

Nov. 9, 1948.

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2,453,483

ELECTROMECHANICAL RAILROAD LOCOMOTIVE

Filed Dec. 3, 1942

7 Sheets-Sheet 1

FIG. 1.

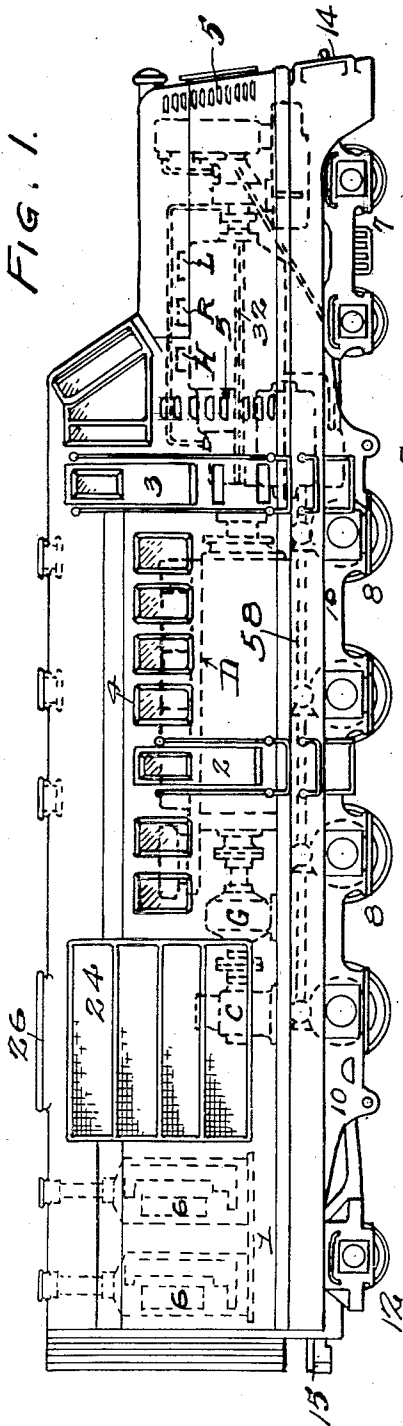


FIG. 4.

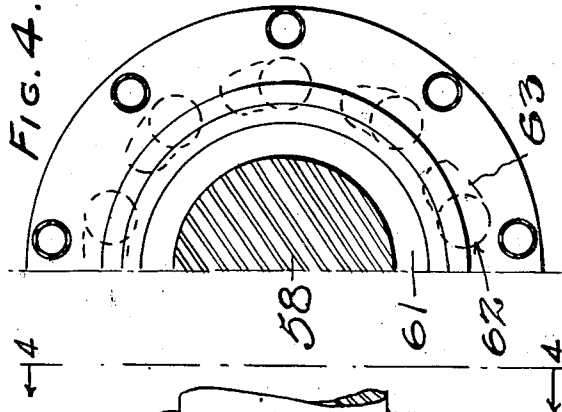
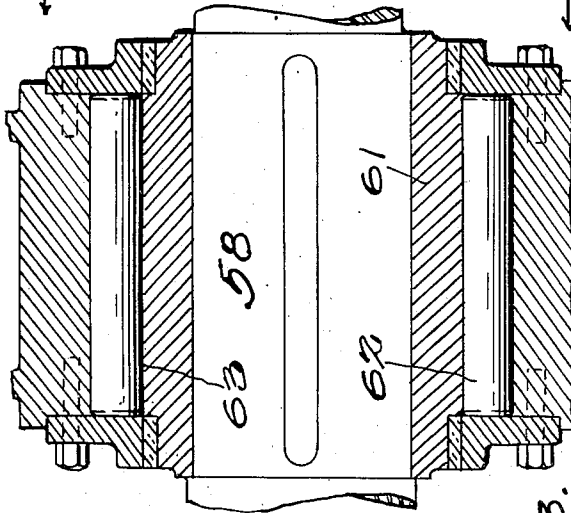
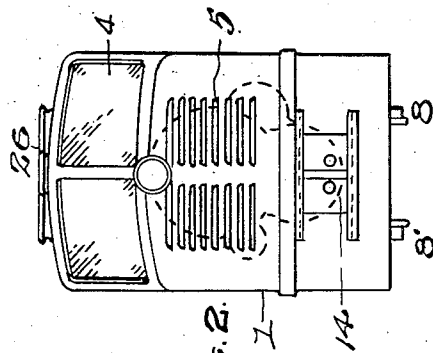


FIG. 3.

FIG. 2.



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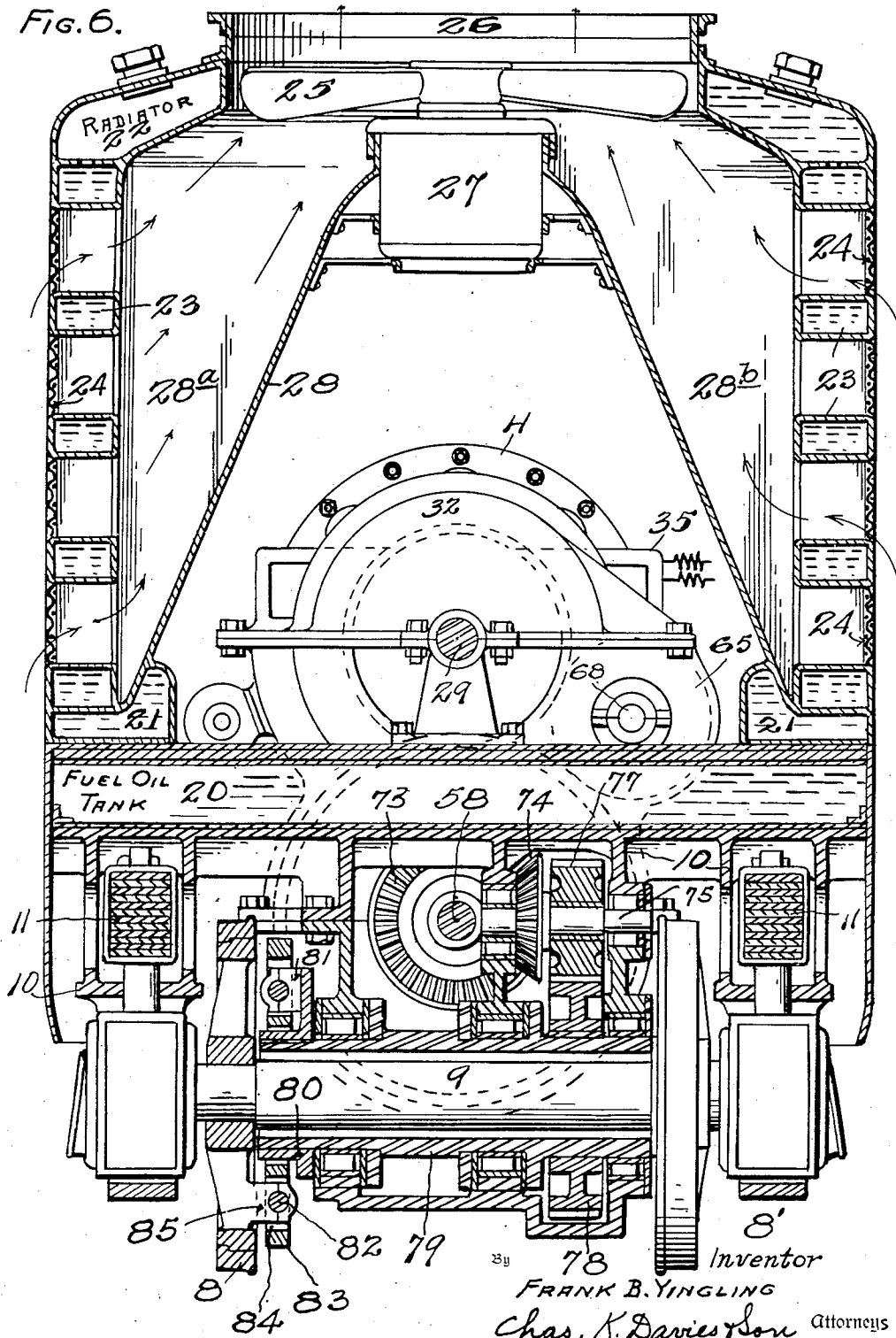
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Fig. 6.



