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DUAL-GENERATOR MOUNTING

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Fig. 1.

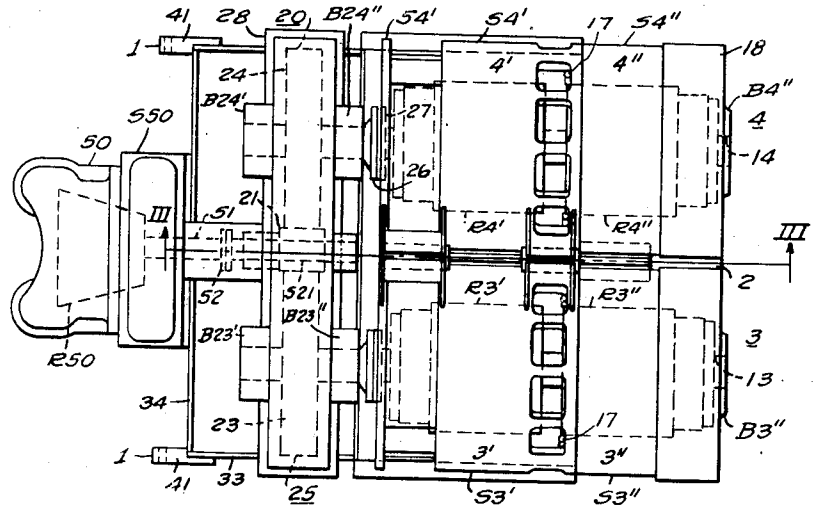


Fig. 2.

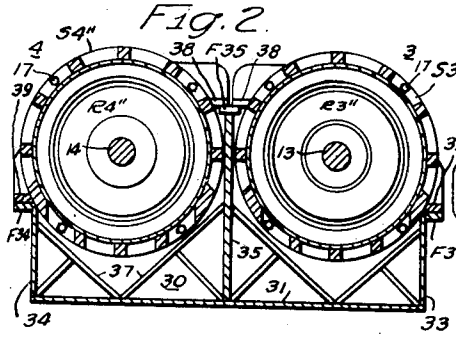


Fig. 3.

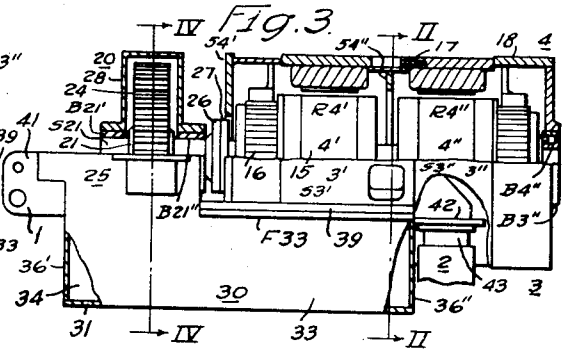


Fig. 4.

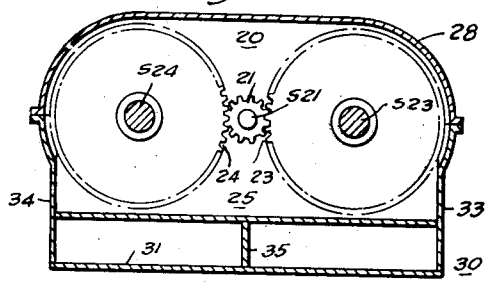
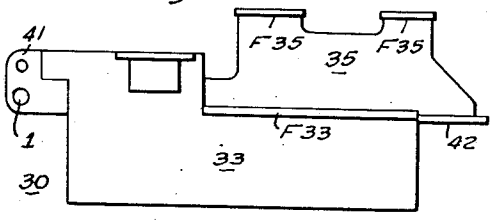


Fig. 5.



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DUAL-GENERATOR MOUNTING

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6 Claims. (Cl. 74—389)

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Our invention relates to light-weight mountings for plural-machine assemblies which are designed for use on transportation-devices, or in other applications where portability is required. While our invention is susceptible of other uses, it was primarily designed to solve problems in connection with some new 6,000 horsepower turbine-electric railroad-locomotives, which required four slow-speed direct-current generators to be driven from one high-speed turbine, through a 6-to-1 reduction-gear.

