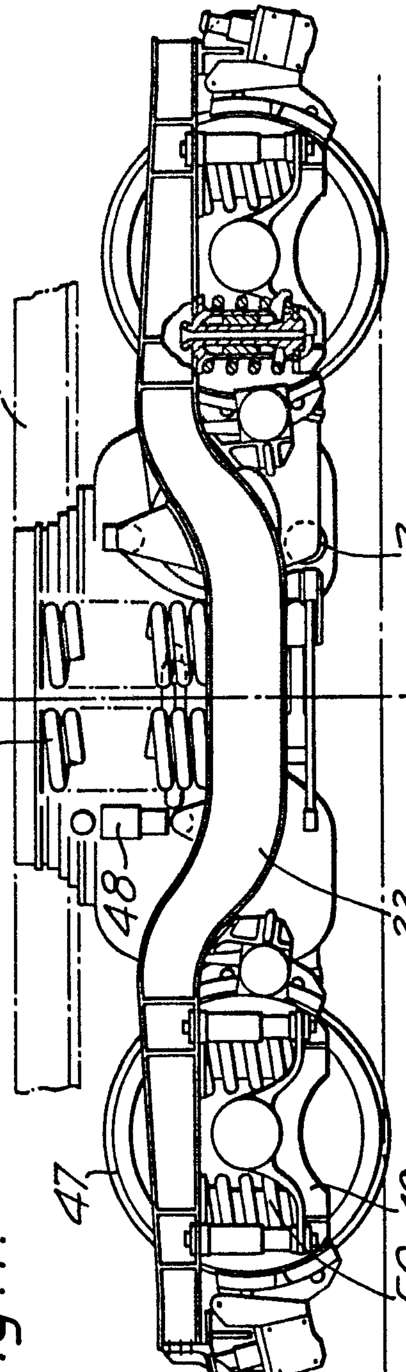

Fig.1.

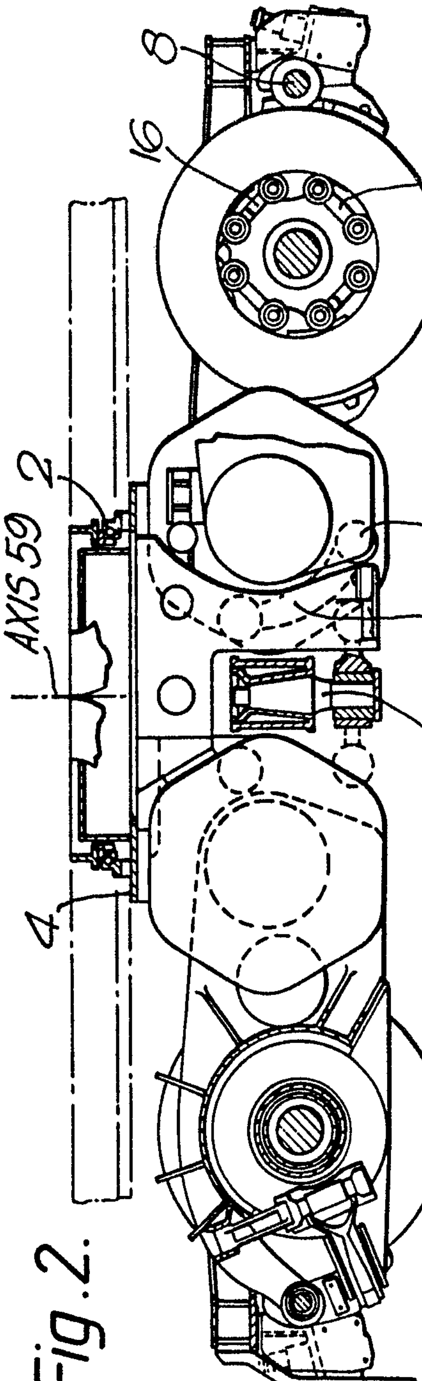

Fig.2.