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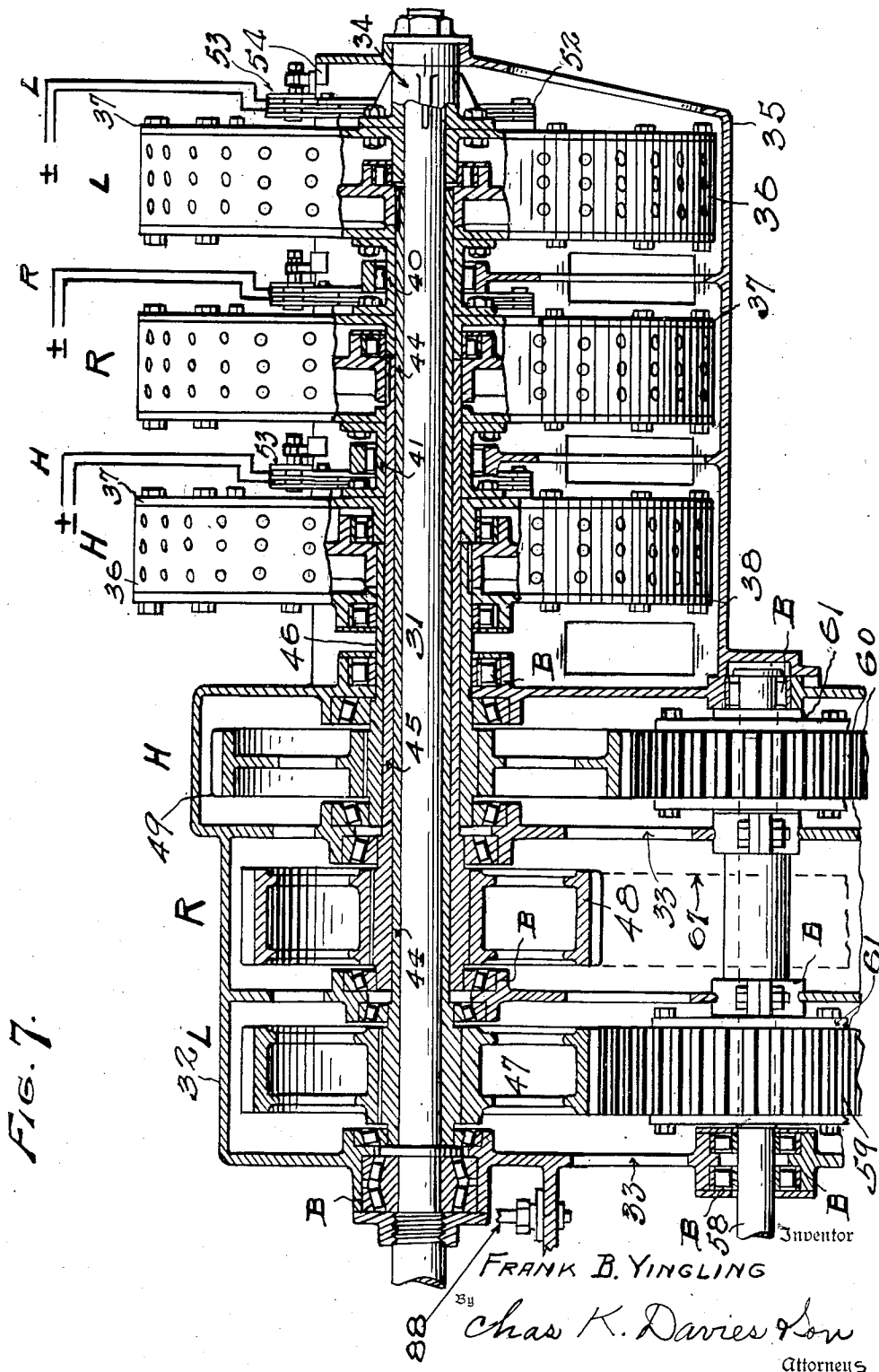
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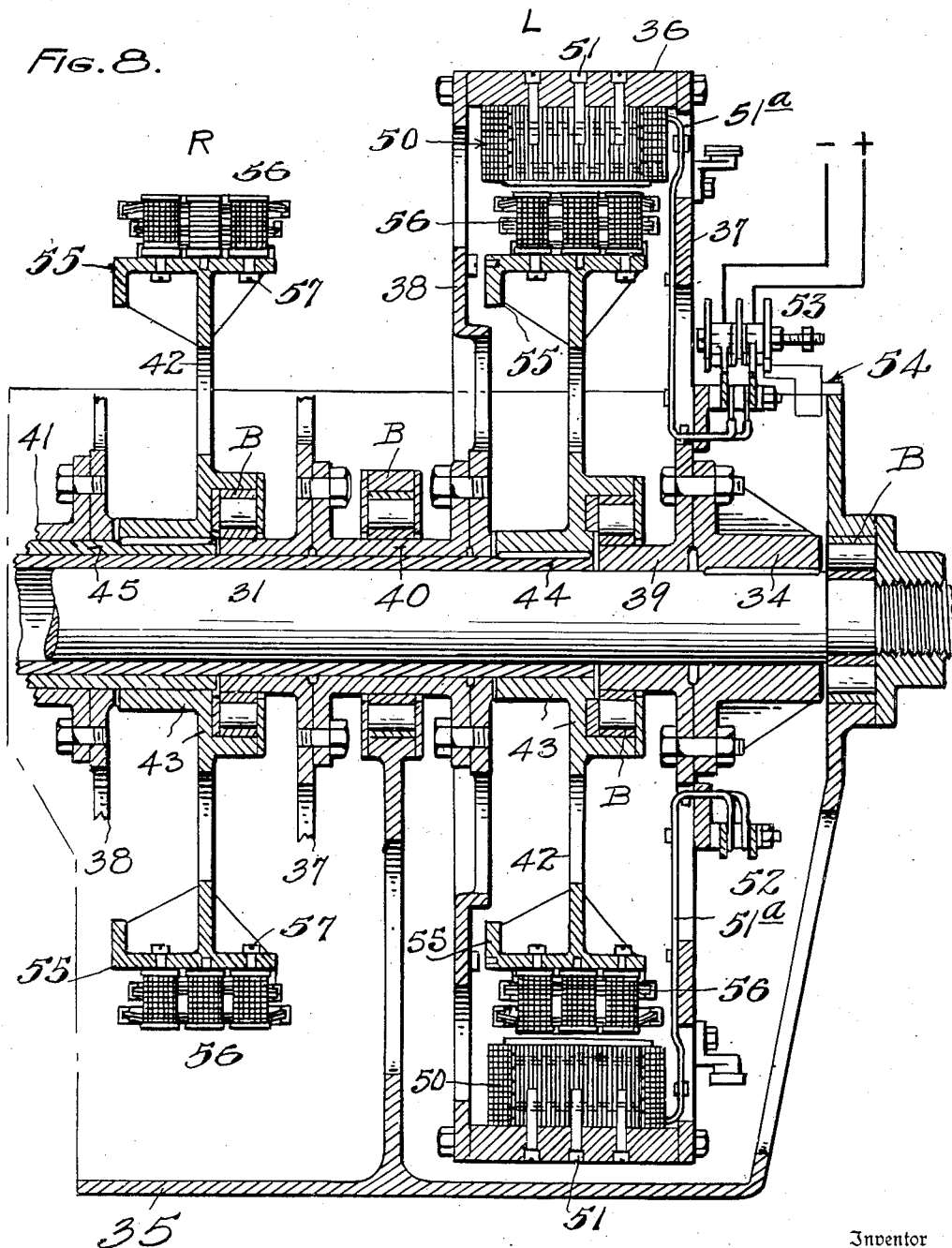
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FIG. 8.



