April 16, 1940. W. J. BESLER ET AL 2,197,373

GEARED LOCOMOTIVE WITH TWIN-SHAFT ENGINE

Filed Jan. 7, 1938 2 Sheets-Sheet 1

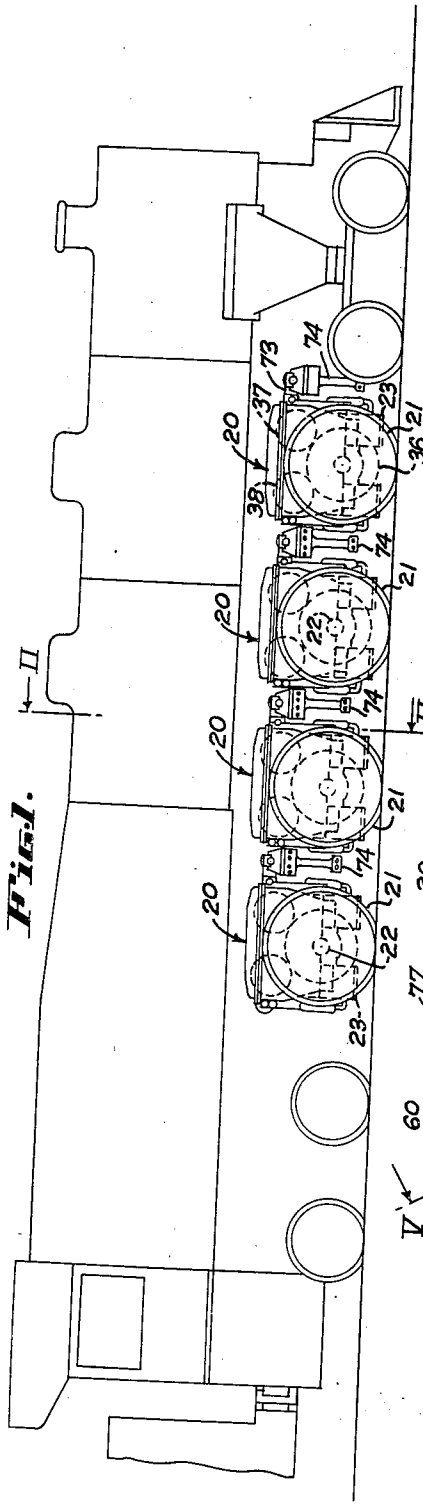

Fig. 1.

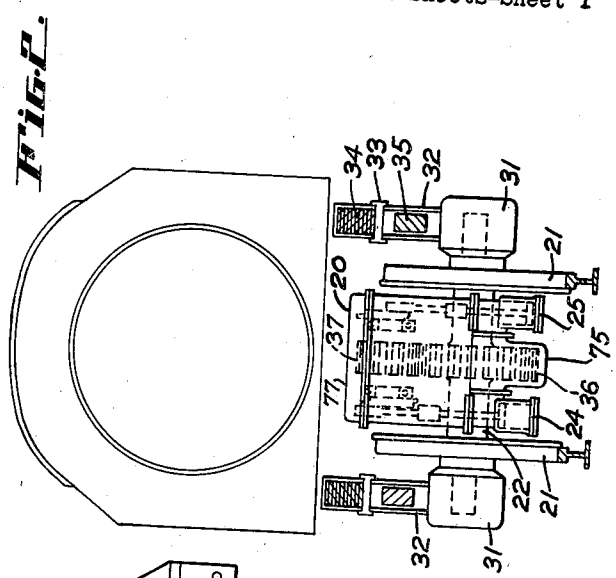

Fig. 2.