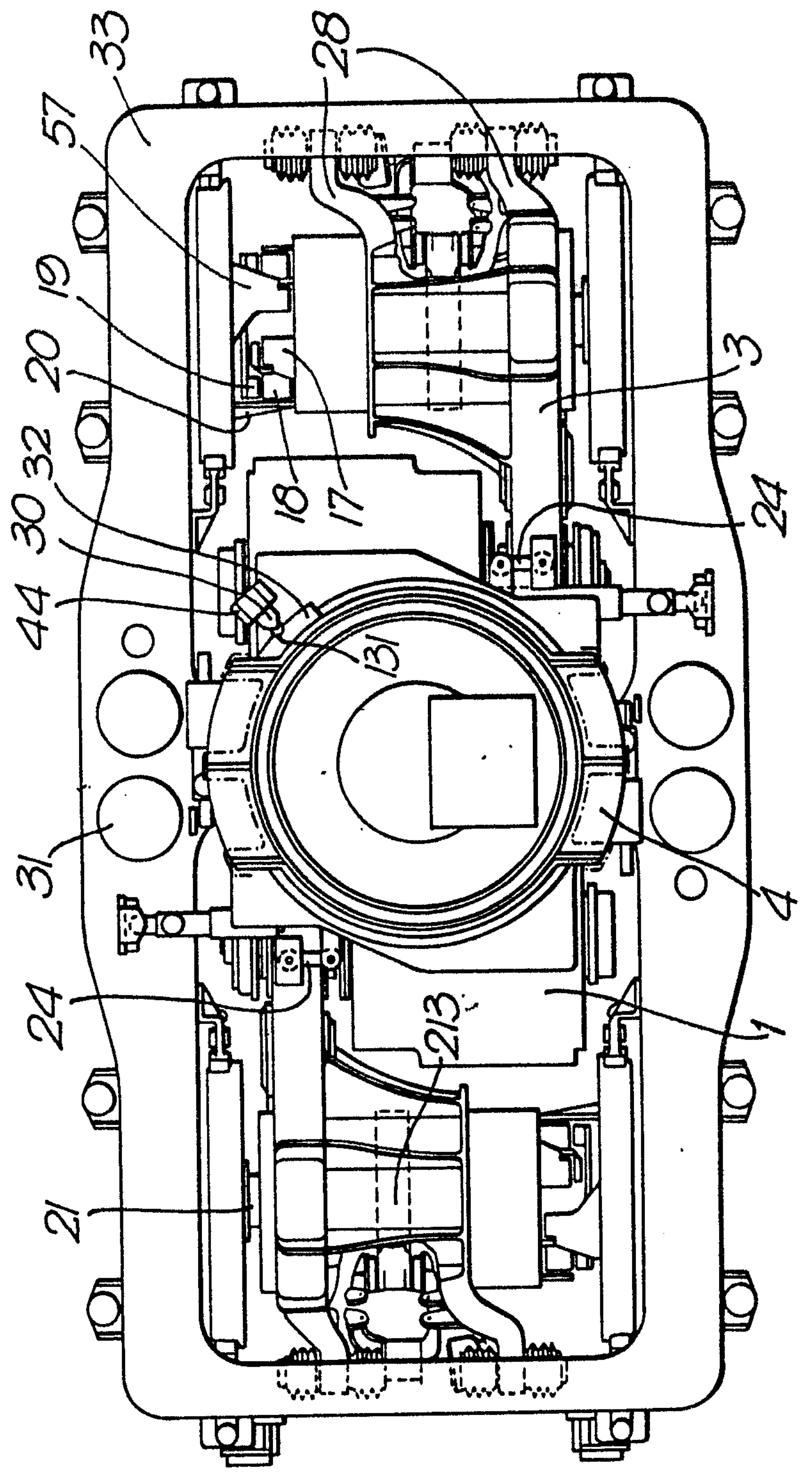

Fig. 3.

