March 11, 1947. B. C. MONROE 2,417,084

STEAM LOCOMOTIVE

Filed May 27, 1943 4 Sheets-Sheet 1

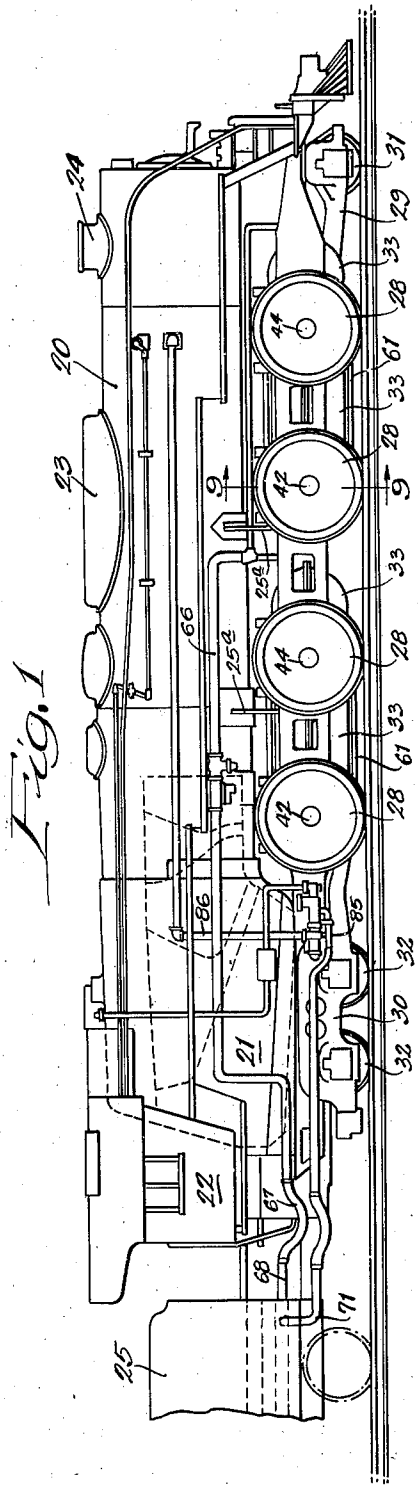

Fig. 1

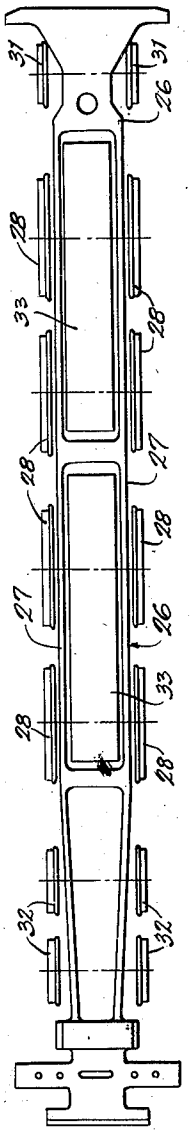

Fig. 2

Inventor:
Benjamin Cutten Monroe,
By Fenning & Fenning
Attorneys.

