

Jan. 7, 1930.

J. A. McGREW

1,742,610

REVERSING AUXILIARY LOCOMOTIVE

Filed July 14, 1927

6 Sheets-Sheet I

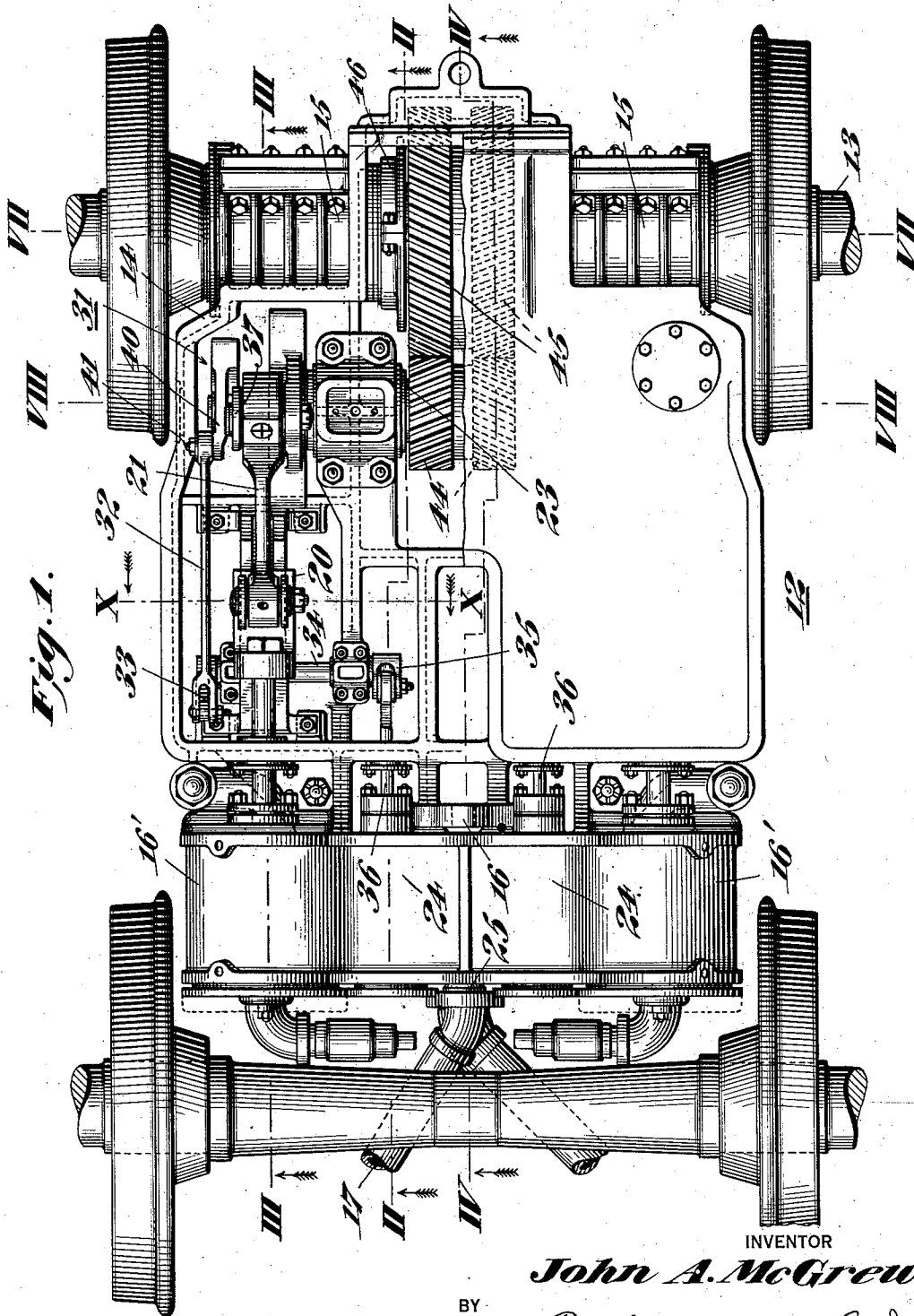


Fig. 1.

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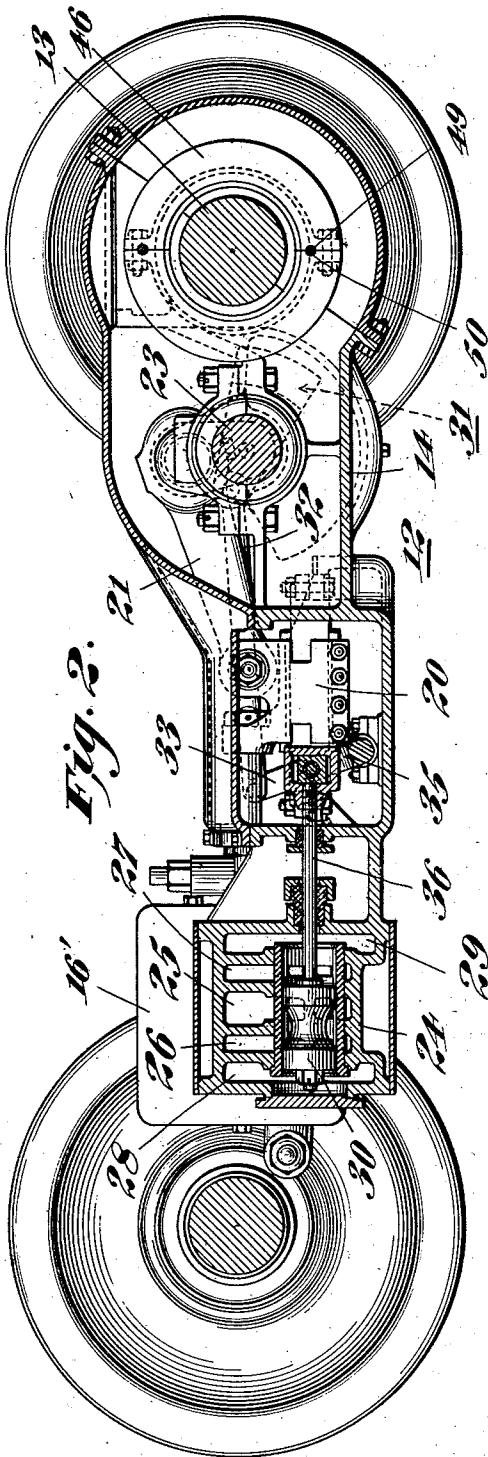


Fig. 2.