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FIG. 13.

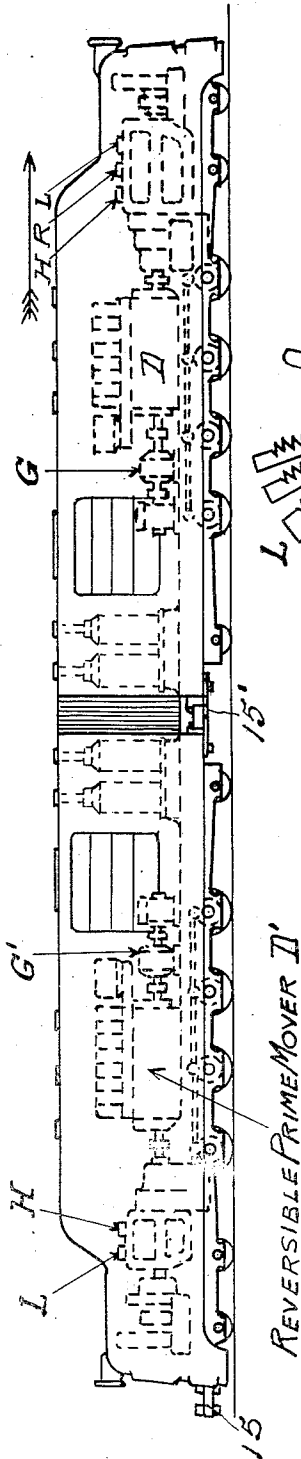
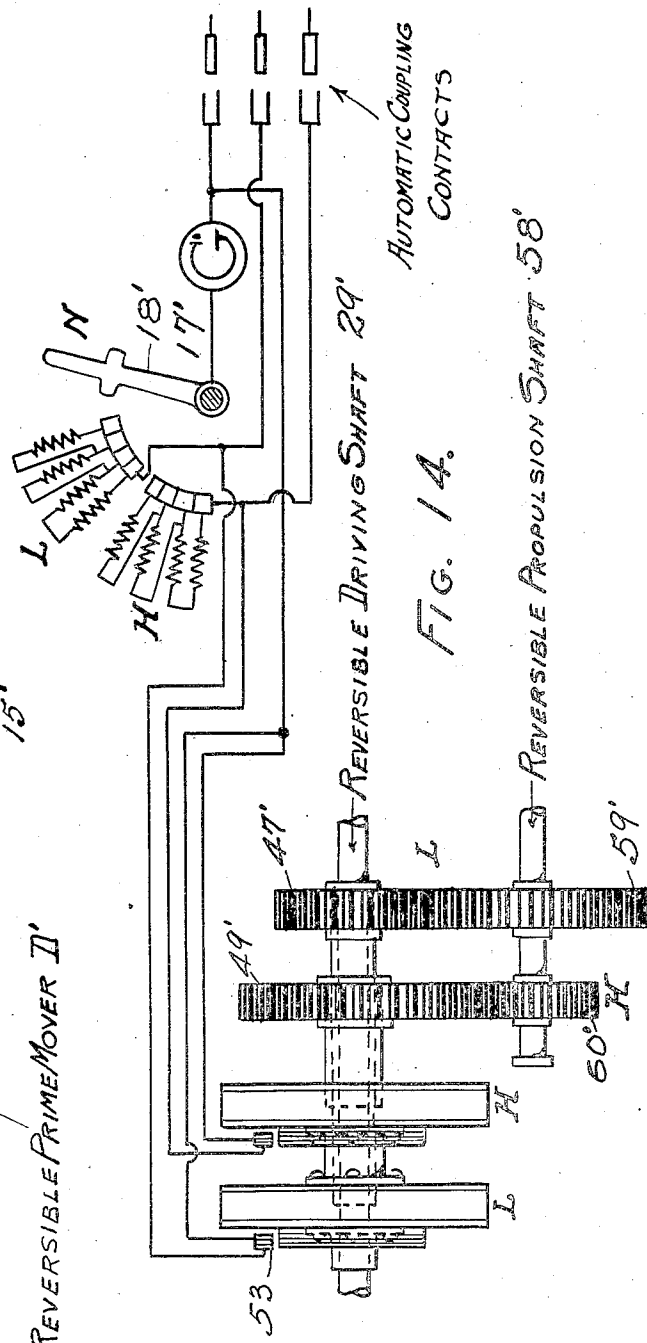


FIG. 14.