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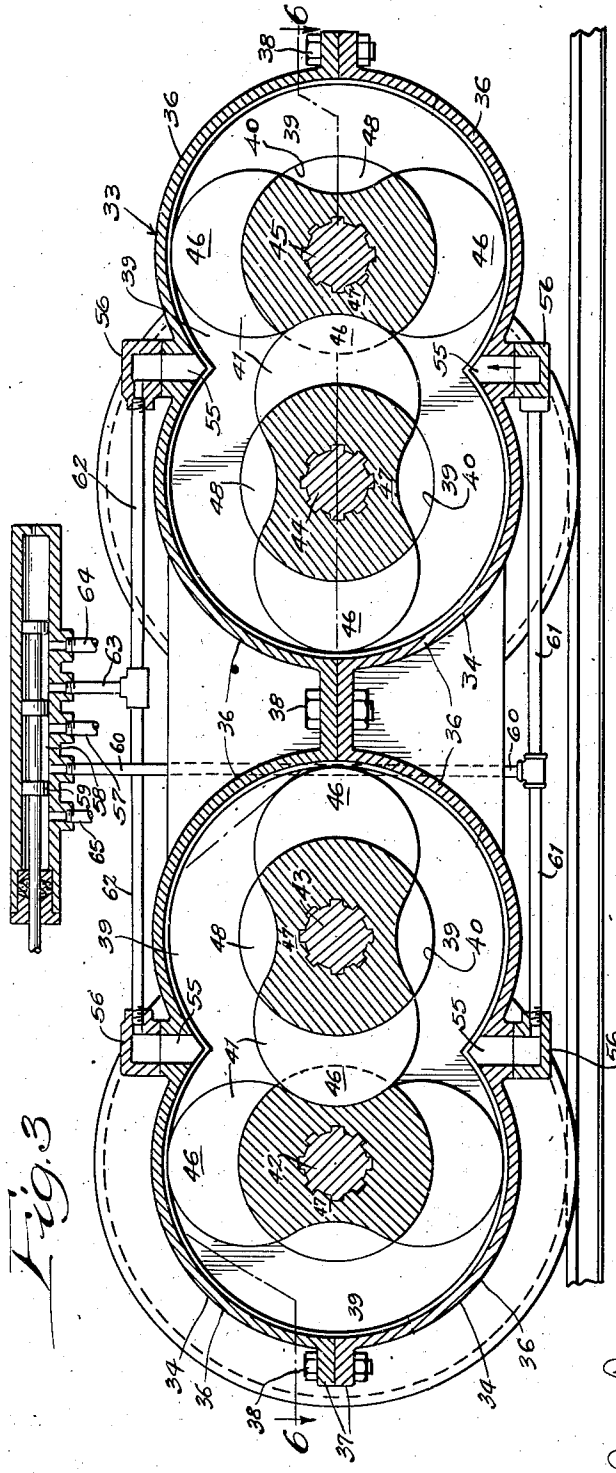

Fig. 3

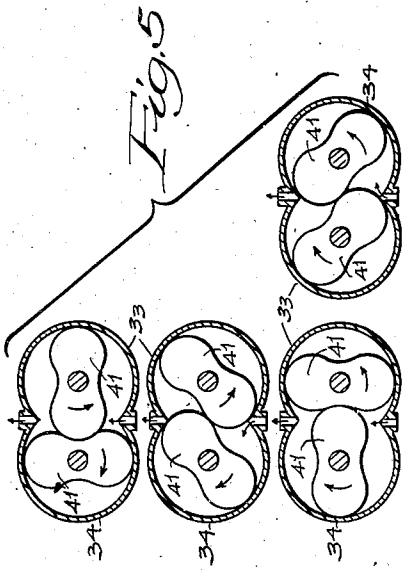

Fig. 5

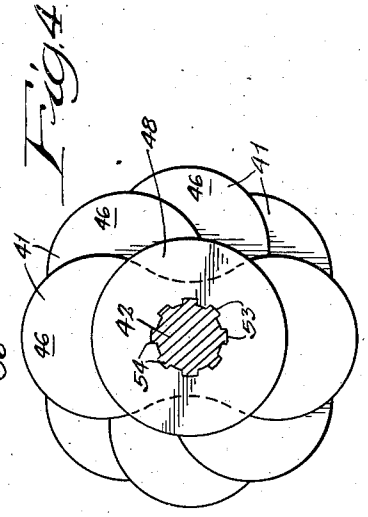

Fig. 4

Inventor:
Benjamin Cutler Monroe,
By Banning & Banning.
Attorneys.