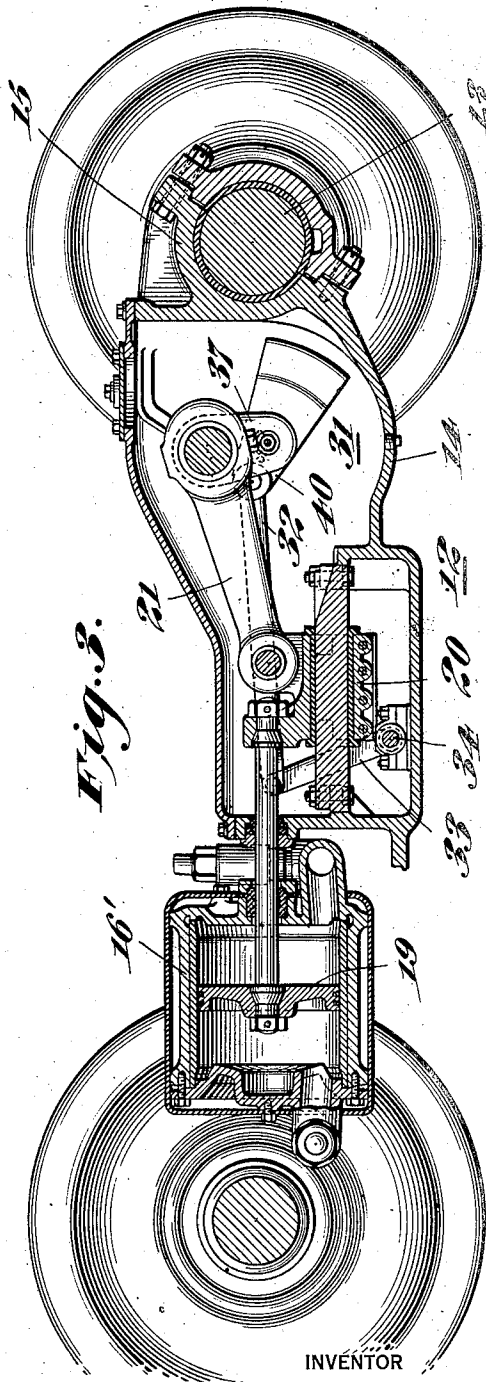


Fig. 3.

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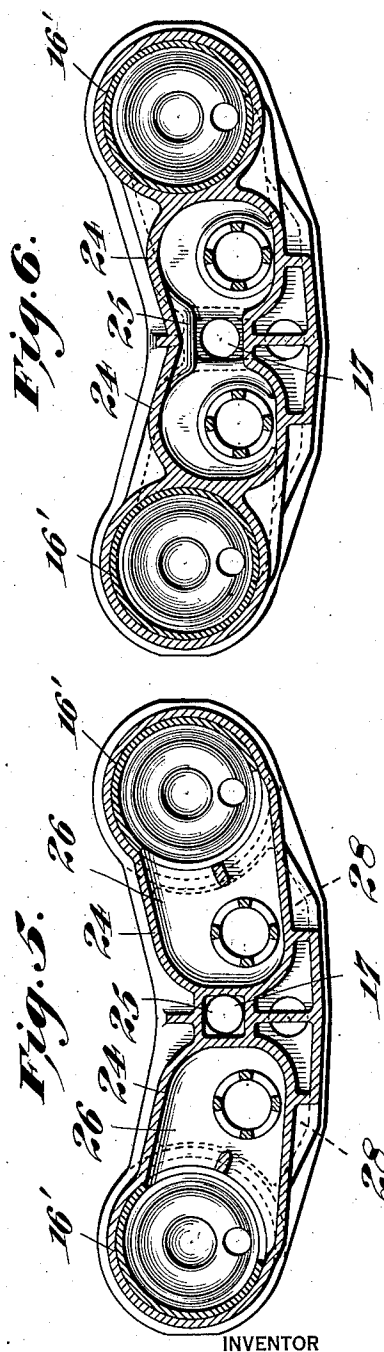
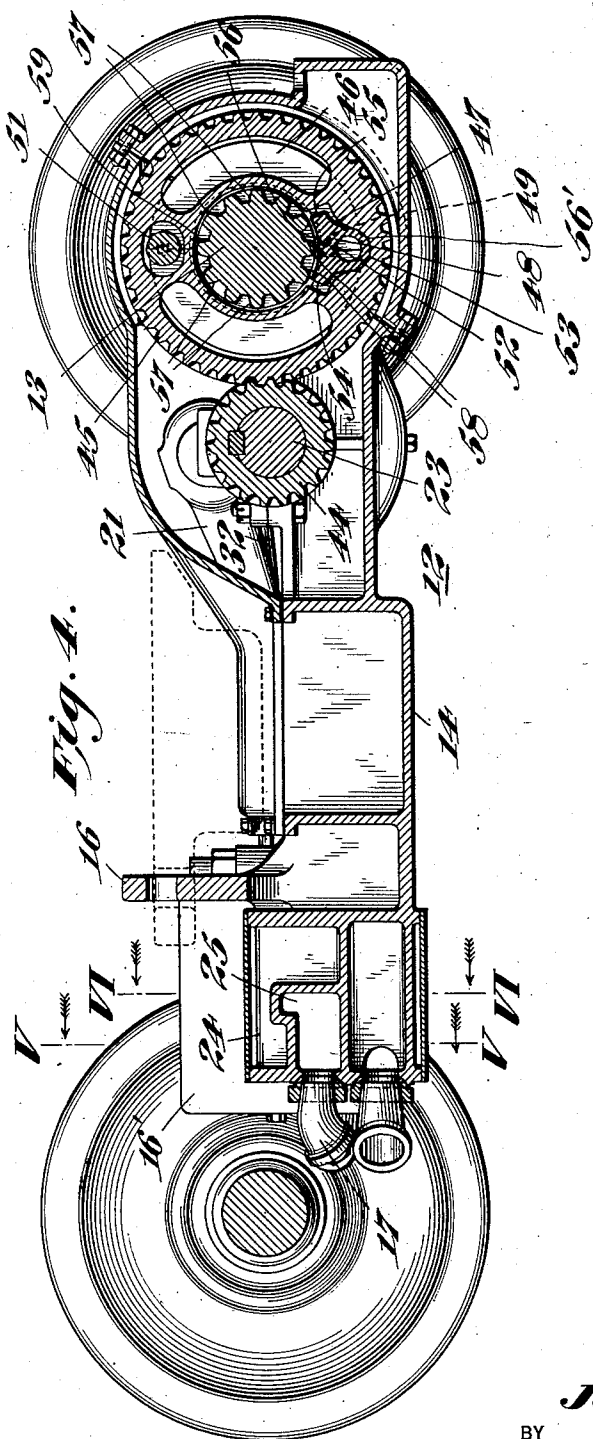
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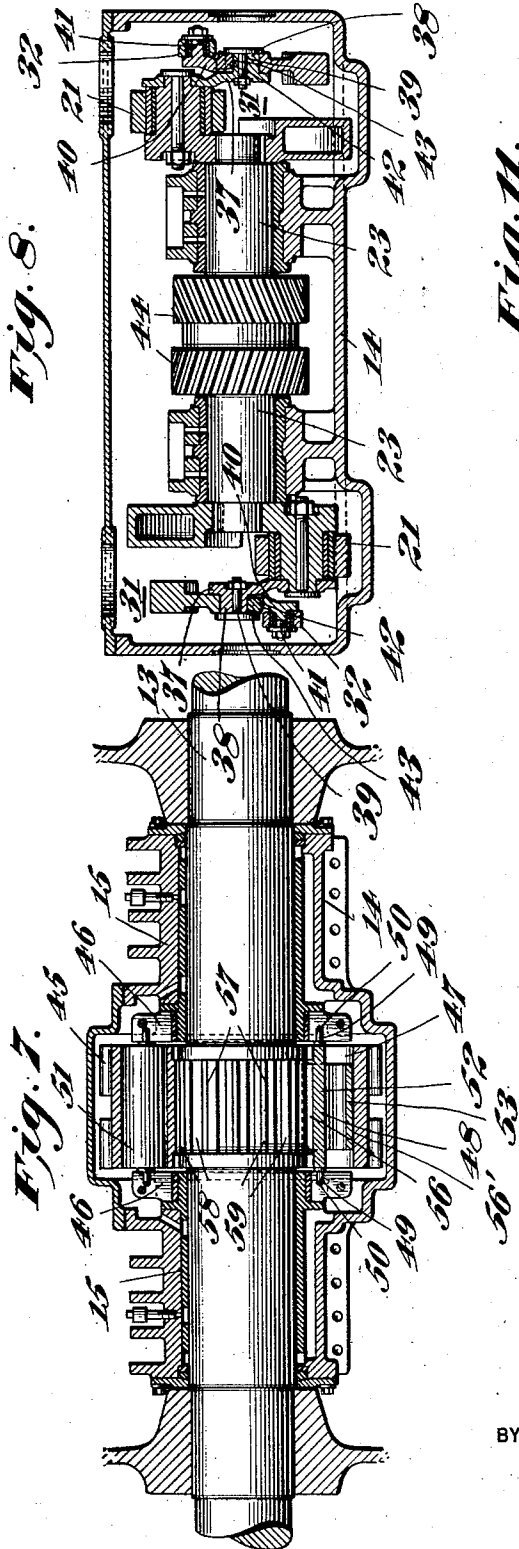