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ELECTROMECHANICAL RAILROAD
LOCOMOTIVE

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Application December 3, 1942, Serial No. 467,762

4 Claims. (Cl. 105—130)

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While I have specifically illustrated and described a single locomotive of the heavy duty, main-line type, it will be understood that my invention is capable of embodiment in locomotives arranged in tandem as illustrated, as well as in three or more coupled units. And furthermore, for lighter duties and lower capacity equipment, the subject matter of my invention may be installed in rail-cars, buses, automotive vehicles and similar power driven vehicles including industrial-plant equipment. In all of these installations the power plant as a whole includes a prime mover such as an internal combustion engine that may or may not be reversible, rotary mechanism for transmitting power from the prime mover to a propulsion shaft, and one or more electromagnetic slip couplings or torque couplings combined in the transmission mechanism.

Ordinarily for heavy-duty large size main-line locomotives as here illustrated and described at least two electromagnetic slip couplings are utilized in connection with differential speed transmission gearing, and if and when it is desired that the engine shall operate constantly in forward movement a third electromagnetic slip coupling is employed in connection with a reversing unit in the power transmission gearing.

For lighter duty and lower capacity equipment, one or more electromagnetic slip couplings may serve the purpose in connection with and when a high power engine is used for propulsion of the vehicle or similar rolling equipment.

In the specific equipment of a main-line locomotive as here illustrated and described I utilize a two-cycle internal combustion engine, or Diesel engine having a constant forward movement, as the prime mover of the power plant, together with an electric generator and an air compressor operated by the engine, and the power from the engine is transmitted from the engine shaft to a propulsion shaft through rotary power transmission mechanism including electromagnetic couplings and a reversing unit. A suitable number of these electromagnetic slip couplings or torque couplings are employed and they are selectively energized or excited and rendered effective preferably by direct current from the electric generator. These slip couplings are of the induction type wherein the magnetic flux is produced when an outer mechanically rotated driving member having salient poles or rotating field is electrically energized to react on a rotatable inner member of the squirrel cage type.

The power for the several electromagnetic

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slip couplings or torque couplings of the transmission mechanism is supplied through a longitudinally extending drive shaft, which forms a front extension of the main engine shaft, and the group or parallel series, here shown as three in number, of electromagnetic slip couplings or torque couplings powered from the drive shaft, provide a low speed, a high speed, and a reverse speed in driving the locomotive.

These electromagnetic slip couplings, or torque couplings, each of which produces a high torque without mechanical contact or friction between its inner and outer rotatable members, transmit speeds with high efficiency from the drive shaft through concentric tubular driven shafts or gear shafts to a propulsion shaft of the locomotive, which driven shafts are coplanar with the engine shaft and drive shaft, and the propulsion shaft, which is located below the engine shaft and drive shaft is in parallelism with these shafts.

The shafts extend longitudinally of the locomotive, and the drive shaft and propulsion shaft are connected by transmission gearing of proper ratio to produce the required speeds of the locomotive in relation to the possible tractive effort.

From the propulsion shaft the power is transmitted and distributed through a group of spaced driving units of the locomotive, here shown as four in number, and each driving unit includes a pair of traction wheels or drive wheels rolling on the railroad track.

While I have illustrated the locomotive as having variable change speed mechanism from a low speed to a high speed forward, and also a reverse speed, and while I have depicted four driving units for the four axles of the pairs of locomotive driving wheels, it will be evident that these speeds may be varied and ratios changed from the exemplifying disclosures in the accompanying drawings.

With this construction and arrangement of the electromagnetic slip couplings or torque transmitting couplings in the rotary transmission mechanism, and by the use of the mechanical driving units combined with the driving wheels of the locomotive, the operation of the locomotive is materially simplified, numerous parts ordinarily required and employed in the manufacture of locomotives now in use and equipped with various kinds of electric power transmission appliances, are eliminated, while the advantages of the electric transmission are retained. Thus, the electrical transmission installations in the present locomotive are simplified and therefore may be produced at lowered cost of production; installed

with greater convenience and at reduced expense; and while in use the parts may be maintained at comparatively low cost. By the interposition of the electro-magnetic slip couplings in the transmission mechanism I am enabled to utilize the maximum horsepower developed by the engine, thus increasing the efficiency of the locomotive over the usual type of Diesel electric locomotive, and the locomotive can perform more work with less cost for maintenance.

The interconnecting gears and pinions of the transmission mechanism between the electro-magnetic slip couplings, or torque transmitters, and the driving units of the locomotive are constantly in mesh, and the transmission of power to the driving units on the rails is accomplished by smooth, continuous, and uniform operation of the gearing. The presence of the group of electro-magnetic slip couplings or torque transmitters incorporated in the power transmission mechanism permits varying speeds of the engine or locomotive when required without changing or disconnecting the load of the trailing cars from the prime mover of the locomotive, and the utilization of these induction slip couplings relieves the engine of undue shocks, strains, and vibrations in starting, accelerating, pulling, decelerating and stopping.

To further relieve the power transmission of strains and stresses when the locomotive is running, as at full capacity, and especially to facilitate assembling and disassembling or dismantling of the spaced driving units on the rails, various flexible joints of mechanical construction are interposed between adjoining rotating parts, which flexible mechanical joints also absorb angularity and any possible relatively minor misalignment of parts, to insure uniform and smooth transmission of power to the traction units or drive wheels of the locomotive.

The operation of the locomotive is accomplished through the selective electro-magnetic slip couplings or torque transmitters, which are under electro control of the engineer, so that the operation of a selected coupling, when energized and effective, becomes stabilized by a supply of variable electrical energy, or excitation currents, from the generator, depending upon the load the locomotive is hauling or pulling.