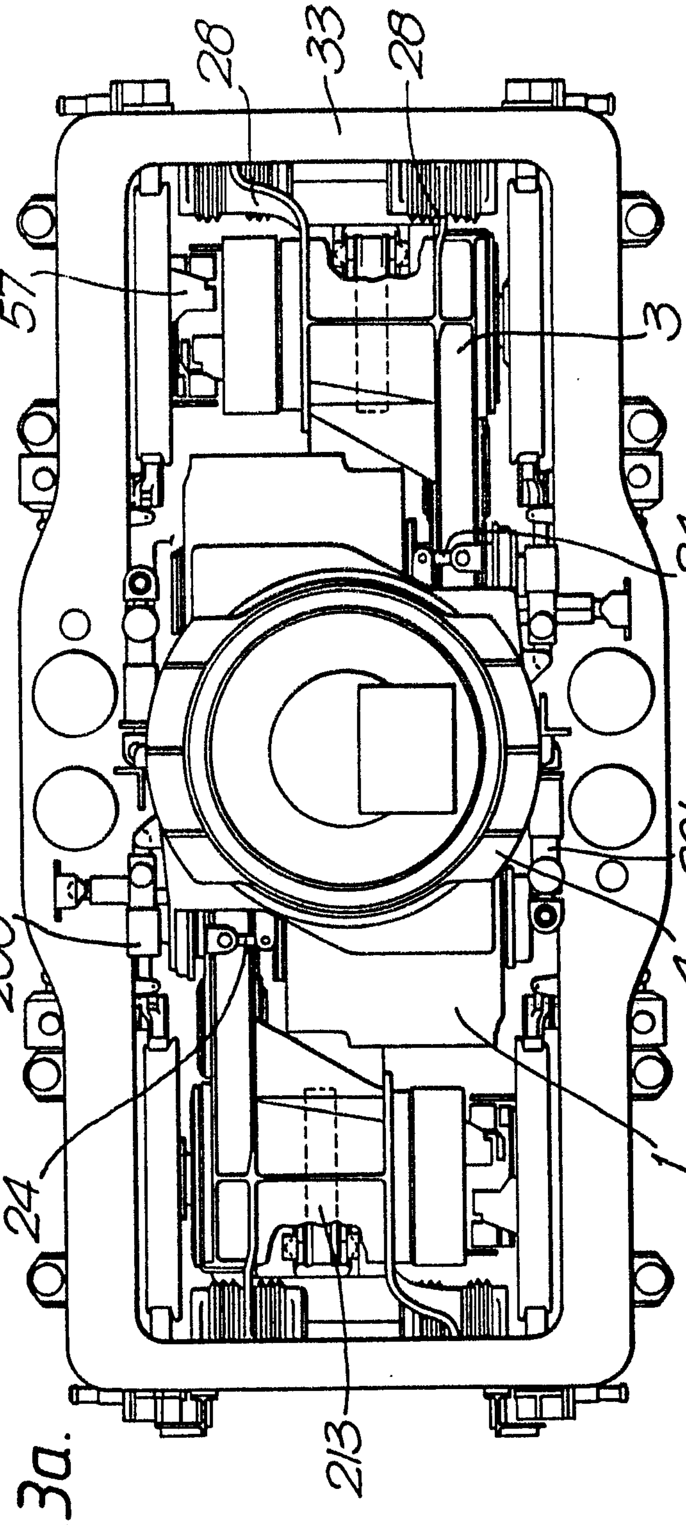

Fig.3a.

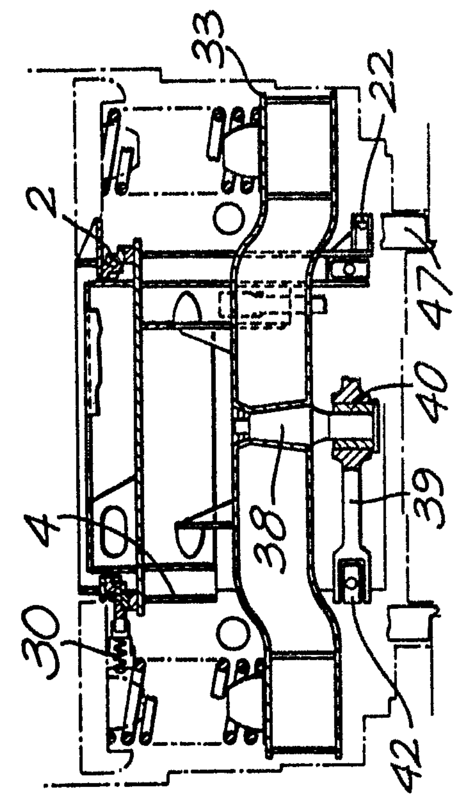

Fig.6.

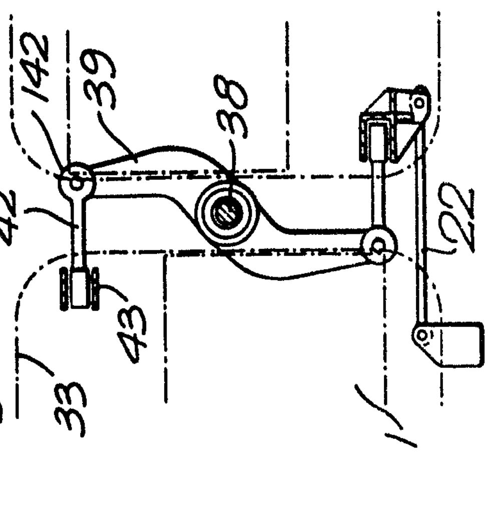

Fig.5.