Fig. 11.

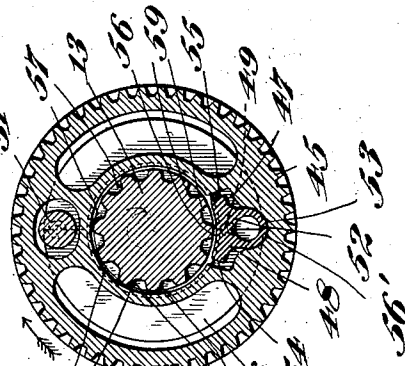


Fig. 10.

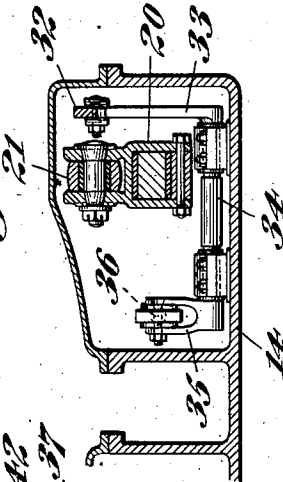
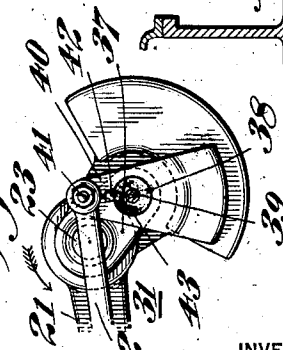


Fig. 9.



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Fig. 9a.

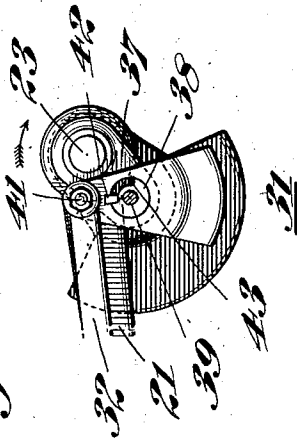


Fig. 11b.

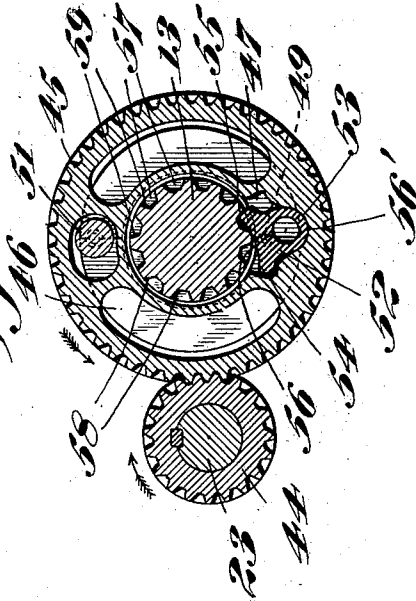
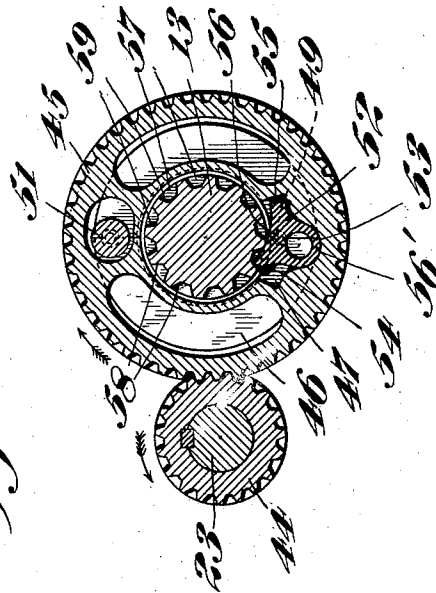


Fig. 11a.