Various other meritorious features are incorporated in the construction of the locomotive to enhance its efficiency in operation, as for instance the ventilation of the locomotive and especially the slip couplings, to prevent excess heating of complementary rotating parts and appliances, as will hereinafter be more fully set forth.

The invention resides in certain novel combinations and arrangements of parts in an electro-mechanical locomotive having a prime mover and its electric energizing generator, and spaced driving units, together with intermediate flexible power-transmission mechanism including a rotary drive shaft receiving power from the prime mover; a group of electro-magnetic slip couplings of the induction type selectively excited with direct current from the generator inter-connecting the drive shaft with a propulsion shaft that transmits power to the driving wheel units; and other features, as will be more fully pointed out and claimed.

In the accompanying drawings I have illustrated one complete example of the physical embodiment of my invention, wherein the parts are combined and arranged according to one mode

I have thus far devised for the practical application of the principles of my invention; but it will be understood that changes, alterations, and modifications may be made in these exemplifying structures, within the scope of my appended claims, without departing from the principles of my invention.

Figure 1 is a view in side elevation of a locomotive embodying my invention, disclosing by dotted lines the arrangement of a two-cycle or Diesel engine as the prime mover with an electric energizing generator and an air compressor at the rear of the engine, together with several electro-magnetic slip couplings or torque transmitters of the induction type connecting the engine to the various ratios of speed-gearing for transmission of power through the longitudinally extending propulsion shaft and spaced driving units to the driving wheels of the locomotive.

Figure 2 is a front elevation of the locomotive shown in Figure 1.

Figure 3 is an enlarged detail sectional view at the bearing hub of one of the overrunning clutches or free wheeling units of the transmission gearing mounted on the longitudinally extending horizontal, propulsion shaft of the locomotive.

Figure 4 is a half section view transversely of the propulsion shaft, looking in the direction of the arrow at line 4—4 of Figure 3.

Figure 5 is an enlarged vertical longitudinal sectional view at the front portion of the locomotive, showing the mechanism for the torque transmission of power to the foremost driving unit of the locomotive.

Figure 6 is a transverse vertical sectional view through the locomotive showing one of the driving units, together with the ventilation and radiation systems of the engine, and indicating the relation of the power transmission mechanism.

Figure 7 is a sectional view with parts in elevation illustrating the rigidly connected hubs between the impeller or driving members of the electro-magnetic slip couplings, and the transmission gearing therefrom to the propulsion shaft.

Figure 8 is a conventional detail view, in section, showing one of the electro-magnetic couplings with the impeller or rotating field mounted to revolve with the drive shaft and engine shaft, and also showing one of the squirrel cage armatures or rotors complementary to the impeller or driving member of the coupling.

Figure 9 is a conventionalized schematic view of the transmission mechanism from the engine and drive shaft to the propulsion shaft including a pneumatic friction clutch for the reverse drive, together with a simplified layout of electric circuits from the rheostat in the engineer's station to the several slip couplings to control the torque transmitted through the air gap of a selected coupling.

Figure 10 is a detail view showing the drive shaft, propulsion shaft, and reverse shaft in section, and illustrating the arrangement of the gearing of the reverse mechanism.

Figure 11 is a detail view illustrating the low speed gearing between the drive shaft and the propulsion shaft.

Figure 12 is a similar view illustrating the high speed gearing on the drive shaft and propulsion shaft.

Figure 13 is a view showing a modified arrangement of two tandem locomotives, the leading locomotive being the same as the single locomotive

tive illustrated in Figure 1, and the rear locomotive traveling backward having a reversible engine in lieu of a reversing unit in the power transmission mechanism in order that the locomotives may be coupled back to back with a flexible vestibule therebetween, both locomotives being under multiple electrical control from a single station in either locomotive, but preferably in the cab of the leading locomotive, depending upon the direction of travel of the double-header.

Figure 14 is a conventionalized schematic view of the power transmission mechanism of the rear locomotive in Figure 13, from the reversible engine and its reversible drive shaft to the propulsion shaft (omitting the reversing friction clutch mechanism of Figure 9) together with a simplified layout of electric circuits from the rheostat in the engineer's station to the high speed and low speed slip couplings respectively, to control the torque transmitted through the air gap of a selected coupling, and also indicating automatically coupled electric contacts between the two locomotives of Figure 13.

In the assembly view Figure 1 I have shown a passenger type railroad locomotive for main line use having a streamlined housing 1, side doors 2 and 3, windows 4, and forward louvers or vent openings 5, and in dotted lines at 6 heating appliances are indicated at the rear of the locomotive for use in furnishing steam-heat for the cars of a passenger train. In this exemplifying figure of the drawings the locomotive is equipped with a front swiveled bogie or pilot truck 7; four driving units of which each unit includes a pair of traction wheels or drive wheels as 8 and 8' journaled with their axles 9 in pockets of the main frame 10 of the locomotive; and equalized springs 11 (Fig. 6) are shown together with a rear two-wheel pony truck 12.

The weight of the locomotive is thus supported to insure stability, and the power is uniformly distributed to the several driving units, on the railroad tracks. The main frame 10 is preferably a single unitary casting which is fashioned with heavy channels, angles, and plates, and the longitudinally extending side sills of the locomotive frame are arranged with pockets that permit the axle and journal assemblies of the driving units to be dropped or removed from beneath the locomotive when replacements or repairs are necessary. At the front of the main frame, in Figure 5, within the housing, an adjustable coupler 13 is supported and which may be projected through a front opening in the housing for use when the slide doors 14 are opened for that purpose, and a standard type of coupler at the rear of the locomotive is indicated at 15. In Figure 5, at 16, a chair or seat is indicated for the engineer or engineman, and the electric control cabinet 17 conveniently located for the engineer contains the necessary electric appliances, as a rheostat, for introducing various resistances to the respective operating or exciting circuits of the electro-magnetic slip couplings or torque transmitters of Figure 9. The rheostat, as indicated, includes a series of resistances, four or more, arranged to regulate current for each coupling-circuit, to start, and to increase to the full speed allowed, under control of the lever 18, and the lever is adjustable for full resistance to start increasing speed. The lever is further adjustable so that no resistance is encountered in the rheostat and a selected circuit when the locomotive is under full load or speed.

By dotted lines in Figure 1 the prime mover of

the power plant is indicated at D, as a two-cycle internal combustion engine of suitable capacity, and at the rear of the engine are indicated an exciting electric generator G, and an air compressor C, both appliances being operated, under suitable controls at the engineer's station, from the shaft of the engine D.