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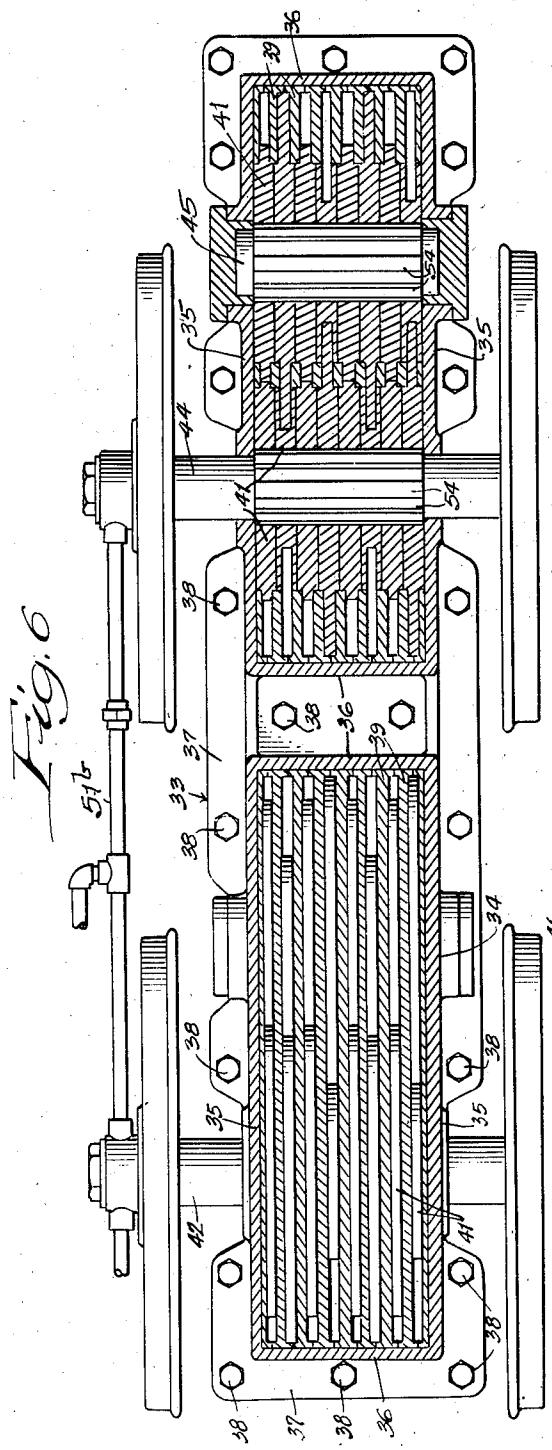

Fig. 6

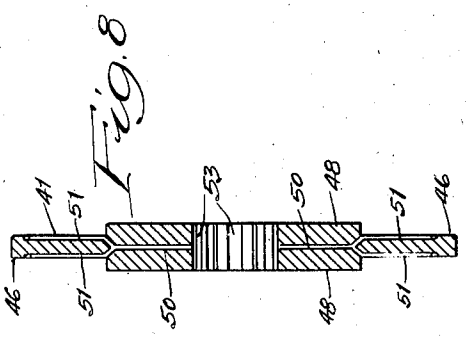

Fig. 8

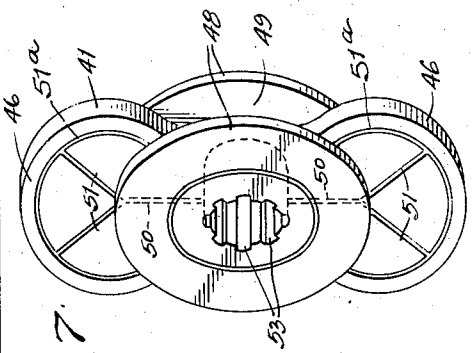

Fig. 7

Inventor:
Benjamin Cutten Monroe,
By Canning & Canning
Attorneys.