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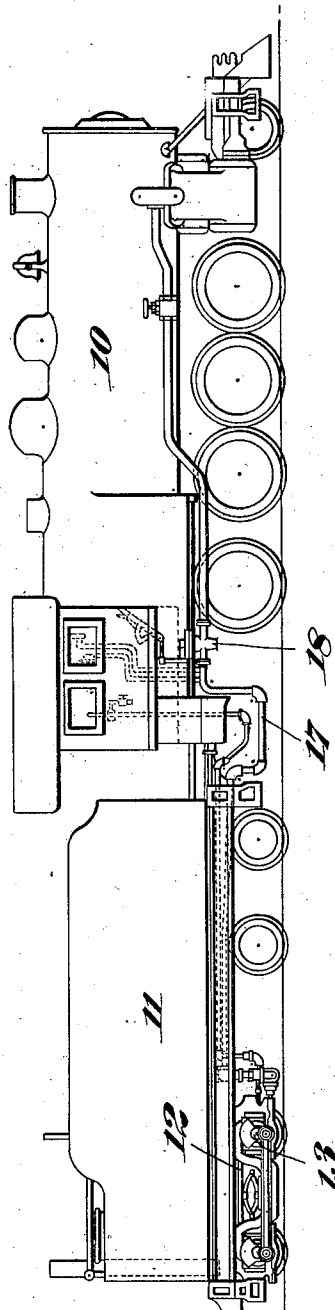
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Fig. 12.



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UNITED STATES PATENT OFFICE

JOHN A. MCGREW, OF ALBANY, NEW YORK, ASSIGNOR TO BETHLEHEM STEEL COMPANY

REVERSING AUXILIARY LOCOMOTIVE

Application filed July 14, 1927. Serial No. 205,680.

My invention relates to power plants in general and particularly to auxiliary propulsion units which are adapted to railway vehicles for the purpose of assisting the main propulsion unit to propel the same.

Heretofore, auxiliary propulsion units have been suggested for railway vehicles to supplement the tractive power of the main propulsion unit to start and accelerate the movement of trains. In such former constructions, the auxiliary propulsion unit is mounted on the vehicle in juxtaposition to a normally idle axle and a mechanism is provided to operatively connect said unit to said axle when it is required to utilize the loads on the wheels, associated with said axle, to provide additional tractive power. Auxiliary propulsion units of the aforementioned type are disclosed in previous patents issued jointly to myself and James T. Loree; these patents being Letters Patent No. 1,412,250, issued Apr. 11, 1922, which discloses an auxiliary propulsion unit, and Letters Patent No. 1,447,352, issued Mar. 6, 1923, which discloses a device for causing entraining of an auxiliary propulsion unit with a normally idle axle of a railway vehicle or the like. The latter device is actuated by motive fluid for said propulsion unit and operates when the fluid is turned on to the latter, as fully explained in said Letters Patent. In my co-pending application filed jointly with Robert S. A. Dougherty, Serial No. 130,606, under date of Aug. 21, 1926, there is disclosed a mechanism which coacts with the action of the propulsion unit to automatically cause the establishment of a driving connection between said unit and the normally idle axle. However, said application and said Letters Patent provide only for the transmission of rotation from the propulsion unit to the axle in one direction, whereas, in the present application, I provide means whereby the rotation of the propulsion unit may be reversed when desired.

In Letters Patent No. 1,447,353, issued to myself jointly with James T. Loree, under date of Mar. 6, 1923, I disclose a mechanism wherein means are provided whereby the rotation of the driven axle may be reversed

at will. This disclosure does not provide means whereby the rotation of the propulsion unit may be reversed, and, furthermore, it provides an intermediary mechanism to secure operative relation between the propulsion unit and the driven axle in one direction and also provides an additional intermediary mechanism, in conjunction with the first mentioned intermediary mechanism for securing the reverse rotation of the shaft. These intermediary mechanisms have been utilized when operated by a pressure fluid and this requires additional lines and valve device for controlling the supply of fluid to such mechanisms, and, furthermore, it is extremely difficult to synchronize their operation with the operation of the propulsion unit.

It is, therefore, one of the objects of my invention to entirely obviate the use of such intermediary mechanisms and to provide means adapted to operatively connect the propulsion unit to the driven axle solely by the initial turning over effort of said unit.

Another object of my invention is the provision of a novel and simple means adapted to coact with a railway vehicle propulsion unit to automatically cause the latter to be operatively connected to a driven axle of such vehicle, during the initial operation of said unit.

Another object of my invention is to provide a driving connection between an auxiliary propulsion unit which is ineffective when the propulsion unit is not in operation and is adapted to be rendered effective by the turning over of said unit in either a forward or reverse direction.

Another object of my invention is to provide an arrangement, wherein an auxiliary propulsion unit supplements a main propulsion unit for moving a vehicle or train of vehicles and including means for establishing a driving connection between the auxiliary propulsion unit and a normally idle axle, and means adapted to automatically reverse the auxiliary propulsion unit when the valves of the latter are set for operating the auxiliary propulsion unit in a direction opposite to the operation of the main propulsion unit.

Another object of my invention is to pro-

vide a mechanism for automatically reversing an auxiliary propulsion unit, which is mounted on a vehicle, when the vehicle is moved by a main propulsion unit in the direction opposite to that in which the initial effort of the auxiliary propulsion unit tends to move it, so that, upon reversal of the latter unit its power will supplement the motive power of main unit to increase its tractive effort.

Other novel features will be more fully understood from the following description and claims taken with the drawings in which;

Fig. 1 is a plan view of an auxiliary propulsion unit mounted on a railway vehicle truck and embodies one form of my invention;

Fig. 2 is a longitudinal section taken on line II—II in Fig. 1;

Fig. 3 is a longitudinal section taken on line III—III in Fig. 1;

Fig. 4 is a longitudinal section taken on line IV—IV in Fig. 1;

Fig. 5 is a transverse section taken on line V—V in Fig. 4;

Fig. 6 is a transverse section taken on line VI—VI in Fig. 4;

Fig. 7 is a transverse section taken on line VII—VII in Fig. 1;

Fig. 8 is a transverse section taken on line VIII—VIII in Fig. 1;

Fig. 9 is a side elevation illustrating the position of the eccentric crank relative to the crank shaft when the valve is set to operate the engine in the forward direction.

Fig. 9^a is a side elevation similar to Fig. 9, but showing the eccentric crank in reversed position relatively to the crank;

Fig. 10 is a cross section taken on line X—X in Fig. 1;

Fig. 11 is a partial cross section taken on line IV—IV in Fig. 1;

Fig. 11^a is a fragmentary view showing the key in its forward driving position;

Fig. 11^b is a fragmentary view showing the key in the reverse driving position;

Fig. 12 is a side elevation of locomotive and tender having mounted thereon an auxiliary propulsion unit embodying one form of my invention.