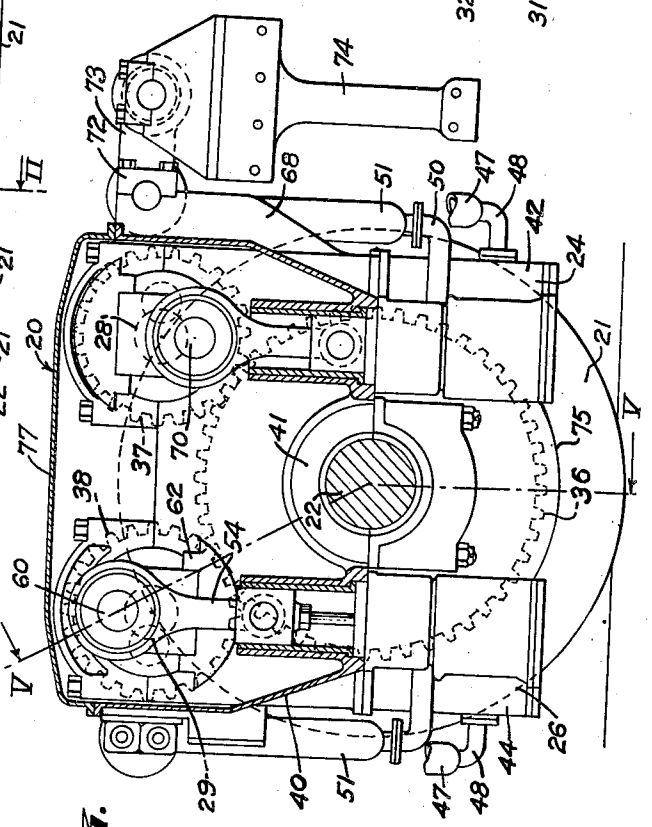

Fig. 3.

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GEARED LOCOMOTIVE WITH TWIN-SHAFT ENGINE

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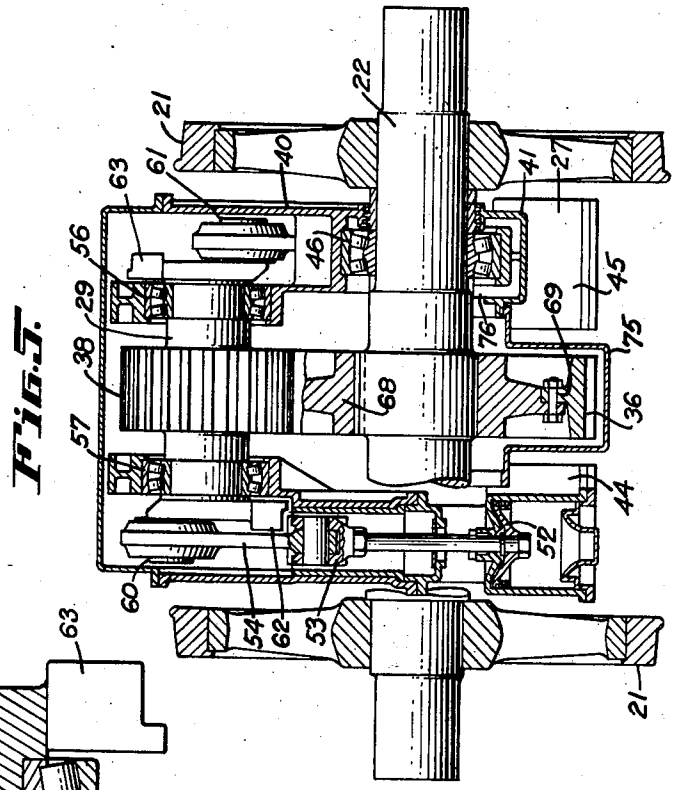

Fig. 3.