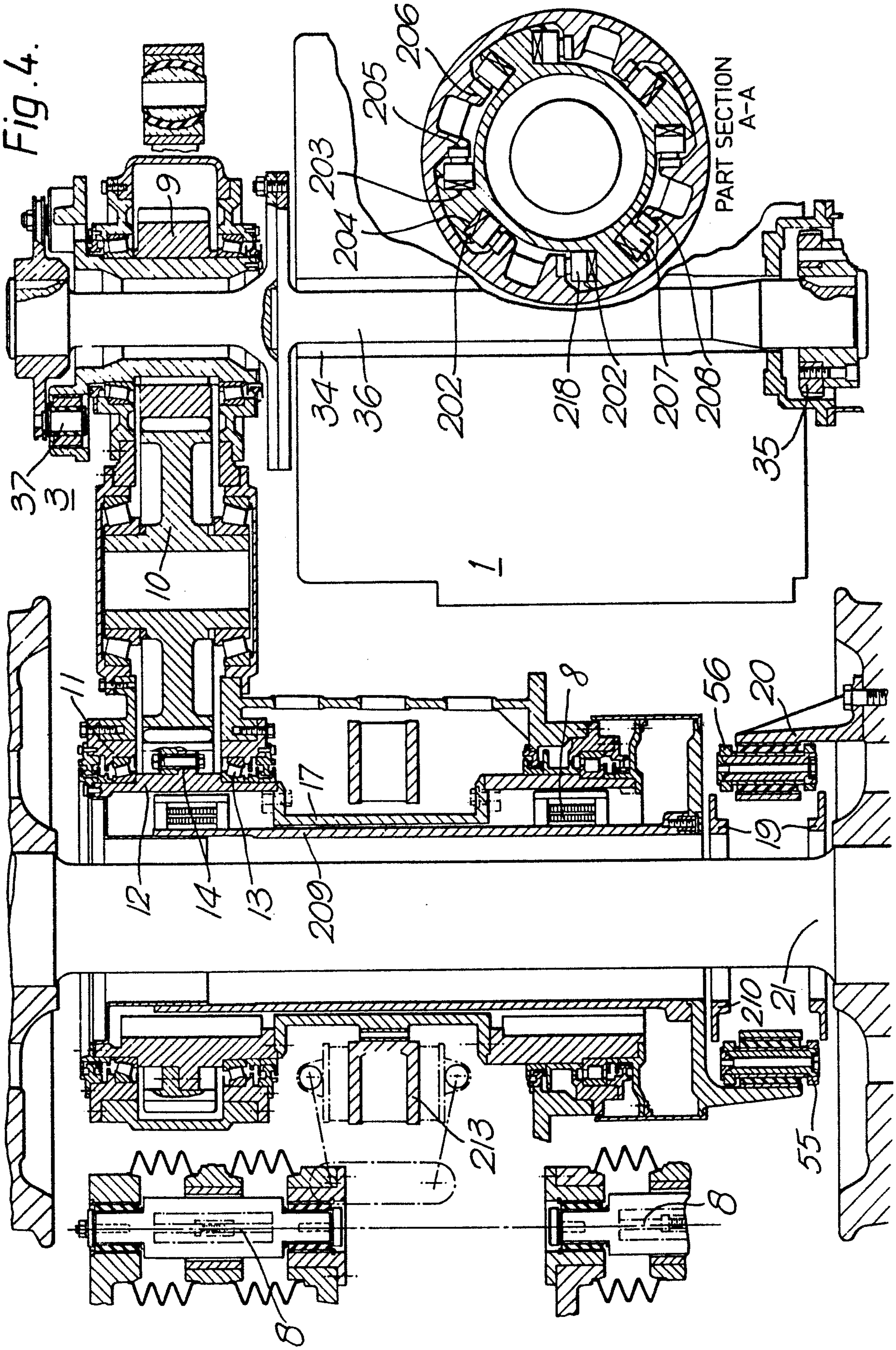
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Fig. 4.