When only a single machine is involved, its own frame is usually sufficiently rigid so that bearing-alinements are not a problem, even though the machine should be supported on only three of its four feet. When two machines are to be mechanically coupled together, even in such a simple arrangement as coaxial alinement, some sort of means is needed for holding the two machines together and for properly alining the bearings, and this need is usually or frequently answered by the provision of a suitably heavy bedplate. When the aggroupment of machines becomes more complicated, as when two side-by-side machines are driven from a single prime-mover through a dual gear-unit, the need for a rigid bedplate becomes extremely urgent.

On the new 6,000 horsepower turbine-electric locomotives, the original generator-bedplate design, weighing approximately six tons for the bedplate alone, was not sufficiently rigid, and was far outside of the permissible weight-allowance. The frame of the locomotive-cab is a relatively flimsy affair, which twists and turns, and is subject to wheel-impacts which are transmitted to the cab-frame through its spring-mountings, as the wheels strike obstructions or unevennesses in the track. As a result, one side or corner of the cab may raise as much as one-quarter inch with respect to the other, whereas bearing-alinement must be maintained, accurate within two-thousandths of an inch for the length of the gear-face. It was estimated that there would be a twisting force of perhaps twenty tons, tending to raise one bearing-center at the outboard end of our dual-generator assembly, and tending to lower the other, thus disturbing the bearing-alinement of these outboard bearings with respect to the bearings of the gear-unit at the inboard or drive-end of the assembly.

In the locomotive in question, nearly all of the locomotive-space was occupied by the boilers, the power-unit occupying only a relatively small space at the tapered end of the locomotive, where available lateral space is diminishing because of

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the taper, and where the available vertical space is limited by the necessity for placing the bottom of the power-unit bedplate with a relatively small clearance over the tops of the driving-motors on the trucks.

It is an object of our invention to provide a novel dual-generator mounting, in which the bedplate-proper is in the form of a light skeleton frame, open at the top, after the manner of an open box. Such a frame has very little twist-resisting rigidity, as one can readily verify by comparing the twist-resisting stiffness of a closed match-box with the twist-resisting rigidity of just the box alone, removed from its enclosure. Such an open-box skeleton-construction needs to be closed across its top, as well as its bottom, in order to be twist-resistant, and we accomplish this, in our design, by utilizing the inherent rigidity of the generator-frames as the closure-means for the top of the box-like bedplate, with certain refinements and modifications which will be subsequently pointed out, and preferably with certain stiffening-means which are added to the generator-frames for the express purpose of rendering them more suitable for the peculiar strains which are now placed upon them.

With the foregoing and other objects in view, our invention consists in the combinations, assemblies, parts, design-methods and systems hereinafter described and claimed, a simplified showing of which is illustrated in the accompanying drawings, wherein:

Figure 1 is a plan view of our complete assembly,

Fig. 2 is a transverse section on the line II—II of Fig. 3,

Fig. 3 is a side elevation of the gear-unit and generators, with the turbine removed, the top half being in longitudinal section, approximately on the line III—III of Fig. 1,

Fig. 4 is a transverse section on the line IV—IV of Fig. 3, and

Fig. 5 is a side elevation of the bottom half of the gear-case and the whole of the bedplate, detached from the rest of the apparatus shown in Fig. 3.

In the illustrated form of embodiment of our invention, the power-plant is mounted in accordance with the well-known three-point mounting-principle, which permits the underlying supporting-member to twist independently of the supported member. Our invention is not limited, however, to a three-point mounting. The three-point mounting is shown in the form of two laterally separated hinges 1, spaced as far apart,

laterally, as practicable, and a single longitudinally removed central-support 2 which is disposed midway between the two lateral sides of the assembly.

As shown in plan-view in Fig. 1, our power-plant consists of two side-by-side direct-current generator-assemblies 3 and 4, each of these generator-assemblies comprising a pair of alined generators 3', 3''; and 4', 4'', making four generators in all. Each of the four generators has its own rigid stationary member or frame S3', S3''; S4' and S4'', respectively, and its own rotating member R3', R3'', R4' and R4''. Each pair of alined generators has a single shaft which is common to the two rotating members of that pair, the two shafts being parallel to each other. Thus, the rotating members R3' and R3'' are mounted on a common shaft 13, while the two rotating members R4' and R4'' are mounted on a common shaft 14. Each of the rotating members R3', R3'', R4' and R4'' consists of an armature-member 15 and a commutator-member 16, disposed with the two rotating members of each pair arranged in back-to-back relation on the common shaft, with the two armatures toward each other and the two commutators at the ends.