In the conventionalized schematic layout of Figure 9 the generator G is indicated, and the electric control station in the engineer's cab, as at 17, contains the electric switches, rheostat, and other instruments of control. The electric control sections of the rheostat are indicated by the letters N, L, H, and R, to designate respectively the neutral position of the lever 18, low speed, high speed, and reverse speed. For convenience in understanding the invention these same letters are employed throughout the drawings, generally, to indicate rotating or mechanical parts of the transmission included in the selected low speed, high speed, and reverse speed of the locomotive. The letters L, H, and R, are also utilized to indicate, as a whole, the three electro-magnetic couplings or torque transmitters receiving power from the engine, and through the three electric circuits receiving direct current from the generator.

In Figure 9 an air valve 19, receiving air under pressure from the compressor C of the air brake system, is also indicated, to provide fluid pressure to actuate an air operated or pneumatic friction clutch, which is embodied in the reversing mechanism of the power transmission means. This pneumatically operated friction clutch is released while the forward speeds are effective or in operation, and it becomes effective to transmit torque while the reverse speed is being utilized.

In Figures 1 and 5 it will be seen that the engine D is mounted directly and rigidly upon the horizontal deck or floor of the locomotive, which is built upon the main frame 10 of the locomotive, and in Figure 6 a fuel tank is combined with the main frame so that the top of the tank or reservoir forms the floor or deck, and the reservoir may be replenished, as required, through suitable filling connections, exterior of the housing.

In the transverse sectional view of Figure 6 the heated water coolant from the engine D is circulated through heat-exchange appliances including side radiators 21 along the deck or floor, and also through upper radiator sections 22 and intermediate sections 23. These built-in radiator sections disposed in horizontal planes are connected with complementary vertically disposed water-sections or radiator sections to form rectangular heat-exchange structures which communicate with the water circulating system of the engine D, and these structures are arranged at the two air-intake openings in the opposite side walls of the locomotive housing and protected from the exterior by reticulated screens or grids 24.

A ventilating fan 25 is located in position to impel air currents upwardly through a roof vent-opening 26, and an electric motor 27 driven from the generator G is mounted in the top wall of an arched interior housing 28 that forms duplex air flues 28a and 28b. These enclosed air flues are open at their outer sides to the atmosphere while their upper ends merge with the vent opening 26, and they afford ample space within the locomotive housing for passage of attendants. The two series of side louvers 5, 5, in Figure 1 provide for passage of air currents from the louvers at the

front end of the housing in Figure 2, through the oil-cooling apparatus, and thence through the front interior portion of the locomotive.

In Figure 5 the transmission of power from the engine D, through its shaft 29 and flexible shaft couplings 29 is shown, to the drive shaft 31 which forms a front extension of the engine shaft; and from this drive shaft power is transmitted, as will be described, to the several driving units of the locomotive. The drive shaft is journaled in bearings B in a gear box 32, and this letter is also employed to indicate other anti-friction bearings, including thrust bearings; while the number 39 is also used to indicate mechanically flexible joints between adjoining shaft sections, and driving units.

The gear box 32, which is embodied in the main frame 19 of the locomotive, is fashioned with compartments for the various rotary parts of the power transmission mechanism, and it is made up in sections that are bolted together to form a closed structure having interior reinforcing ribs or webs fashioned with ports or openings 33 for circulation of lubricating oil. In this manner the intermeshed gears and pinions of the change speed mechanism are sealed within communicating compartments of the gear box 32 to rotate in an oil bath, the oil being constantly circulated while the engine is running.

To provide the two forward speeds, as well as the reverse travel of the locomotive, the drive shaft 31 transmits power to the several rotating parts indicated as L, H, and R, including the three electro-magnetic slip couplings or torque transmitters, and the generator G supplies the preferably direct current for selectively energizing or exciting these slip couplings, of which couplings the outer member or impeller is mechanically revolved without mechanical contact with the enclosed rotatable driven member of the coupling. The required full torque may thus be induced and constantly transmitted through the coupling, regardless of speed, and torsional strains, shocks, or vibrations are eliminated for the reason that they cannot pass through the air gap from the impeller or driving member to the rotor or driven member of the torque transmitter or coupling.

As best seen in Figures 7 and 8 the drive shaft 31 is provided with a rigid head 34 keyed thereon, and the impeller or driving members of the couplings formed by the rotating fields of the three electro-magnetic transmission devices L, H, and R, are rigid with the head and also with the drive shaft 31. These three induction couplings L, H, and R, are of substantially identical construction, although the special dimensions of parts are varied, and the couplings are mounted in spaced but compact relation in an open frame 35 located forward of the closed oil-proof gear box 32. In each coupling magnetic flux is produced in the outer driving member which reacts on the inner driven member to produce the torque that tends to hold the rotating speeds of the two members together, at the same revolutions per minute.

In its mechanical structure each impeller includes an outer cylindrical shell 36, and two circular side plates 37 and 38 bolted to the shell at opposite sides thereof, and the side plate 37 is fashioned with a central annular hub 39. The drive head 34 is bolted to the plate 37 of the L coupling; the side plate 33 of the L coupling is rigidly united by a flanged joint sleeve 40 to the plate 37 of the R coupling; and the side plate

38 of the R coupling is united by another sleeve joint 41 with the side plate 37 of the H coupling. The drive shaft 31, shown as broken away at its ends in Figure 7, is journaled in bearings B at the front of the frame 35 and in thrust bearings B at the rear of the gear box 32, and the two cylindrical, flanged, joint-sleeves 40 and 41 are also mounted in bearings B of the frame 35.

The side plates of the impellers or driving members are bolted to their respective shells, and the flanged joint-sleeves 40 and 41 are bolted rigidly through attaching flanges to the adjoining plates of the impellers.

The armatures, which form the inner rotors or driven members of the three induction couplings L, H, and R, each includes a spider frame 42 having usual arms or spokes of the squirrel cage type, and a central hub 43 mounted by anti-friction bearings B on the hub 39 of its complementary enclosing impeller or driving member. These hugs 43 of the rotors are each mounted on and keyed to the forward ends of three tubular driven shafts 44, 45, and 46, concentrically arranged and loose on the drive shaft 31.

These tubular driven shafts are of varying length, their forward ends terminating within the couplings, and their rear ends terminating within the gear box 32 where bearings B are provided for them. As best shown in Figure 7 the longest, low speed driven shaft 44 has keyed thereon a low speed gear 47; the reverse, intermediate tubular driven shaft 45 has a reverse gear 48 keyed on its enlarged rear end within the box 32; and the short, outer, tubular driven shaft 46 has a high speed gear 49 keyed on its enlarged rear end; the three driven gears being enclosed within the gear box 32.