Referring to the drawing: In Fig. 12, the locomotive is designated by the numeral 10, and the tender by numeral 11. In the preferred embodiment of my invention the locomotive engine constitutes the primary propulsion unit and the auxiliary propulsion unit 12 is mounted in juxtaposition with a normally disconnected load bearing axle 13. In the particular embodiment shown in the drawing, the unit 12 is mounted in juxtaposition with an axle of a tender truck, but, however, it should be understood that any load bearing axle of the train may be operatively connected to said unit in order to supplement the tractive power of the prime

mover, without departing from the spirit of my invention.

Referring now to Figs. 1 and 2, the frame 14 of the propulsion unit 12, is provided with spaced bearings 15 fitting the axle 13. The other end of the frame is preferably supported by a link 16 connected to the frame 14 and extending upwardly to a supporting member, as illustrated and described in a co-pending application of Richard J. McCarty, Jr., Serial No. 102,915, filed Apr. 19, 1926. It will be understood that the foregoing description relates to a conventional mounting of a frame 14 and does not constitute an essential part of the present invention, as various other ways of mounting the frame may be adopted.

The auxiliary propulsion unit is preferably of a twin cylinder engine of the double acting type and upon the frame 14 there is mounted a pair of steam receiving cylinders 16', each of the cylinders being supplied with steam from the locomotive boiler through the conduit 17 and is controlled by the engineer through the medium of the throttle valve 18. As the operating mechanism associated with each cylinder of the twin cylinder engine is identical, I have confined the following description to the operation of single set of mechanism in order to clarify the description. The cylinder 16' is provided with a reciprocating piston 19 connected to a crosshead 20 slidably mounted on suitable bearings on the frame 14. Rods 21 connect the crosshead 20 to the crank pins of the crank shaft 23 which is suitably mounted in bearings attached to the frame 14. Intermediate the cylinders 16' is a steam chest 24 which is connected to the conduit 17 and is provided with a steam port 25, and steam passages 26 and 27 respectively. Steam is delivered to and exhausted from the cylinder through the latter passages. There is also associated with each of the steam passages 26 and 27, a pair of exhaust passages 28 and 29 respectively. A piston valve 30 operates over the aforementioned port and passages and when the valve is at its position shown in Fig. 2, steam is passing from the port 25 through the passage 26 to the cylinder at the left-hand side of the piston in Fig. 3 and steam is being exhausted from the cylinder at the right-hand side of the piston through the passage 27 to the exhaust passage 29. By referring to Fig. 5, it will be noted that the bottom walls of the exhaust passages 28 and 29 are at a level below the cylinders so that the liquid of the condensed steam does not collect in the cylinders, but flows from the latter by gravity. This latter construction eliminates the use of drain cocks which are usually provided to drain the cylinder before the engine is operated under power.

The piston valve 30 is operated from an eccentric crank 31 mounted on the main crank

pin of the crank shaft 23 and is disposed at the outside of the connecting rod 21 (see Figs. 1 and 9). An eccentric rod 32 transmits the motion of the crank 31 to the arm 33 of the rocker shaft 34 which is journaled in suitable bearings on the frame 14 (see Figs. 1 and 10). At the other end of the rocker shaft 34, is keyed another arm 35 which is connected to the piston valve 30 through the medium of a valve stem 36.

the piston at the point of reversal, but, so far as I am aware, it has never been suggested to move the piston relatively to the position of the valve at the time of reversal.

Furthermore, it has heretofore been found necessary to provide fairly complicated intermediary mechanism to change the relative position of the piston and valve when the valve is moved to cause the reversal, whereas, I accomplish this reversal automatically, eliminating such intermediary mechanism, in the manner hereinafter described. In order to counterbalance the inertia effects on the moving parts of the valve mechanism, I provide a counterbalancing device by extending the crank arm 40 beyond the axis in the direction opposite to the end having the crank pin 41 and increase the cross section thereof to secure the necessary weight. Fixed to the central portion of the crank shaft 23, is a toothed gear 44 disposed in alignment with and in meshed relation with a toothed gear 45 rotatably mounted on the axle 13 and which is constrained by suitable means against axial movement on said axle. It will be noted in the preferred form shown in the drawings that the gears 44 and 45 are provided with herringbone gear teeth in meshed relation so that the resultant working forces between the teeth act in a medial plane which is transverse with respect to the axes of said gears and thus secures the constraint of the gear 45 axially solely by virtue of the engagement between the teeth of said gears, and provides a structure wherein the gear 45 is more or less self centering with respect to the gear 44, and, furthermore, by such construction the necessity of providing side bearings for maintaining the gear 45 centrally is eliminated. At each side of the gear 45, is rotatably mounted a friction plate 46 which is preferably formed from a plurality of segmental pieces bolted together, as shown in Fig. 1 and rotatably mounted on exterior bearing surfaces formed on the bearings 15. While the plates 46 are adapted to rotate relatively to said bearings, they preferably are adapted to grip the latter frictionally, so that, they are not a free running fit thereon, but, require a comparatively large amount of power to cause relative rotation, compared with the power which would be required to rotate them, if, the contiguous bearing surfaces were the ordinary running fits established in this class of work. The normal pressure between said bearing surfaces may be conveniently adjusted on account of the plate 46 being built up segmentally, for instance, shims or the like may be placed between the abutting end of segments and removed or changed in thickness to regulate the friction. The gear 45 is slotted, as at 47, to receive a key member 48 which is rotatably supported intermediate the plates 46 by means of a trunnion member 49 loosely engaging aligned apertures 50 formed

The eccentric crank 31 is of novel construction. Usually, the eccentric crank is fixedly mounted relatively to the main crank pin and is disposed angularly with respect thereto so that the crank pin at the extending end of the eccentric crank moves in the path of a circle concentric with the axis of the journal of the main crank shaft, this type is exemplified by the well-known Walschaerts valve gear. Instead of this latter type of construction, I provided an eccentric crank comprising a web portion 37 fixedly mounted on the main crank pin and disposed in alignment therewith, so that, the journal member 38, projecting laterally at its extending end, is disposed in axial alignment with the journal portion of the main crank shaft 23. The journal member 38 is apertured, as at 39. Rotatably mounted on the journal member 38, is a crank arm 40 having a laterally projecting crank pin 41 and to the latter is pivotally mounted the eccentric rod 32. The crank arm 40 is retained on the journal member 38 by any suitable means, such as a bolt fastening means which passes through the aperture 39. The relative rotation between the member 38 and the crank arm 40 is limited by the key 42, fixed to the crank arm 40, and projecting into a key slot 43 formed in the journal member 38. The key 42 is narrower than the slot 43 to allow a limited angular movement between the crank arm 40 and the crank shaft 23. It will be seen that the arm 40 is free to swing from the position, shown in Fig. 9, to the position shown in Fig. 9', while the main crank shaft is maintained stationary. Conversely, when the parts are positioned as in Fig. 9, the main crank shaft may rotate clockwise, through a limited angle without movement to the arm 40. The amount of relative angular movement between the main crank and the eccentric crank is limited by the engagement of the sides of the key 42 with the opposed side faces of the key slot 43. The key and the key slot are so dimensioned that the crank shaft has a limited free angular movement with respect to the eccentric crank arm which corresponds substantially to the amount of relative movement between the valve 30 and the piston 19, required to reverse the engine. With valve gearing employed with engines of this type, it is usual, when it is required to reverse the engine to move the valve relatively to the position of

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in said plates. Diametrically opposite the key member 48 and rotatably suspended on said friction plates is a counterbalance 51 which functions to balance extraneous forces acting on key member 48 and the gear wheel structure during its rotation.