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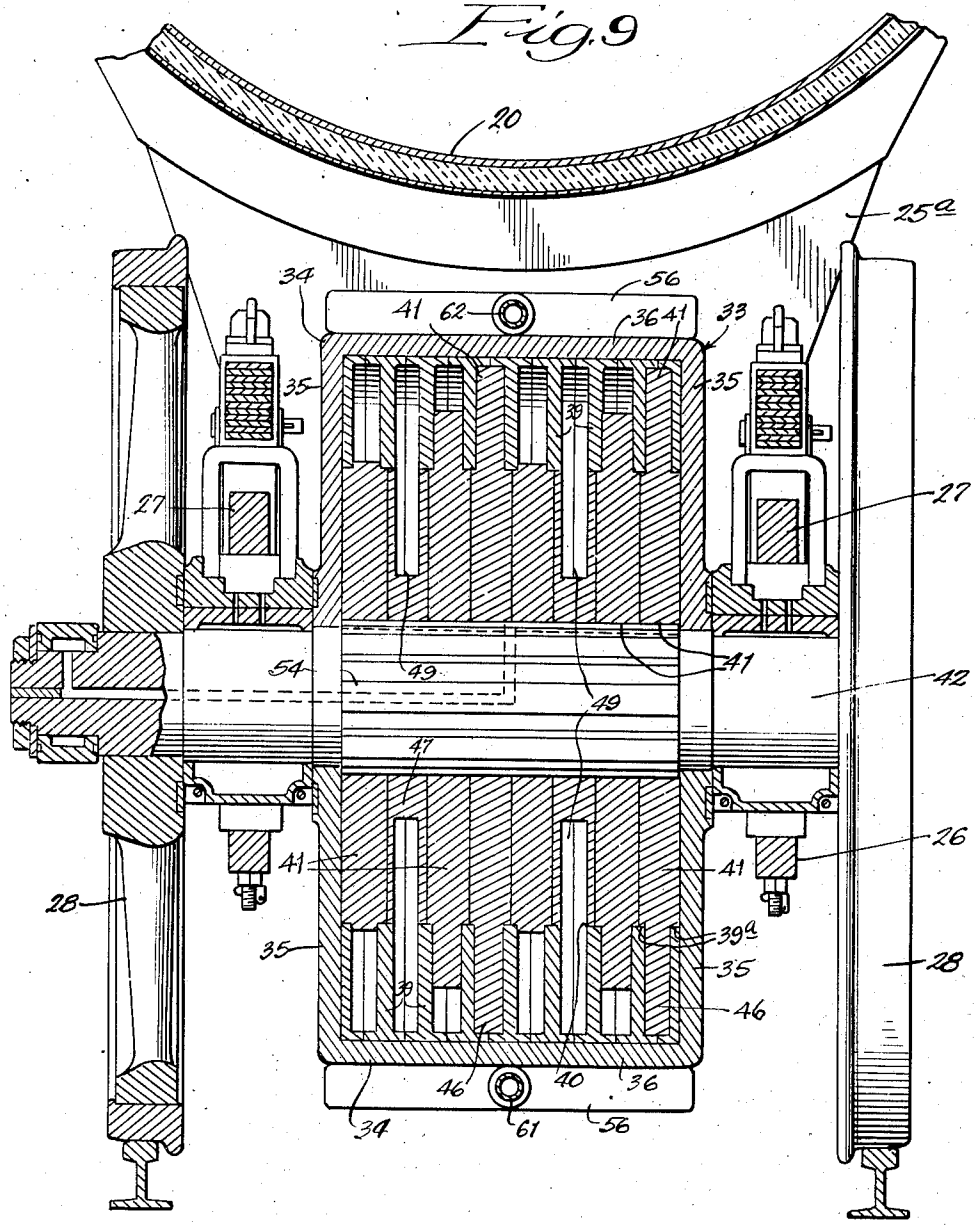
Fig. 9



Inventor:
Benjamin Cutten Monroe,
By Dunning & Dunning
Attorneys.

Patented Mar. 11, 1947 2,417,084

UNITED STATES PATENT OFFICE

2,417,084

STEAM LOCOMOTIVE

Benjamin Cullen Monroe, Tuscola, Ill.

Application May 27, 1943, Serial No. 488,656

5 Claims. (Cl. 105—38)

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The present invention is directed primarily to the employment, in a locomotive of standard construction as regards the chassis, boiler mountings, fire box, and stack, of a specially designed type of rotary engine unit in such form that it may be bodily removed from its mountings beneath the boiler for purposes of repair or replacement without thereby, in material degree, disturbing the remaining structure of the locomotive which is a matter of major importance in railroad transportation, since it greatly reduces the time occupied in servicing the engine and permits its prompt return to active duty.

The power unit itself is so constructed by the provision of multiple steam compartments, that it may be operated either at full or at fractional capacity so that in starting or ascending grades full pressure contact areas may be brought into service while with light loads or when running free the available contact area may be reduced to the desired degree.

The employment of the rotary engine unit of the present invention avoids the use of counter balances and driving rods on the wheels which is a feature of major importance since the momentum acquired by counter balance weights and rods when running at a high speed, produces a heavy pounding or hammering effect on the rails as well as a swaying or rocking movement of the engine, which frequently results in the breaking or displacement of rails or even more serious consequences.

By eliminating counter weights and drive rods the engine will run more steadily and in perfect balance without jerks or inequalities in the driving effort while at the same time the engine can be reversed before coming to a dead stop without danger of breakage of rods, gears, or other parts commonly employed on locomotives of the reciprocating type.

The present engine is designed to start a dead load without the employment of gears or the like and to reverse by valve action rather than through gears or similar transmission trains. Also the uniformly continuous application of steam power in its aggregate effect upon a multiplicity of angularly related rotor blades not only promotes smooth running but reduces noise and avoids back pressure tending to draw the fire. Thus with the present engine there is no coughing or barking, and it does not puff or blow while in motion. The above features will be dealt with more fully hereafter.