The rear or outboard generator-frame, S3'' or S4'', of each pair of alined generators, is rigidly supported from the rear end of the forward or inboard generator-frame, S3' or S4', of that pair, through accurately machined joints and bolted connections as shown at 17. The outboard or rear end of the rear generator-frame, S3'' or S4'', of each pair, is provided with a heavy end-plate 18 which supports an outboard bearing B3'' or B4'' as the case may be, for rotatably supporting the outboard ends of the respective generator-shafts 13 and 14.

At the front or inboard end of the side-by-side generator-assemblies 3 and 4, we provide a gear-unit 20. This gear-unit 20 has a centrally disposed gear-member, in this case a pinion 21, and two laterally disposed gear-members, in this case bull-gears 23 and 24, meshing with the pinion 21 which is disposed between the two bull-gears. Each of the three gear-members has its own gear-shaft S21, S23 and S24, respectively. The gear-unit 20 has a lower gear-casing 25, having front and rear bearings for each of the three gear-shafts, as shown at B21', B21''; B23', B23''; and B24', B24'', respectively. The rear ends of the bull-gear shafts S23 and S24 have drive-flanges or coupling-flanges 26 which are adapted for connection to similar drive-flanges 27 at the front end of the shafts 13 and 14 of the two side-by-side generator-assemblies 3 and 4, thus supporting the front ends of the generator-shafts from the bull-gear shafts. The gear-unit 20 is closed by a removable upper gear-casing 28.

In accordance with our invention, we provide a skeleton, open-box-type, bedplate 30, extending back rigidly from the bottom of the lower gear-casing 25, toward the outboard end of the two side-by-side generator-assemblies 3 and 4. This bedplate 30 comprises a bottom member 31, which is preferably in the form of a sheet or plate, two rearwardly extending upright side-members 33 and 34, a rearwardly extending upright central plate 35, front and back upright end-members 36' and 36'', and gusset-plates 37 which are disposed, as necessary, to prevent buckling of the several parts.

The side-members 33 and 34 and the central plate 35 of the skeleton bedplate are preferably, although not necessarily, provided with top flanges F33, F34 and F35, respectively, which are utilized for mounting the front or inboard generators 3' and 4' of the two side-by-side generator-assemblies 3 and 4. For reasons which will be subsequently pointed out, it is quite preferable for the upright central plate 35 of the bedplate to be relatively tall, or deep in a vertical direction, while the two side-members 33 and 34 of the bedplate are relatively shallow, or much shorter in vertical height.

The generator-frames S3' and S4' are each rigidly secured to the upright central plate 35 and to one of the upright side-members 33 or 34 of the bedplate. Thus, the central plate 35 of the bedplate extends up between the two generator-frames S3' and S4', to a point which is higher than the shaft-axis level (or center) of the two side-by-side generator-frames S3' and S4', and these generator-frames are provided with high front and back foot-members 38 which are securely bolted to the top flange F35 of this central plate 35 of the bedplate. The side-members 33 and 34 of the skeleton bedplate extend up only to about the bottom of the generator-frames S3' and S4', to about the place where the generator-foot is usually mounted, but in this case, each of the generator-frames S3' and S4' is provided with a continuous, longitudinally or axially extending foot 39, which is bolted to the top flange F33 or F34 of one of the bedplate side-members 33 or 34, at frequent intervals, substantially along its entire length, so as to reenforce the relatively thin bedplate-flange F34 or F35, as the case may be, substantially continuously along its exposed upper surface.

In the particular design which is illustrated in the drawing, the front upright end-member 36' of the bedplate is disposed somewhat in front of the front end of the gear-unit 20, while the back upright end-member 36'' of the bedplate is disposed approximately underneath the rear end of the two forward generator-frames S3' and S4', so that the two rearward or outboard generators 3'' and 4'' have an overhung mounting. The front upright end-member 36' of the bedplate is provided with two lugs 41 which engage the two supporting-hinges 1, respectively, while the back center of the rear upright end-member 36' of the bedplate is provided with a supporting-foot 42 which rests on the central support 2 through a suitable flexible mounting 43.