The key member 48 comprises a body portion 52 having a convex top surface 53 and a pair of laterally, downwardly and oppositely projecting abutment portions 54 and 55 respectively. The key 48 is provided with a concave bottom surface 56 which is concentric with and sufficiently clear of the surface of the axle so that the latter may turn freely when the key is in its normal position, as shown in Fig. 11. The surface 53 is radiused from a point spaced from the axis of the trunnion member 49 and is adapted to frictionally engage the surface 56' of the slot 47.

Formed on the axle 13 are a plurality of radially disposed grooves 57, the side walls 58 and 59 of which constitute abutment faces for the abutment portions 54 and 55 respectively, when the key is rocked from its normal position, as hereinafter described.

In operation, assuming that the relative position of the crank arm 40 and the main crank is in the position shown in full lines in Fig. 9, then the relative positions of the piston 19 to the valve 30 is such, that, when steam is admitted to the steam chest, the main crank shaft will rotate in the direction indicated by the arrow in Fig. 9. This rotates the gears 44 and 45 in the direction indicated by the arrows in Fig. 11, which is the direction to move the vehicle forward. When the parts are related as aforesaid, and assuming that the valve gear of the locomotive is set for the forward movement of the latter, the engineer opening the main throttle valve of the locomotive admits steam to the main propulsion unit to operate the locomotive in the forward direction; the axle 13 turning freely within the gear 45. In the event that the engineer wishes to increase the tractive effort of the locomotive, he opens the throttle valve 18, preferably gradually, and admits steam to the auxiliary propulsion unit, thereupon the crank shaft is rotated and causes the rotation of the gear 45, by virtue of its meshed engagement with the gear 44 which is fixed to said shaft. During the initial angular movement of the gear 45, the friction plates 46 tend to remain at rest, by virtue of their inertia and the aforementioned frictional grip on their respective bearings, and this results in a relative angular movement between the gear 45 and the friction plates 46 which carry the key 48. This angular movement causes the key to tilt about the axis of trunnion member 49, on account of the latter remaining stationary relatively to the axis of the gear 45 while the latter moves about its axis and presses against the surface 53 of the key. When the key is thus tilted,

the end face of leg 54 engages one of the abutments 58 formed on the axle 13, as shown in Fig. 11^a. The engagement of the key with the axle 13 constitutes a driving connection between the gear 45 and the axle when the auxiliary propulsion unit is operated to supplement the tractive effort of the main propulsion unit in the forward direction.

The relative arrangement of the key to the abutments of the axle 13, is such, that while power is being transmitted from the auxiliary unit to the axle, the key is maintained in contact solely by the resultant of the working forces set up between the contiguous surfaces of the axle, key and gear 45 respectively. It will be noted, that due to the loose fit between the trunnion member 49 and the apertures 50, said member is not subject to the driving forces, but such forces are transmitted directly through the body of the key which functions as a column structure between gear 45 and the axle 13. When the auxiliary unit is shut off, power is no longer transmitted therefrom, but, however, the axle continuing its rotation, the key tilts back to its normal position which is symmetrical about the radial line passing thru the axis of the gear 45, and the axle revolves freely in the gear 45.

Assuming that the relative position of the piston 19 and the valve 30 remains as set in the aforementioned operation, and that the valve gearing of the locomotive is set to cause the reversal of the latter at starting. When steam is admitted to the auxiliary unit, the latter operates to move the vehicle in the opposite direction, that is, rotate the gear 45 in the direction opposite to the direction of rotation of the axle 13. The initial rotation of the gear 45 causes the key to tilt and engage the axle, as described above. The power of the main propulsion unit being very much greater than that of the auxiliary unit, causes gear 45 to rotate in opposition to the effort of the crank shaft. By virtue of its meshed relation with the gear 45, the crank shaft is forced to reverse its direction of rotation. Owing to the lost motion connection between the crank arm 40 and the crank shaft 23, the piston is caused to change its position with respect to the valve so that the auxiliary unit is automatically reversed, then operates in the same direction as the main propulsion unit, and the gear 45 is immediately accelerated by the power of the auxiliary unit to rotate at a speed greater than the speed of rotation of the axle. During the initial acceleration of said gear, the key rocks, by virtue of the lost motion between the friction plates 46 and the gear 45, as formerly explained, from its last mentioned position to its position shown in Fig. 11^b and thus effects a driving connection between the gear 45 and the axle whereby the auxiliary propulsion unit supplements the power of the main propulsion unit. So it is

evident that regardless of the setting of the valve of the auxiliary propulsion unit, the latter may be operatively secured to a normally idle axle by simply admitting steam to said unit to obtain, almost immediately, synchronous operation with the main propulsion unit.

It will be noted that gear 45 is materially larger than the gear 44, so that when the auxiliary unit is operatively connected to the axle 13, the latter rotates at a comparatively slow speed, compared to the speed of the crank shaft 23 and it will be further noted that relative angular movement between the crank arm 40 and the crank shaft 23, when changing the relative position of the piston and to the valve, as above described, is limited to less than half the angle of a complete revolution of the crank shaft. It will, thus appear, that the automatic reversal of the auxiliary unit by the opposing effort of the main unit is effected during a fraction of a revolution of the wheels mounted on the axle 13.

It will be seen from the foregoing description that I have devised a simple and novel arrangement for automatically entraining an auxiliary propulsion unit with an axle normally disconnected therefrom and effect such entrainment regardless of the direction of operation of said unit and eliminates the employment of any intermediary mechanism. Furthermore, I provide a novel combination with a main propulsion unit of an auxiliary propulsion unit, wherein the latter unit is automatically reversed by the effort of the main unit without the employment of intermediary reversing mechanism.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a power plant, the combination with a main power unit of an auxiliary power unit, a source of motive fluid supply, means to reverse the operation of the main power unit, and means depending upon the operation of the latter unit to cause the reversal of the auxiliary power unit and secure the synchronous operation of said units.