Each impeller or driving member of a coupling is revolved mechanically by power from the drive shaft 31 to produce a revolving or rotating field, and this driving member is equipped with proper electrical devices including salient polyphase poles 50, of the rotating field type, and mounted at the inner periphery of the outer cylindrical shell 36, between side plates 37 and 38, as by screws or bolts 51, or in other suitable manner, and these cores and laminated coils are connected by the conductor wires 51a to the commutator rings 52 carried by the impeller, and mounted as here shown at the right or front side of each of the several impellers.

The complementary stationary brushes indicated at 53 are supported in holders 54, and the direct current from the generator G is supplied through the two-wire circuits L, R, and H, in Figures 7 and 9, to the brush of a selected coupling for energizing or exciting the field and producing the magnetic torque between the two members of a selected coupling.

The spiders or squirrel cage rotors 42 supported on their concentric tubular driven shafts 44, 45, and 46 and journaled to revolve with relation to the drive shaft 31, are fashioned with circumferentially spaced arcuate rim-sections 55 upon which are rigidly mounted the magnetic coils or poles 56, suitable fastening means, as screws or bolts 57, being employed in mounting the poles. Each rotor is mounted to rotate within an impeller, the proper clearance or air-gap between the driving member and the driven member being provided to induce flow of magnetic flux when the poles of a selected impeller are energized to effect the torque between the driving and driven member, of the selected coupling.

It will be apparent that the three electro-

magnetic couplings are independent of one another in receiving energizing electric current from the generator, and in performing their functions as torque transmitters. The operating speeds of the couplings as shown are the same for all full speeds, but the speeds may be varied by the controller regulating the induction current as desired. The number of poles employed in the respective couplings are the same, and each coupling is designed to render maximum electrical performance to set up the necessary torque between an impeller and its rotor when the coupling is energized with current from the generator G. While the capacity of the couplings is the same they may vary in use, and the electrical energy supplied to each coupling when its impeller is energized from the generator is of ample capacity to produce the maximum torque as transmitted by the engine for inducing the selected rotor of the selected coupling to revolve with its complementary impeller, and at the desired speed.

In Figure 9 the electric control lever 18 cooperates with a selected one of the three adjustable resistance segments H, L, and R, of the rheostat contained in the control cabinet 17, and indicated in Figure 5 as within easy reach of the engineer occupying the seat 16.

Under control of the lever 18 the L coupling may be operated for first or low forward speed within a range up to an approximate maximum locomotive speed of fifty miles per hour; while the locomotive may attain a high speed forward ranging between fifty to one hundred miles per hour when the H coupling, under control of the lever 18 becomes effective. Under control of the lever 18 and through the adjustable resistance of the rheostat the effective capacity of an operating coupling may be increased or decreased resulting in an acceleration or in a deceleration of the locomotive speed, as power is transmitted through a selected driven shaft and the transmission gearing (to be described) to the rotary mechanical driving units of the locomotive by way of the propulsion shaft. In changing from first to low speed to second or high speed of the locomotive, the transmission gearing will take the load only when the first speed has reached its maximum, and then the second or high speed may continue to accelerate up to the maximum high speed of the locomotive; or an intermediate speed of the locomotive may be achieved within the range of either the low speed limits or of the high speed limits of the locomotive through the use of the adjustable rheostat in the electrical equipment.

By shifting the lever 18 from first speed L to second speed H forward the effectiveness of the L coupling is of course cut off as the H coupling now becomes effective; and vice versa, the H coupling becomes ineffective when the lever 18 is shifted to first or L position to energize and operate the L coupling.

To reverse the transmission of power through the driving units and reverse the direction of movement of the locomotive with a speed range up to approximately thirty miles per hour, the lever 18 is shifted from neutral position N, or from either the H position or the L position, to the R position, thus rendering effective the R coupling.

If the application of power or torque is shifted from the L coupling to the R coupling, under control of lever 18, it will be seen that the forward speed of the locomotive is decelerated as the

torque of the slip coupling R tends to act as a brake in the transmission mechanism, and, if desirable, the forwardly moving locomotive may thus be controlled, brought to a stop, or operated in reverse direction, as required. Or, when the locomotive is descending a grade, either the L coupling or the H coupling may be cut out and the R coupling then energized, thus controlling the speed of the locomotive through the torque of the reversing coupling R without either partial or full recourse to use of the air brake system of the locomotive, or the air brake system of the train that is being hauled by the locomotive.

In other instances, the action of the reversing coupling R may be combined with the action of the air brake system of the locomotive, or the air brake system of the train of cars being hauled by the locomotive.

Normally, in transmitting power from the drive shaft 31 to the three tubular driven shafts, the power is transmitted from the energized impeller of a selected coupling to its enclosed rotor or armature with a difference in speed, which difference varies as the energizing current varies under control movement of the rheostat lever 18. The mechanically revolved multi-impeller is constantly rotating with the engine shaft 19 and its drive shaft 31 while the engine is running. When a selected impeller is electrically energized and its enclosed complementary rotor is thereby magnetized or activated, the rotor is gradually brought up to speed by flow of magnetic flux between the impeller and its rotor, and as the rotor thus comes up to speed, although the relative rotary motion between the impeller and the rotor decreases, the speeds of the driving and driven members do not synchronize, and there is a slip between the two members of approximately three to five per cent at full speed.

In order to assure a smooth start and pick-up in speed of the locomotive, the voltage or direct current from the generator G is reduced preferably by the use of the inserted arcuate contacts for the resistances indicated in the rheostat of Figure 9.

In Figure 5 it will be seen that rotary motion is transmitted from the drive shaft 31 through the couplings L, R, and H, and their respective driven shafts 44, 45, and 46, thence through the spur gears 47, 48, and 49, with different ratios, and intermediate gears to the propulsion shaft 53 that is horizontally disposed below the engine and drive shafts, with its forward end journaled in bearings in the gear box 32, and its rear portion also journaled in bearings B in the main frame 10 of the locomotive.

In Figures 5 and 6 it will be seen that the low speed gear 47 meshes with a complementary gear 59 on the propulsion shaft 53, and the high speed gear 49 meshes with the smaller gear 60 on the propulsion shaft 58. These two gears 59 and 60 run loosely in one direction on the propulsion shaft, and an overrunning clutch is provided for each gear so that they each revolve the propulsion shaft for forward drive, but only one of them will run freely when the L or H gearing is employed.