The invention in greater detail is also directed to the form and arrangement of the rotor blades which receive the impact of the steam, to the provision for housing and mounting the same, and to the special features of construction which facilitate the quick and easy removal of the entire power unit from the locomotive frame.

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Further objects and details will appear from a description of the invention in conjunction with the accompanying drawings wherein,

Figure 1 is a side elevation of a freight locomotive equipped with the features of my invention;

Fig. 2 is a plan view of the locomotive frame showing two of the power assemblies carried thereby;

Fig. 3 is a longitudinal view of the power unit sectioned through the housing frame;

Fig. 4 is a detail showing an assemblage of the rotor blades on a single shaft with the intervening partition plates removed to better illustrate the angular relation of the blades around the axis of the shaft;

Fig. 5 is a composite diagram showing four positions progressively assumed by coacting blades during a single cycle;

Fig. 6 is a sectional plan view taken through line 6—6 of Fig. 3;

Fig. 7 is a perspective view of one of the rotor blades;

Fig. 8 is a longitudinal section through the same;

Fig. 9 is an enlarged cross-sectional view taken on line 9—9 of Fig. 1.

The locomotive in its general structure is of the standard type comprising the boiler 20, fire box 21, cab 22, steam chest 23, stack 24, with the tender 25 coupled in the usual manner. The boiler is cradled in saddles 25*a*, which extend across the main frame or chassis 26 formed with side sills 27 in the usual manner. The frame extends from end to end of the locomotive and is spring-supported upon the axles of driving wheels 28—28 as well as upon the usual bolsters 29 and 30 which mount the forward and rear truck wheels 31 and 32 respectively. The mountings in question are of standard construction and need not be described in detail.

The features which more particularly form the subject matter of the present invention will now be described. The power plant in the form shown for purposes of illustration consists of two self-contained assemblies each comprising two units, coupled together as shown in Figs. 3 and 6 and enclosed within an auxiliary housing frame which in its entirety is designated 33. The housing frame comprises two casings 34 of identical character, each having flat vertical sides 35 and a two-lobed body, each lobe having a semi-cylindrical wall 36 with the two walls merging into one another in the middle vertical plane which provides on the interior a two-lobed chamber having cylindrical walls struck on arcs of curvature which intersect one another.

The entire housing is divided on a medial horizontal plane into upper and lower sections which carry marginal flanges 37 along their meeting edges which lie in tight face contact and are

united by bolts 38, thus giving to the entire structure which houses duplicate power units, the characteristics of an integral construction providing two curvedly-walled lobe-shaped chambers in tandem relation for enclosing the rotor blades presently to be described.

The lobe-shaped chambers of the two power units are divided into longitudinally extending narrow compartments by partition plates 39, each having a T-flanged edge contour complementary to the lobe-shaped body wall of the housing which plates extend inwardly to a substantial extent as shown in Fig. 3, each plate, however, being provided with two circular apertures 40 whose edges in each case are concentric with the curvature of the adjacent body wall of the housing. Each compartment provides a steam chamber for a pair of coacting rotor blades 41 which in the case of the entire assembly are carried by driving axles 42 and 44, and idle shafts 43 and 45.

Each rotor blade is of kidney-shaped formation which provides enlarged outer heads 46 connected by a reduced waist 47. The head portions are circularly edged throughout 240° of curvature at which point the edge merges into the concavely curved edge of the waist which is struck on an equal radius so that the head of one of the lobes will exactly register with the waist of the companion lobe, and this edge contact will continue throughout the entire cycle of rotation of the coacting rotor blades rotating in opposite directions as shown diagrammatically in Figure 5.

Each rotor blade is off-set on each of its side faces to provide a central disc-shaped boss 48 of circular formation beyond which the heads of the blade extend, as shown in Fig. 7, leaving a channel 49 for the entrance of the head of the companion rotor blade.

The disc-shaped bosses are of a diameter to fit closely into the apertures 40 in the partition plates 39, the off-set shoulders being of a proper depth to permit adjacent bosses to closely contact with one another so that with the blades and partitions assembled as in Fig. 6, there will be little, if any, possibility for the escape of steam from one compartment into the next which is highly important in maintaining the required steam pressure against the exposed edges of the blades which constitute the effective surfaces against which the steam impinges.