2. In a power plant, the combination with a main power unit of an auxiliary power unit, a source of motive fluid, a normally idle shaft adapted to be rotated by either of or both of said units, and means whereby said auxiliary power unit may be reversed in operation by the rotation of said shaft.

3. In a power plant for propelling a vehicle, the combination with a main propulsion unit of an auxiliary propulsion unit having a drive shaft, a normally idle axle adapted to be rotated by the effort of the main propulsion unit, and means coacting with the action of the auxiliary propulsion unit in either direction to cause the establishment of a driving connection between said shaft and the axle.

4. In a power plant for propelling a vehicle, the combination with a main propulsion unit, of an auxiliary propulsion unit, a normally idle axle adapted to be rotated by the effort of the main propulsion unit, and means coacting with the action of the axle to cause the reversal of said auxiliary unit.

5. In an auxiliary locomotive propulsion unit, the combination of a cylinder having ports, a piston within said cylinder, a valve for controlling said ports, a crank shaft, means operatively connecting the latter to said piston, an eccentric member mounted on said crank shaft, a lost motion device connecting said member to said crank shaft, means operatively connecting said eccentric member to said valve, a driving gear fixed to the latter, an axle, a driven gear rotatably mounted on said axle and in meshed relation to said driving gear, a carrier member adapted to rotate about the axis of said axle, a key member adapted to oscillate on said carrier member, an abutment formed on said driven gear adapted to engage said key member, and an abutment formed on said axle adapted to be engaged by said key member during the rotation of said crank shaft.

6. In an auxiliary locomotive propulsion unit, the combination of a cylinder having ports, a piston within said cylinder, a valve for controlling said ports, a crank shaft, means operatively connecting the latter to said piston, an eccentric member mounted on said crank shaft, a lost motion device connecting said member to said crank shaft, means operatively connecting said eccentric member to said valve, a driving gear fixed to the latter, an axle, a driven gear rotatably mounted on said axle and in meshed relation to said driving gear, a carrier member adapted to rotate about the axis of said axle, a key member adapted to oscillate on said carrier member, an abutment formed on said driven gear adapted to engage said key member, and a pair of opposed abutments formed on said axle, one of which is adapted to be engaged by said key member during the rotation of the crank shaft in one direction, and the other of said pair of abutments being adapted to be engaged by said key during the rotation of the crank shaft in the opposite direction.

7. In an auxiliary locomotive propulsion unit, the combination of a cylinder having ports, a piston within said cylinder, a valve for controlling said ports, a crank shaft,

means operatively connecting the latter to said piston, an eccentric member mounted on said crank shaft, a lost motion device connecting said member to said crank shaft, means operatively connecting said eccentric member to said valve, a driving gear fixed to the latter, an axle, a driven gear rotatably mounted on said axle and in meshed relation to said driving gear, a carrier member adapted to rotate about the axis of said axle, a key member adapted to oscillate on said carrier member, an abutment formed on said driven gear adapted to engage said key member, a series of abutments formed on said axle adapted to be engaged by said key member during the rotation of said crank shaft in one direction, and a second series of abutments formed on said axle oppositely directed with respect to the first mentioned series and adapted to be engaged by said key member during the rotation of said crank shaft in a reverse direction.

8. In a power plant for propelling a vehicle, the combination with a main propulsion unit of an auxiliary propulsion unit, an axle normally disconnected from the latter unit, said auxiliary propulsion unit comprising a cylinder having ports, a piston within said cylinder, a valve controlling said ports, a crank shaft, a rod connecting said crank shaft to said piston, an eccentric device mounted on said crank shaft and having a limited angular movement with respect thereto, instrumentalities connecting said eccentric device to said valve, a driving gear fixed to said crank shaft, a key member, a driven gear rotatably mounted on said axle and having a recess formed therein receptive of said key member, a carrier member disposed at each side of said driven gear and rotatably mounted on bearings coaxial with said axle, and an abutment formed on said driven gear adapted to be engaged by said key member during the rotation of said crank shaft, a bearing engaging each of said carrier members and rotatably supporting said key member independently of said driven gear and said axle, and a pair of opposed abutments formed on said axle adapted to be engaged by said key member.

9. In a power plant for propelling a vehicle, the combination with a main propulsion unit of an auxiliary propulsion unit, an axle normally disconnected from the latter unit, said auxiliary propulsion unit comprising a cylinder having ports, a piston within said cylinder, a valve controlling said ports, a crank shaft, a rod connecting said crank shaft to said piston, an eccentric device mounted on said crank shaft and having a limited angular movement with respect thereto, instrumentalities connecting said eccentric device to said valve, a driving gear fixed to said crank shaft, a key member, a driven gear rotatably mounted on said axle and hav-

ing a recess formed therein receptive of said key member, a carrier member disposed at each side of said driven gear and rotatably mounted on a bearing coaxial with said axle, a bearing member engaging said carrier member and rotatably supporting said key member, means to regulate the running fit of said carrier member with respect to its bearing, and an abutment member formed on said axle adapted to be engaged by said key.

10. In an engine construction, the combination with a driving shaft, of a normally disconnected driven shaft, a driving gear fixed to said driving shaft, a driven gear rotatably mounted on said driven shaft in meshed relation to the first mentioned gear, a key member normally disengaged from said driven shaft, means to support said key member independently of said driven gear, an abutment formed on said driven shaft, an abutment formed on said driven gear and means adapted to rotate said driving shaft so that the driven gear moves angularly with respect to said supporting means and causes said key member to be interposed between said abutments to establish a driving connection between said shafts.

11. In an engine construction, in combination, a power cylinder having ports, a piston within the cylinder, a valve controlling said ports, a main crank, a rod connecting said piston to said main crank, an eccentric member, means to connect said member to said valve, and a lost motion connection between said eccentric member and said main crank, whereby the rotation of the latter in one direction secures the synchronous operation of the piston and the valve and whereby rotation of the main crank in the opposite direction causes a change in the relative position of the piston with respect to the position of the valve.

12. In a power plant, the combination with a main propulsion unit of an auxiliary propulsion unit, a source of motive fluid supply, a driven shaft adapted to be rotated by either or both of said units, and means coacting with said shaft to reverse said auxiliary propulsion unit when said shaft is rotated through the effort of the main propulsion in a direction to oppose the operation of the auxiliary propulsion unit.

13. In a railroad vehicle, in combination, a main propulsion unit, an auxiliary propulsion unit, an axle normally disconnected from the latter unit, a source of motive fluid supply, a reversing gear for said main unit, means coacting with the action of said auxiliary propulsion unit to automatically connect the latter to said axle, and means to secure the automatic reversal of the auxiliary propulsion unit dependent upon the action of the main propulsion unit.