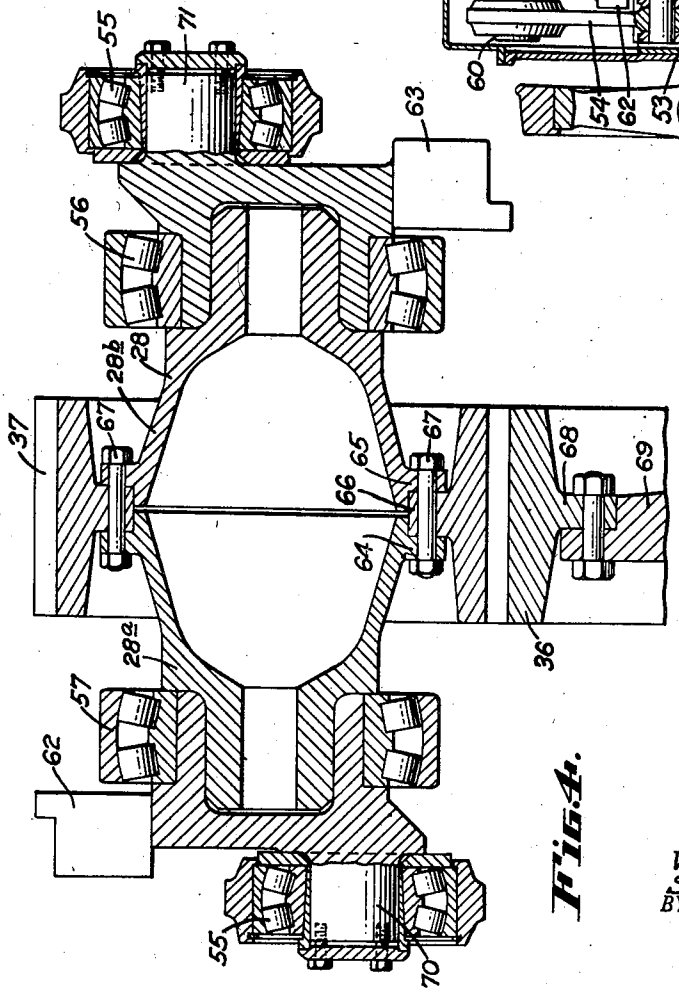

Fig. 4.

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GEARED LOCOMOTIVE WITH TWIN-SHAFT ENGINE

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13 Claims. (Cl. 105—37)

This invention relates to steam locomotives and more particularly to steam locomotives which are powered by a plurality of steam units which are geared directly to and drive the individual traction axles.

Among the objects of the present invention is to provide such a locomotive power unit which will have vertical cylinders.

Another object is to produce an engine of the type herein described wherein the engine lies with the axle in unsprung weight and wherein the pistons and cylinders of the engine are so disposed that the forces due to track hammer act in line with the forces produced by the thrust of the pistons. The significant advantage of this disposition is that the piston is not slapped against the cylinder walls. If a piston in an unsprung engine is placed so that the track jar causes it to contact the cylinder walls, in certain instances the force has been found to be sufficiently severe to cause damage to the piston lands, and in some cases causes damage to the piston rings or the piston grooves and thereby bind the free action of the piston rings.

It is also an object of the present invention to provide an engine unit in which the main frame construction is such that the many forces produced by the engine itself and the forces to which it is subjected from external sources are directly in line with the studs or bolts acting as cylinder retainers and bearing cap retainers so that none of these parts are subjected to a shearing action.

It is a further object of the present invention to provide such an engine with parallel twin crank-shafts driving to a central common ring gear mounted on the driving axle, and wherein the entire engine is mounted on, carried by and takes alignment from the driving axle.

It is also an object to produce an engine unit of the kind herein described which is mounted on and geared directly to the traction axle in unsprung weight, and which is attached to the main locomotive frame only by means of a torque link connection and by the journaling of the driving axle.

It is a further object herein to provide an engine unit with vertical cylinders which may be readily balanced completely for primary force and couples.

Further objects are to provide a construction of maximum simplicity, economy and ease of assembly, and such further objects, advantages and capabilities as will later more fully appear and as are inherently possessed thereby.

The invention further resides in the combination, construction and arrangement of parts illustrated in the accompanying two sheets of drawings, and while there is shown therein a preferred embodiment, it is to be understood that the same is capable of modification and change and comprehends other details and constructions without departing from the spirit and scope of the present invention.

Referring to the drawings:

Figure 1 is a side elevational view in outline of a conventional locomotive with the main side frame, journalings, etc., removed and showing the relative positions of each of the four drive units.

Figure 2 is a vertical section taken on the line II—II of Figure 1, and shows a diagrammatic section of the engine unit as mounted on the drive axle and between the drive wheels. The journal boxes, saddles, springing and side frame are here indicated.

Figure 3 is a view partly in section and partly in elevation of the completely assembled drive unit illustrating the positions of the cylinders, the driving gears, the crank-pins, and other details.

Figure 4 is a fragmentary vertical section showing one of the crank-shafts.

Figure 5 is a vertical section taken on the line V—V of Figure 3.

Referring now more particularly to the drawings, in Figure 1 there is illustrated a side elevational outline of a conventional locomotive with the side frame members removed to show the relative positioning of four individual power units for driving a locomotive. Obviously, one or more of the units may be employed for the driving power depending on the size and the purpose of the locomotive. These units, one of which is shown complete in Figure 3, are generally indicated by the numeral 20. The unit 20 consists of three major elements, i. e., a pair of locomotive wheels 21, an axle 22, and a reciprocating steam engine which will generally be indicated by the numeral 23. This reciprocating engine consists of four vertical cylinders, 24 to 27 inclusive, two of which are positioned on either side of the axle 22, and is characterized by having two identical crank-shafts 28 and 29.