If desired, an oil seal may also be afforded by the provision of a duct 50 which may be drilled through the shouldered inner portion of the blade and which terminates in diverging grooves 51 connecting with a circular groove 51*a* in the side faces of the blades which contact the partition plates and thus distribute oil which may be admitted to the axles and shafts through piping 51*b*.

The sealing effect is further enhanced by the rim contact of the T-flanges along the edges of the partition plates which not only serve as spacers but also embrace the rims of the blades, thus serving to additionally seal the same so that the leakage of steam will be negligible in most cases. (See Fig. 6.)

A group of blades, eight in number as shown, are threaded onto the shaft for which they are intended, the blades being keyed to the shaft by the provision of grooves 53 which engage with complementary splines 54 on the shaft so that a rigid union is provided, with adjacent blades standing in angular relation to one another, being progressively set at angles of 45°; and in view of the fact that the blades are symmetrically formed at each end, the provision of a group of eight

blades set at the angle stated will divide the complete group into two sets of four blades each with the first and fifth blades standing in alignment, and the second and sixth and the remaining blades likewise aligning.

As shown in Fig. 3, the housing at the upper and lower medial sections is provided in each case with a row of ports 55 which constitute inlet and outlet ports for the introduction and escape of steam which may be admitted in either direction. Each row of ports is capped by a cross-header 56 so that steam admitted to one or the other of the cross-headers will simultaneously enter through the 8 ports communicating with the 8 compartments, although the inflow of steam into the various compartments will be conditioned by the positions occupied by the coacting blades at any particular instant. This duplication of ports and headers permits either to act as the steam inlet and the other as the steam outlet.

As shown in Fig. 3, the blades on the driving axles 42 and 44 which mount the driving wheels are the ones which are subject to the driving impact of the steam while the companion blades serve to confine the steam in greater or less degree within the compartments so that it may act effectively on the driving blades. Assuming for the time being that live steam is admitted through the lower row of ports in Fig. 3, it will, in one compartment, impinge against the exposed edges of the driving blade which at the instant assumed will occupy the position shown in the top view of Fig. 5. In this position, the effective driving action will be measured by the lower inner edge area of the driving blade plus the right-hand lower exposed area of the companion blade, which areas exceed the exposed lower left-hand edge area of the companion blade, so that a preponderant force will be exerted to rotate the driving blade in a clock-wise direction until the blades assume the position shown in the middle view of Fig. 5.

At this point the effective driving area on the driving blade will extend from the inner middle point on the edge, to the point of tangent contact at the lower end of the blade plus the exposed left-hand lower edge of the companion blade; while the counter effect will be limited to the short edge area of the driving blade measured from the center point to its point of contact with the companion blade. Thus the preponderant force on the driving blade will continue in the clock-wise direction until the blades assume the position shown in the lower left-hand view of Fig. 5, at which time, in like manner, the preponderant driving effect will continue in the same direction.

As the rotation of the driving blade continues, a volume of steam will be trapped beneath the driving blade, as shown in the lower right-hand view of Fig. 5, but in these circumstances the preponderant driving effect on the companion blade supplemented by the exposed edge section of the driving blade will continue to maintain rotation in the same direction until the trapped steam is exhausted through the upper port.

It will thus be seen that at all points in the rotation, a preponderant steam pressure is exerted in the proper direction to maintain the desired rotation ,and although the effective preponderance will vary at different points in the cycle in the case of any single pair of blades, the fact that multiple pairs of blades are mounted on the same shaft at each instant and are set progressively at varying angles in the adjacent

compartments, will establish a condition which maintains substantial uniformity in the effective driving action at all stages throughout the cycle so that the engine will run smoothly and without pulsations due to variations in the aggregate driving pressure.

Furthermore, by suitable valve control, a set of four blades can be cut out without disturbing the progressive angular relation of the remaining set of four blades, so that although the power is reduced, the freedom from pulsations will be maintained, or if desired, other variations in the number of sets of blades subjected to steam pressure can be provided. It will also be understood that a greater or less number of blades than the eight pairs shown can be used.