14. In a power plant, the combination with a main power unit of an auxiliary power

unit, operating in opposition to said main unit, a normally idle shaft, means to connect said auxiliary unit to said shaft, and means coacting with the action of said shaft to effect the reverse operation of said auxiliary unit.

15. In a power plant, the combination with a main power unit of an auxiliary power unit, operating in opposition to said main unit, a shaft normally disconnected from said auxiliary unit, means to connect said auxiliary unit to said shaft, and means coacting with the section of said shaft to cause said units to operate in unison.

16. In a power plant, the combination with a main power unit of an auxiliary power unit, operating in opposition to said main unit, a shaft, means to connect said auxiliary unit to said shaft, and means coacting with the action of said main unit to cause said units to operate in unison.

17. In combination with an engine of a shaft normally disconnected from said engine and having an abutment formed thereon, and an entrainment mechanism for connecting said shaft to said engine actuated by the action of the engine, including a driven gear rotatably mounted on said shaft, a bearing, a carrier member rotatably mounted on said bearing, means to adjust the running fit of the carrier member with respect to its bearing, and a key member rotatably mounted on said carrier member intermediate said gear and said shaft and adapted to engage said abutment.

18. In an auxiliary locomotive, the combination of an axle, an engine having a crank shaft and a frame, said frame having bearings freely mounted on said axle, a driving gear fixed to said crank shaft, a driven gear rotatably mounted on said axle between said bearings and constantly in mesh with said driving gear and having a longitudinal recess formed therein, a carrier member disposed at each side of said driven gear and rotatably mounted on a bearing portion formed on the exterior portion of said bearings, means to adjust the running fit of one of said carrier members with respect to its bearing, a key member extending through said recess and rotatably mounted on said carrier members, and an abutment formed on said axle adapted to be engaged by said key member.

19. In an auxiliary locomotive, the combination of an axle, an engine having a crank shaft and a frame, said frame having bearings freely mounted on said axle, a driving gear fixed to said crank shaft, a driven gear rotatably mounted on said axle between said bearings and constantly in mesh with said driving gear and having a longitudinal recess formed therein, a carrier member disposed at each side of said driven gear and rotatably mounted on a bearing portion

formed on the exterior portion of said bearings, a key member extending through said recess and rotatably mounted on said carrier members, and an abutment formed on said axle adapted to be engaged by said key member.

20. In an auxiliary locomotive, the combination of an axle, an engine having a crank shaft and a frame, said frame having bearings freely mounted on said axle, a driving gear fixed to said crank shaft, a driven gear rotatably mounted on said axle between said bearings and constantly in mesh with said driving gear, and having a longitudinal recess formed therein, a carrier member disposed at each side of said driven gear and rotatably mounted on a bearing portion formed on the exterior portion of said bearings, a key member extending through said recess and rotatably mounted on said carrier members, and a pair of oppositely directed abutments formed on said axle adapted to be engaged by said key member.

21. In an engine, the combination of a frame, an axle, bearings engaging said axle for supporting said frame, a cylinder on said frame and provided with ports, a piston within said cylinder, a crank shaft supported in bearings attached to said frame, a rod connecting said piston to said crank shaft, a valve controlling said ports, a journal member fixed to said crank shaft and having a slot formed therein, an eccentric member mounted on said journal member, a key connected to said eccentric member projecting into said slot, said key being narrower than said slot so as to permit a limited relative angular movement between the eccentric member and the journal member, a driven gear having a longitudinal recess formed therein rotatably mounted about said axle and disposed between said bearings, a driving gear fixed to said crank shaft and in meshed relation to said driven gear, a carrier member rotatably mounted on said bearings, a key extending thru said recess rotatably supported on said carrier member, and an abutment formed on said axle adapted to be engaged by said key member.

22. In an engine, the combination of a frame, an axle, bearings engaging said axle for supporting said frame, a cylinder on said frame and provided with ports, a piston within said cylinder, a crank shaft supported in bearings attached to said frame, a rod connecting said piston to said crank shaft, a valve controlling said ports, a journal member fixed to said crank shaft and having a slot formed therein, an eccentric member mounted on said journal member, a key connected to said eccentric member projecting into said slot, said key being narrower than said slot so as to permit a limited relative angular movement between the eccentric member and the journal member, a driven gear having a longitudinal recess formed

- therein and rotatably mounted about said axle and disposed between said bearings, a driving gear fixed to said crank shaft and in meshed relation to said driven gear, a carrier member rotatably mounted on said bearings, a key extending through said recess rotatably supported on said carrier member, and a pair of oppositely disposed abutments connected to said axle adapted to be engaged by said key.
23. In an engine, the combination of a frame, an axle, bearings engaging said axle for supporting said frame, a cylinder on said frame and provided with ports, a piston within said cylinder, a crank shaft supported in bearings attached to said frame, a rod connecting said piston to said crank shaft, a valve controlling said ports, a journal member fixed to said crank shaft and having a slot formed therein, an eccentric member mounted on said journal member, a key connected to said eccentric member projecting into said slot, said key being narrower than said slot so as to permit a limited relative angular movement between the eccentric member and the journal member, a driven gear having a longitudinal recess formed therein and rotatably mounted about said axle and disposed between said bearings, a driving gear fixed to said crank shaft and in mesh with said driven gear, a carrier member rotatably mounted on said bearings, means to adjust the running fit of said carrier member with respect to said bearings, a key extending through said recess rotatably supported on said carrier member, and a pair of oppositely disposed abutments connected to said axle adapted to be engaged by said key.
24. The method of assisting the tractive effort of a main propulsion unit of a railroad vehicle which consists, in admitting steam to an auxiliary propulsion unit to effect, by the action of said auxiliary unit, an operative driving connection between the auxiliary unit and an axle of said vehicle, and reversing the operation of the main propulsion unit to effect, by the action of the latter unit, a reversal of the operation of the auxiliary propulsion unit.
25. In combination, a driving element, a driven element, a device establishing a driving connection between said elements, said device including a key member engaging said driven element, a carrier member for supporting said key member, means to actuate said driving element, and friction means to retard the movement of said carrier member when said driving element is moved, whereby said key member is moved to disengage said driven element.
26. In combination, a driving element, a driven element, a relatively fixed member, and means to establish a driving connection between said elements; said means including a member movable with said driving element, a drive member intermediate said elements normally disengaged from one of the elements and mounted on said movable member, and friction means engageable with said fixed member to retard said movable member and cause a lag between the latter member and the driving element, whereby said connection is effected.
- In testimony whereof I hereunto affix my signature.
- JOHN A. McGREW.