The axle 22 is journaled in the conventional journal boxes 31 which are sprung to the main engine frame through saddles 32, rocker-pin 33 and the conventional leaf-springs 34. A portion of the main side frame is shown in Figure 2 at 35 and it is to be understood that the construction may include for strength, a binder (not shown)

on the main side frame which passes underneath the journal boxes 31 in the customary manner.

On the axle 22 is mounted in any suitable manner the large drive ring gear 36 which meshes with pinions 37 and 38 mounted on the twin crank-shafts 28 and 29 respectively. Shafts 28 and 29 are parallel and identical and revolve at the same speed and in the same direction of rotation because of the common gearing to drive ring gear 36. Shaft 28, which is the forward shaft, has two cranks, one at either end being placed 90° from each other and 180° out of phase with the corresponding cranks of its twin shaft 29.

Referring particularly to Figures 3 and 5, it will be seen that the main engine block 40 is a large single casting preferably, to which the cylinders 24 to 27 inclusive and the valve cylinders 42 to 45 inclusive may be attached in any suitable manner by well known means. The engine block 40 is formed along its longitudinal axis on its lower face as at 41 thus making it adaptable for mounting the axle 22 and so space for suitable bearings 46 is likewise provided. The engine block 40 is held in position on the axle 22 by bearing supports 41, which also provides space for the bearings 46 in complement to the engine block 40. Each group of cylinders on either side of the axle 22 is provided with suitable intake manifold 47 which admits live steam to each of the cylinders through connecting inlets 48. The exhaust is removed through outlet connections 50 and into the exhaust manifold 51. The operation of the valve gears controlling speeds forward, reverse and apropriate cut offs may be of any well-known construction for steam engines. All of the engine units of the locomotive operate independently except that all have the same single source of live steam.

Construction of the individual driving portions of the engine including the piston heads 52, the cross-heads 53, connecting rods 54, self aligning bearings 55, etc., are or may be all of standard constructions.

The individual crank-shafts 28 and 29 are best shown in the Figure 4 and the top portion of Figure 5. In each of these views it should be noted that for purposes of clarity the crank-shaft shown has the crank at the right end of the shaft 90° from its true position. These crank-shafts are each mounted in the engine block 40 with suitable bearings 56 and 57. Space is provided on the interior of the main engine block 40 to accommodate the pinions 37 and 38 which are directly geared to the main driving gear 36 which is mounted on the axle 22. The crank-pins 60 and 61 on crank-shaft 29 (also crank-pins 70 and 71 on crank-shaft 28) have suitable balancing counterweights 62 and 63 which will be referred to herein later with respect for complete balancing of this engine unit for primary forces and couples.

In Figure 4 there is shown in more detail a construction of crank-shaft 28 with gearing which has been found desirable both from the standpoint of the selection of materials for the construction of the parts and also from the ability to reduce the weight of the moving parts. It is to be understood that the present invention is not limited to this form as any suitable kind of crank-shaft and pinion may be employed, and that this form is shown and described for the purposes of illustration only. The crank-shaft 28 mounted with bearings 55 and 56 is shown as being hollow and can be made in two parts, 28*a* and 28*b*. Annular flanges 64 and 65 are provided on each portion for joining the two together but space is provided between the two flanges for receiving an inner annular tongue 66 forming a portion of the pinion gear 37 (or 38). The joining of these parts by any suitable means, such as for example, the nuts and bolts here shown as 67 bring the two portions 28*a* and 28*b* of the crank-shaft and the tongue of pinion gear so that the gear 37 and crank-shaft 28 become an integral unit. The advantage of making the pinion gear 37 apart from the crank-shaft is that it permits the use of a better range of materials and permits treatment of the materials in fabrication which could not otherwise be accomplished. Further it has the advantages of quick and easy replacement in the event of damage to the pinion gear without the loss of the crank-shaft and vice versa. Since the crank-shafts 28 and 29 are identical no matter their form, what has been described with respect to either is applicable to both. Also, in Figure 4 the main driving axle is shown to have a median annular ring 68 which is mounted on the axle 22 by any suitable means and which is adapted at its outer periphery to receive the inner annular tongue 69 of the main driving ring gear 36. This main drive ring gear has the same advantages described for the pinion gear 37.