As shown in Fig. 3, two units within a single power assembly in tandem relation are employed to impart rotation to the driving axles **42** and **44**, and this tandem relation requires that the respective ports in the two units be connected to admit steam to and exhaust the steam from the respective units simultaneously. A suitable arrangement of piping and valve control is shown for purposes of illustration. Steam admitted through the supply pipe **57** enters the valve chamber **58** controlled by slide valve **59** and descends through a pipe **60** which communicates with branch pipes **61** leading to the lower sets of ports for the respective units. Likewise, exhaust branch pipes **62** leading from the upper sets of ports connect with a pipe **63** leading to the valve chamber, and in the adjustment shown the exhaust steam will be discharged through the pipe **64**; by reversing the position of the valve to the left, the steam may be admitted through the pipe **63** and branch pipe **62** and exhausted through the pipe **60** to a discharge pipe **65**, which adjustment will reverse the direction of rotation of the driving axles.

The driving axles **42** and **44** each carry a pair of driving wheels which rotate in unison in the manner described, but the shafts **43** and **45** idly rotate in suitable bearings in the unit housing; and in the embodiment of the invention shown in Fig. 2, two complete assemblies are fitted between the side sills of the chassis so that 4 driving wheels on each side will be provided, it being understood, however, that a single assembly, with 2 driving wheels on each side, might be employed or that 3 or even more can be mounted in the manner shown and that each power assembly constitutes a self-contained structure which may be bodily removed as a unit from the engine.

It will be furthermore understood that the nature of the invention is such that it permits the power speed ratio of a single locomotive to be changed by a substitution of power assemblies having a differing power speed ratio, thus permitting a single locomotive to be re-equipped for differing kinds of service.

Each driving assembly is removably fitted between the side sills of the locomotive chassis frame as shown in Fig. 2 so that it may be bodily removed without difficulty for purposes of repair or replacement. Such removal can readily be effected from below by temporarily supporting the frame of the locomotive and releasing the driving unit with the wheels attached and without substantial disassembling of the remainder of the locomotive other than a disconnection of the steam supply pipes or associated valve controls.

It is furthermore evident that if desired, the

lower half only of the power assembly housing can be removed to afford access to the interior without disturbing the remainder of the structure; or if desired, the driving axles and the idle shafts with the blades carried thereby can be bodily removed together with the lower half of the housing without disturbing the upper half, which in these circumstances may be independently supported upon the chassis. This capacity for partially or wholly removing the power assembly is a factor of major importance in that it saves the time required in conditioning the locomotive for continued service.

It will also be noted that the elimination of the usual cylinders and side rod driving connections employed in reciprocating engines permits the forward driving wheels to be located much closer to the front of the locomotive than is customary in standard constructions. This more advantageously distributes the weight as well as eliminates all of the usual equipment exterior of the driving wheels, and at the same time locates the entire power plant for the locomotive centrally beneath the boiler and at a relatively low level which serves to advantageously ballast the locomotive. This together with the elimination of counter-weights on the wheels and the driving rods and connections serves to eliminate the swinging or swaying action of the locomotive when traveling at high speed.

As illustrated, each power assembly is closely fitted within the confines of the frame or chassis, but without positive connection therewith, so that the chassis and the boiler carried thereby may be spring-supported upon the driving axles and truck wheels and be free to move up and down under stress of road conditions without restraint from the power assemblies which are directly carried by the driving wheels and are thus structurally unified therewith.

The construction is also one which eliminates the danger of serious disaster due to the breaking of drive rods or connections located in an exposed position exterior of the driving wheels.

The exhaust steam whether admitted through the exhaust pipe **64** or **65** is led rearwardly through a main exhaust pipe **66** which discharges through a flexible connection **67** into an exhaust intake pipe **68** in the tender **25**.

In view of the fact that the exhaust from the rotary engine units of the present invention is substantially continuous and uniform and not subject to the pulsations characteristic of the discharge from a reciprocating locomotive engine, and in view of the fact that the steam from the power units is condensed and utilized for the pre-heating of the air and water, the employment of a suction fan is necessary to induce a continuous and uniform draft through the boiler by suction from a point in advance of the boiler tubes. The uniform draft thus produced results in a more uniform and properly controlled combustion within the fire box with a consequent saving of fuel than is possible to obtain where the back pressure from the cylinders is utilized to draw the fire in the customary manner. Furthermore, by the maintenance of a steady draft without back pressure from the cylinders, there is less likelihood of creating leaks in the flues, so that there will be a saving of power and fuel.