In the assembly which is illustrated in the drawing, mechanical power is supplied to the two generator-shafts 13 and 14 by means of a centrally alined machine which is illustrated in the form of a high-speed steam-turbine 50, disposed in front of the gear-unit 20, that is, on the side of the gear-unit opposite to the two side-by-side generator-assemblies 3 and 4. The turbine has a rigid stationary member S50, a rotating member R50, and a shaft 51 for the rotating member, the shaft 51 being in alinement with the pinion-shaft S21 of the gear-unit, and having a suitable coupling-means 52 for uniting the two shafts 51 and S21.

The turbine 50 operates at rather high temperatures, and is thus subject to considerable thermal expansion, so that, in order to maintain the proper alinement between its shaft 51 and the gear-shaft S21 of the centrally disposed gear-member or pinion 21 of the gear-unit, it is desirable to rigidly support the stationary member S50 of the turbine, in overhung fashion, from the gear-unit end of the assembly comprising the gear-unit 20, the bedplate 30, and the two gener-

ator-frames S3'' and S4''. The details of this overhung turbine-mounting are not shown in the drawing, except to indicate that the turbine-frame S50 is rigidly secured to the lower gear-casing 25.

In the operation of our invention, it will be noted that the bedplate 30 is practicably a very much elongated rearward extension of the bottom of the lower gear-casing 25, or rather the lower gear-casing 25 may be regarded as a part of the front end of the skeleton bedplate 30. In fact, these two parts may be molecularly integral parts of each other, welded or otherwise united in a molecularly integral whole. The lower gear-casing 25, which supports the six gear-shaft bearings, should be quite rigid, but whether that rigidity is secured by the thickness of the walls of the lower gear-casing 25, or from the reenforcing nature of the underlying part of the bedplate 30, is largely a moot question, depending somewhat on where the gear-casing is regarded as ending and where the bedplate-structure is regarded as commencing. At any rate, the front and rear bearings for supporting each one of the three gear-shafts are rigidly supported.

The whole necessity for a bedplate is threefold, namely: to provide a longitudinal or axially extending connection between the gear-unit 20 and the twin-generator assembly; to maintain the central rearward supporting-foot 42, at the rear end of the bedplate, at a rigidly fixed vertical height with respect to the plane of the two bull-gear shafts S23 and S24 of the gear-unit; and to prevent relative twisting or warping of the bedplate, that is, to prevent one of the generator outboard-bearings B3'' to fall, while the other generator outboard-bearing B4'' rises, with respect to the horizontal plane of the axes of the two bull-gear shafts S23 and S24 of the gear-unit.

The longitudinal rigidity of the bedplate is easy to provide, being obtained by the vertical thickness or depth of the three longitudinally extending sides or plates 33, 34 and 35 of the skeleton bedplate 30, as well as by the very great longitudinal rigidity of the generator-frames S3' and S4'.

The type of rigidity which resists the warping distortion of the bedplate is obtained by using the rigid generator-frames S3' and S4' as an arch-shaped top for the open-box bedplate-structure, so that the entire structure, including the bedplate and the two generator-frames, has a very great diagonal-rigidity, resisting the twisting-motions which result in relatively lifting corner with respect to another. In contributing to this warp-resistant rigidity, it is thus desirable for the central longitudinal member or plate 35 of the skeleton bedplate-structure to rise higher than the two side-members 33 and 34 of the bedplate, so that an arch-like effect is obtained, as seen from an end-view or traverse section, as in Fig. 2.

The generator-frames, being of tubular construction, are inherently rigid, in their normal design. The rigid end-plates 18 of the two rear or outboard generator-frames S3'' and S4'' are necessarily rigid structurally, in order to support the outboard bearings B3'' and B4'', respectively. At the other ends of the four generator-frames S3', S3'', S4' and S4'', there are no bearings to be supported. However, we preferably provide rigid stiffener-plates or internally mounted rings 54' and 54'' (Fig. 3) at the front and rear ends of the two front frames S3' and S4', for the

purpose of giving these frames additional stiffness against the cave-end type distortion, at these points.