Positioned below the driving gear 36 and the axle 22, is an oil pan 75 which may be attached to the bearing supports 41 in any suitable oil tight manner. Lubricating oil is maintained in this pan so that the ring gear 36 operates constantly in a bath of oil. As this gear operates, oil is carried to the pinions 37 and 38, to the bearings 56 and 57 and even working over to lubricate the crank bearings and the cross-heads 53. Oil is also carried directly to the axle bearings 46 through apertures 76. This positive lubrication is provided in addition to and as supplementing the customary pressure system so that sufficient lubrication is assured at all times.

So that all of the moving parts may be totally enclosed, a cover member 77 is positioned on the top of the engine block 40. There are no loads or forces going through this cover member and therefore it can be made of lighter material which not only effects a saving in cost but also makes for easy accessibility to the top of the engine unit.

The fact that the engine of this invention may be completely balanced for primary forces and couples without difficulty is one of the important features of the concept here disclosed. In describing the balancing of the engine the positions of the crank-shafts shown in Figure 3 will be taken for the purpose of the description and the direction of the lineal movement of the entire unit will be assumed from left to right.

As shown, the crank-shafts 28 and 29 are of equal length, parallel, revolve in the same direction and have the same speed of rotation. The direction and speed of rotation must necessarily be the same since each of the crank-shafts 28 and 29 drive directly to the main ring gear 36 by means of their respective pinions 37 and 38. As has already been stated, both crank-shafts have a crank at each end, to wit: 60 and 61 on shaft 29, and 70 and 71 on shaft 28, which are set at 90° to each other and the cranks on rear crank-shaft 29 are 180° out of phase with the corresponding cranks on forward crankshaft 28. This being true the conditions for balancing are stated. It will be observed that the plane of

rotation for each crank is in the same plane as that of the corresponding crank on the other shaft, also, that the masses reciprocated by the cranks lie in the same plane and that the planes of reciprocation of both crank-shafts are parallel because of the vertical cylinders. Looking at Figure 3, the position of the near crank 70 on crank-shaft 28 is at dead center at the bottom of the stroke, and the far crank 71 is 90° ahead of crank 70 in a counter-clockwise direction. The position of crank 60 on the rear crank-shaft 29 is at dead center at the top of the stroke, and the far crank 61 is 90° ahead in a counter-clockwise direction being the same direction of rotation as that described for crank-shaft 28.

Each of the twin crankshafts 28 and 29 may readily be placed in static balance by well-known means of counterbalancing.

In accomplishing the dynamic balance for completely balancing the engine unit, suitable counterweights such as 62 and 63 already described in connection with shaft 29 are employed to oppose the inertia force at the crank-pin at both the top and bottom of the stroke. At 90° from the end of the stroke the inertia force is zero, but the counterweights individually have a centrifugal force which being equal but opposite in direction are cancelled. At any intermediate position complete dynamic balance also exists as the decrease of inertia forces from maximum to zero or the increase from zero to maximum is directly balanced by the resultant effect of the opposing counterweights on similar ends of crankshafts 28 and 29.

The main engine block 40 is also provided with a suitable tongue portion 68 at the top of which is mounted a self aligning torque bearing 72 and torque link 73 which is adapted for engagement to the main engine frame through transom member 74. Thus it will be seen that the only connection between the engine unit or drive unit and the main engine frame is by means of the single torque link and the journaling of the drive axle.

We claim:

1. A locomotive power unit comprising a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine having twin parallel crank shafts with a plurality of vertical cylinders mounted on opposite sides of, carried by and taking alignment from said axle, said engine being mounted with static balance as unsprung weight on said axle.

2. A locomotive power unit comprising a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine with a plurality of vertical cylinders mounted on, carried by and taking alignment from said axle, the said engine having two identical crank-shafts driving a common drive gear mounted on said axle, and said engine being mounted with static balance as unsprung weight on said axle.

3. A steam locomotive comprising a plurality of drive units, each unit being operated separately except for a common source of live steam, each of said units comprising in combination a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine with a plurality of vertical cylinders, said engine being mounted substantially in static balance as unsprung weight on said axle and taking alignment therefrom.