By utilizing a steady flow of exhaust steam for the purpose of pre-heating both the air and the water, the employment of an injector is rendered unnecessary with a resultant saving in fuel and

in consequence there will be no need to frequently replenish the water supply carried by the tender, with a consequent reduction in the size of the tank.

By mounting the power units directly upon the axles which carry the driving wheels, and by spring-supporting the locomotive chassis and body directly upon the axles, each power plant will constitute a self-contained integrated assembly which will at all times maintain the interfitted relationship of its parts without disturbance occasioned by any vibration or swinging or swaying movements to which the body of the locomotive may be subjected.

At the same time the close interfit between each power assembly and the chassis will maintain the power assemblies against any lateral or longitudinal displacement while permitting limited vertical movement of the chassis which is spring-supported upon the axles. Due to these factors, and to the absence of driving connections between the body of the locomotive and the driving wheels, the possibility of displacement of any operating parts is avoided and wear and friction reduced to a minimum.

The present invention is designed to coordinate the entire operation of the locomotive including the maintenance of draft and the heating and infeeding of water to the boiler, to the special design and functioning of rotary engine units of the character described, so that there is a distinct inter-relationship between all of the features of the present invention which are designed to improve the general structure of the locomotive as a whole and not merely to employ a rotary type of engine as a substitute for the reciprocating drive ordinarily employed in locomotive construction.

I claim:

1. A rotary engine housing having upper and lower casing halves, a plurality of partition plates T-shape in cross section arranged to bear against one another to form rotary engine chambers therebetween, and to slip in assembled relation into each half of the housing.

2. A rotary engine including an engine housing having walls forming the sides of an engine chamber, coacting bladed rotors within the chamber and rotating about spaced axes, each blade rotating in sealed engagement with the walls of the chamber and each of said rotors being recessed between the blades to receive the blade of the cooperating rotor, the side walls of each recess forming a continuation of the side walls of the chamber.

3. A steam locomotive including driving wheels, a pair of driving axles connecting the driving wheels, a main frame or chassis carrying a boiler and associated parts and including longitudinally extending spaced side sills, a power assembly consisting of two power units arranged in tandem relation and consisting of a rigidly constructed housing for both power units mounted on the driving axles and fitting within the main frame or chassis, a companion shaft for each power unit extending transversely of the housing in parallel spaced relation with each other and with the driving axles, co-operating rotor elements in each power unit mounted directly upon the driving axle and companion shaft respectively, means for admitting and exhausting a pressure medium to and from the power units to impinge against the rotor elements, and spring means mounted on the axles and supporting the main frame or chassis.

4. A steam locomotive including driving wheels, a pair of driving axles connecting the driving wheels, a main frame or chassis carrying a boiler and associated parts and including longitudinally extending spaced side sills, a power assembly consisting of two power units arranged in tandem relation and consisting of a rigidly constructed casing for both power units having upper and lower casing halves and mounted on and having laterally spaced bearings for the driving axles and fitting within the main frame or chassis, a companion shaft for each power unit extending transversely of the casing in parallel spaced relation with each other and with the driving axles, co-acting rotor elements in each power unit mounted directly upon the driving axle and companion shaft respectively, means for admitting and exhausting a pressure medium to and from the power units to impinge against the rotor elements, the rotor elements, axle and shaft being removable as a unit from the casing independently of the main frame or chassis when the lower casing half is removed, said main frame or chassis including spring means mounted on said axles for supporting said main frame or chassis.

5. A steam locomotive including driving wheels, a pair of driving axles connecting the driving wheels, a main frame or chassis carrying a boiler and associated parts and including longitudinally extending spaced side sills, a power assembly including two power units arranged in tandem and consisting of a rigidly mounted casing for both power units composed of upper and lower casing halves and mounted on the driving axles and fitting within the main frame or chassis, a companion shaft for each power unit extending transversely of the casing in parallel spaced relation with each other and with the driving axles, coacting rotor elements in each power unit mounted directly on the driving axle and companion shaft respectively, means for admitting and exhausting a pressure medium to and from the power units to impinge against the rotor elements, the power assembly being removable independently of the main frame or chassis and the parts carried by the same when the lower casing half is removed, spring means mounted on said axles for supporting the main frame or chassis, and front and rear trucks having spring means for yieldably supporting the main frame or chassis at the front and rear ends thereof and constituting the sole support for the main frame or chassis when the power assembly is removed.

BENJAMIN CULLEN MONROE.

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