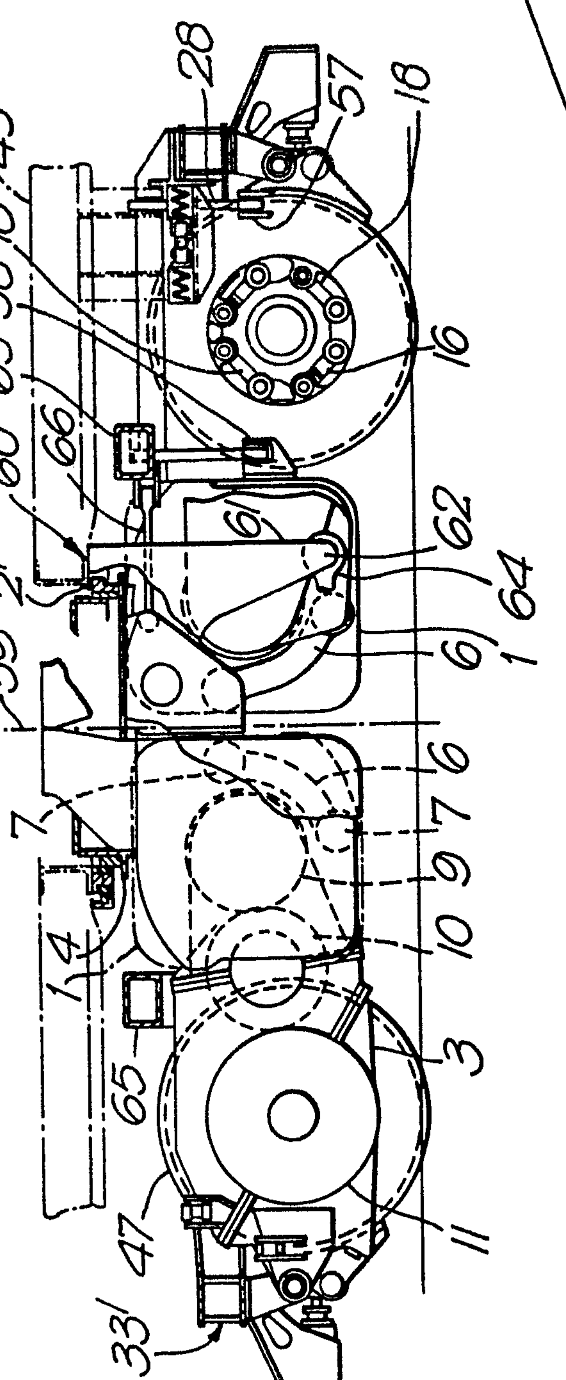

Fig. 7.

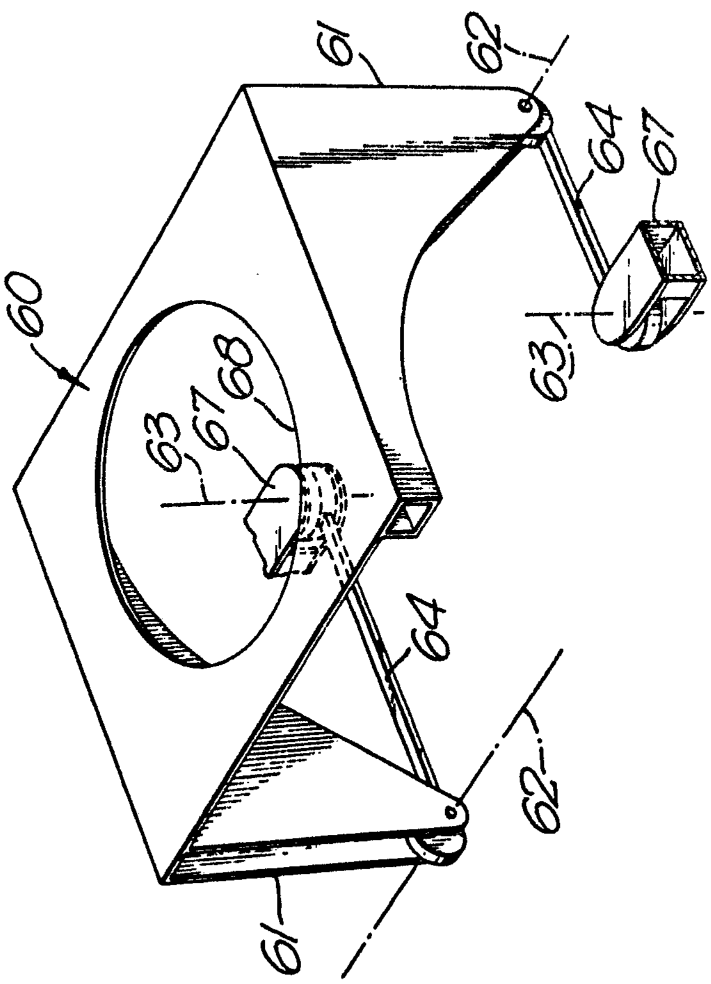

Fig. 8.

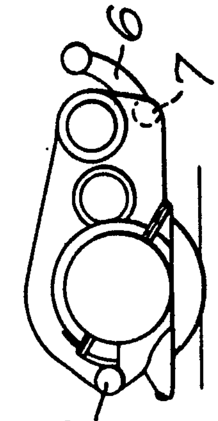

Fig. 4A.

Fig. 9.