4. A steam locomotive comprising a plurality of drive units, each unit being operated separately except for a common source of live steam, each of said units comprising in combination a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine with a plurality of vertical cylinders, said engine being mounted with static balance as unsprung weight on said axle and taking alignment therefrom and being provided with two identical crank-shafts each driving to a central ring gear mounted on the driving axle.

5. A steam locomotive comprising a plurality of drive units, each unit being operated separately except for a common source of live steam, each of said units comprising in combination a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine with a plurality of vertical cylinders mounted with static balance as unsprung weight upon said axle, said engine having two identical and parallel crank-shafts each rotating in the same direction and at the same rate, and each having a plurality of cranks with the same plane of rotation as the corresponding crank on the second shaft but 180° out of phase therewith.

6. A steam locomotive comprising a plurality of drive units, each unit being operated separately except for a common source of live steam, each of said units comprising in combination a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine wherein the planes of reciprocation are vertical and parallel mounted with static balance on said axle as unsprung weight, said engine also being provided with two identical and parallel crank-shafts rotating in the same direction and at the same rate of speed, each having a plurality of cranks operating in the same plane of rotation as the corresponding crank on the second shaft but 180° out of phase therewith, and each shaft suitably counterweighted for static balance and for dynamic balance when operated together.

7. A steam locomotive comprising a plurality of drive units, each unit being operated separately except for a common source of live steam, each of said units comprising in combination a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine wherein the planes of reciprocation are vertical and parallel mounted in static balance on said axle as unsprung weight, said engine also being provided with two identical and parallel crank-shafts, rotating in the same direction and at the same rate of speed, each having a plurality of cranks operating in the same plane of rotation as the corresponding crank on the second shaft but 180° out of phase therewith, and each shaft suitably counterweighted for static balance and for dynamic balance when operated together, also, said engine being geared to a common gear on the drive axle to furnish the motive power.

8. A steam locomotive comprising a plurality of power units, each of said units comprising in combination a pair of drive wheels, a drive axle therebetween, and a multi-cylinder steam engine with a plurality of vertical cylinders mounted substantially with static balance as unsprung weight on said axle wherein the only attachment of said unit to the main locomotive frame is through a torque link and the journalings of the drive axle.

9. A steam engine adapted for mounting with static balance upon and taking alignment from a locomotive wheeled axle and between the said wheels, comprising in combination a plurality of vertical cylinders and two identical crank-shafts driving a common gear mounted on said axle for driving said wheels.

10. A multi-cylinder steam engine adapted for

mounting with static balance upon a wheeled axle of a locomotive and between the wheels thereof, comprising in combination two identical crank-shafts each rotating in the same direction and at the same rate, a plurality of cranks on each crankshaft, each crank being in the same plane of rotation as the corresponding crank on the second shaft but 180° out of phase therewith.

11. A multi-cylinder steam engine adapted for mounting with static balance upon a wheeled axle of a locomotive and between the wheels of the same, comprising in combination a plurality of cylinders wherein the planes of reciprocation are vertical and parallel on either side of said axle, two identical and parallel crankshafts rotating in the same direction and at the same rate of speed, a plurality of cranks on each of said crankshafts, each crank being in the same plane of rotation as the corresponding crank on the second shaft but 180° out of phase therewith, and each shaft being counterweighted for static balance and for dynamic balance when operated together.

12. A multi-cylinder steam engine adapted for mounting with static balance upon a wheeled axle of a locomotive and between the wheels thereof, comprising in combination a plurality of cylinders mounted on each side of the axle so that the planes of reciprocation are vertical and parallel, two identical and parallel crankshafts each rotating in the same direction and at the same rate, a plurality of cranks on each crankshaft, each crank operating in the same plane of rotation as the corresponding crank on the second shaft but 180° out of phase therewith, and each shaft being provided with counter-weights for static balance and dynamic balance when operated together, said engine being geared to a common gear on the axle for driving said wheels.

13. A steam engine adapted for mounting with static balance upon a wheeled axle of a locomotive and between the wheels thereof, comprising in combination a main engine block mounted as unsprung weight upon said axle, a plurality of vertical and parallel cylinders arranged on both sides of said axle, two identical crankshafts each rotating in the same direction and at the same rate, a plurality of cranks on each crankshaft, each crank being in the same plane of rotation as the corresponding crank on the second shaft but 180° out of phase therewith, said engine being geared to a common gear on the drive axle to furnish the motive power for driving said wheels.

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