In the particular installation which is illustrated, the turbine operates at 6000 R. P. M., and the generators, because of limitations in regard to successful commutation, have to operate at not more than 1000 R. P. M. The maximum output which is practicably obtainable from a 1000-R. P. M. direct-current generator also necessitates the utilization of four machines, as shown, in order to obtain an electrical output of 6000 horsepower. The warp-provoking movement of the two supporting-hinges I is of the order of one-quarter inch, whereas the warp-resisting stiffness, as above described, must be sufficient to prevent a bull-gear shaft-tilting of more than two-thousandths of an inch, as measured along the axial length of one of the bull-gears; that is, the angular distortion of the bull-gear shaft should make an angle no greater than an angle whose tangent is equal to two-thousandths of an inch divided by the width of the gear-teeth. As a result of our construction, we have been enabled, with a weight of five thousand pounds, to achieve a far greater stiffness than would otherwise have been possible with a weight of twelve thousand or fourteen thousand pounds, if an attempt were made to obtain the necessary rigidities in a massive bedplate-structure alone, instead of utilizing our expedient of combining a relatively flimsy bedplate with the relatively rigid generator-frames, in such manner as to make one element reenforce the other.

While we have illustrated our invention in a single form of embodiment which we now prefer, it is obvious that many changes of omission, addition and substitution of equivalents may be made, by those skilled in the art, without departing from the essential features of our invention, and we desire, therefore, that the appended claims shall be accorded the broadest construction consistent with their language.

We claim as our invention:

1. In combination: two side-by-side machines, each having its own rigid stationary member, a rotating member, and a shaft for the rotating member, the shafts of the two side-by-side machines being parallel with each other and each having a drive-flange at its inboard end, and means carried by the rigid stationary member of each of said side-by-side machines for providing a rigidly supported bearing for the outboard end of its own shaft; a gear-unit disposed at the inboard end of said side-by-side machines, said gear-unit having a centrally disposed gear-member, two laterally disposed gear-members meshing with said centrally disposed gear-member, each of the three gear-members having its own gear-shaft, a lower gear-casing having two bearings for each of the three gear-shafts, and a removable upper gear-casing, the gear-shafts of the two laterally disposed gear-members each having a drive-flange for connection to a drive-flange of one of the two side-by-side machines; and a skeleton, open-box-type, bedplate extending back rigidly from the bottom of the lower gear-casing toward the outboard end of the two side-by-side machines, said bedplate comprising a bottom member, two rearwardly extending upright side-members, a rearwardly extending upright central plate, front and back upright end-members, and gusset-plates to prevent buckling of the several parts; each of the stationary members of said two side-by-side machines having

means for rigidly securing it to said upright central plate and to one of the upright side-members of the bedplate.

2. The invention as defined in claim 1, characterized by said upright central plate extending up past the shaft-axis level of the two side-by-side machines.

3. The invention as defined in claim 1, characterized by the two upright side-members of the bedplate having their upper surfaces below the shaft-axis level of the two side-by-side machines, and the side of the stationary member which rests on each upright side-member having a substantially continuous foot-flange for reenforcing the side-member substantially continuously along its exposed upper surface.

4. The invention as defined in claim 1, characterized by said upright central plate extending up past the shaft-axis level of the two side-by-side machines; and further characterized by the two upright side-members of the bedplate having their upper surfaces below the shaft-axis level of the two side-by-side machines, and the side of the stationary member which rests on each upright side-member having a substantially continuous foot-flange for reenforcing the side-member substantially continuously along its exposed upper surface.

5. The invention as defined in claim 1, in combination with a centrally alined machine disposed in front of the gear-unit, on the side of the gear-unit opposite to said two side-by-side machines, said centrally alined machine having a rigid stationary member, a rotating member, a shaft for the rotating member, in alinement with the gear-shaft of the centrally disposed gear-member, means for rigidly supporting the stationary member of said centrally alined machine from the gear-unit end of the assembly defined in claim 1, and means for uniting the shaft of said centrally alined machine and the gear-shaft of the centrally disposed gear-member.

6. The invention as defined in claim 1, characterized by each of said two side-by-side machines comprising a pair of alined machines having separate rigid stationary members and separate rotating members but a common shaft, the front machines of the two pairs being mounted as defined in claim 1, the rigid stationary member of the rear machine of each pair being rigidly supported from the rear end of the rigid stationary member of the front machine of that pair, and the rigid outboard bearing-supporting means for each of the two parallel shafts of said side-by-side machines being carried by the rear machine of its pair.

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No references cited.