In the enlarged Figs. 3 and 4 one of these duplicate clutches is shown with a bearing bushing 61 keyed on the propulsion shaft, and an annular series of cam rollers 62 surrounds the bushing with the rollers retained in cam grooves 63 in the bore of the hub of the spur gear.

In Figs. 5 and 9 a spur gear 64 is keyed on the propulsion shaft 58, and reverse drive of the

locomotive is transmitted from the reverse gear 48 of a tubular drive shaft through a reversing unit to this gear 64. The reversing unit is indicated as a whole by the letter R in Figures 9 and 10, and it is mounted in a casing 65 forming one of the compartments of the box 32. This unit includes spaced gears 66 and 67 which respectively mesh with gears 64 on the propulsion shaft and 48 on the driven tubular shaft of the reverse drive. Gear 66 is loosely mounted on the reversing shaft 68, and gear 67 is keyed on the reverse shaft. The loose gear 66 is rigidly bolted to a multi-disk friction clutch-casing 69 so that the gear 66 and its attached clutch 69 are normally loosely journaled on the reverse shaft. The clutch and its gear are pneumatically operated to engage with and rotate with the reverse shaft under control of the electric control lever 18 through the use of a shunt circuit connected with the reverse R circuit, and a solenoid or electric motor 70 opens the air valve 71 in an air pipe 72 when the lever 18 is turned to R position in Figure 9. The air pipe is connected with the air brake system of the locomotive, or to the compressor C in Figure 1 at the rear of the engine D. The air pipe 72 is connected with an air chamber at the left end of the clutch unit and this chamber communicates with the interior of the clutch through air-ducts in the reverse shaft, to supply air under pressure to cause engagement of the clutch and thus render operative the reversing mechanism. This reversing unit also renders the R rotor inactive when the L or the H forward speeds are in use.

The four mechanical driving units in Figure 1 each receives power from the propulsion shaft 58, and as each driving unit is similar in construction and operation a description of one unit will suffice for the four units. As best seen in Figures 5 and 6 each driving unit includes a bevel drive gear 73 on the propulsion shaft, which gear meshes with a complementary pinion 74 on a transversely extending jackshaft 75 journaled in bearings in the gear box 76, which is rigidly fixed with the main frame 10 of the locomotive. A spur gear 77 on the jackshaft meshes with the gear 78 that is keyed on a tubular axle 79 that surrounds the solid axle 9 on which the two traction wheels or drive wheels 8 and 8' are rigidly mounted.

The power wheel 8 of the pair of traction wheels of each driving unit is connected with the tubular driving axle 79 by a flexible joint that includes a drive hub 80 rigidly mounted on one end of the tubular axle opposite the gear 78, which hub is fashioned with two diametrically arranged radial bearing lugs 81 having seats for solid cylindrical joint pins 82. As here shown four of these pivot pins are mounted in an open center annular plate or flat ring 83 which is fashioned with four pairs of opposed sockets to receive the ends of the pivot pins, and these pins bridge the space across complementary holes 84 in the flat driving ring or plate.

The power wheel 8 of each driving unit is fashioned with two diametrically arranged integral bearing lugs 85 having semicircular seats for two of the pins, and cap plates are bolted to these lugs to insure stable and substantial joints between the annular bearing plate and the power wheel. In connection with the springs 11 of the journal boxes, the flexible joints between sections of the propulsion shaft, the oversize driving tubular axle that surrounds the solid axle 9, and the flexible joints between the tubular drive axle and

the power wheel 8, all provide for and absorb relative angular movement of parts when the locomotive is operating full power at any speed on the rails, as well as when passing over irregularities in the railroad track that might cause vertical movement of these parts.

The transmission gearing within the closed gear boxes 32 and its reverse gear compartment 65 run in an oil bath supplied from the reservoir 86 at the front of the locomotive, and the oil pump 87 in the reservoir supplies the lubricant through pipe 88. The oil circulates through the various compartments and ports 32' in the interior of the boxes, and the circulating oil is returned through pipe 89, which communicates with the bottom portion of the gear box, by the suction side of another pump 90 which forces the oil through pipe 91 into a radiator 92, from whence it is discharged into the tank or reservoir 86. These two pumps 87 and 90, and also a rotary fan 93, are operated by power taken off the forward end of the drive shaft 34, and the three appliances operate when the engine is running.

In addition to supplying a circulating lubricant for the transmission gears, the circulating oil transfers heat from the gears and boxes, and the fan and radiator assist in cooling the oil thereby enhancing the cooling and ventilating systems of the engine in eliminating excess heat from within the interior of the locomotive housing. Excess heating of the electro-magnetic couplings is thus materially reduced by the lowered temperature of the interior of the locomotive, due to the cooling of the engine and gearing, and also to the use of the fan 93 which causes air currents that ventilate the couplings.

Air currents are also created by the rotary movements of the multi-impeller and the rotor of an energized coupling which aid in carrying off heat produced in the selected, effective, coupling. Thus the tendency toward excess heating of the parts of a selected coupling, due to slip, when operating with the overrunning clutches in the forward direction in the low and high speeds, and the friction clutch in reverse direction, is reduced to a point where the efficiency of the selected energized coupling is maintained at its maximum. Due to the constant rotation of the multi-impeller unit while the engine is running, and the use of the open slotted, supporting frame in which the couplings are journaled, the three couplings are ventilated before the selected coupling is energized, and after the selected coupling is energized and effective this venting action of the three-impeller unit continues.

In starting the locomotive when the L-coupling of the rotating impeller unit is energized, the slip is high, and the load requires a great acceleration torque for starting and pick-up, the impeller unit is already operating in the nature of a forced draft to vent the L coupling and the spaces adjacent thereto.

Thus during the starting and accelerating periods while the slip is high the energized variable speed coupling accelerates the load quickly and the rotating multi-impeller unit dissipates the created heat as the required torque is developed in the selected energized coupling. Due to this prevention of excess heating in the slip couplings they are maintained in condition to perform their functions with great efficiency, as high as ninety-five to ninety-eight per cent; while on the other hand the efficiency of electric generators with required traction motors, and

other necessary equipment now in use attains only from sixty to seventy per cent in efficiency, and on hard, slow hauls of the generator-motor type of electric locomotive this efficiency is rapidly and materially reduced, due to the excess heat generated. The heat thus created in the generator-motor type of locomotive must be dissipated in the interest of efficiency and for this purpose valuable power is required and consumed, as for instance in operating venting fans, thereby decreasing the power that should be applied to the driving units of the locomotive.

As is well known in the operation of locomotives equipped with traction or driving units equipped with electric motors, especially when ascending steep grades and when hauling or pulling heavy loads, the speed of the drive wheels of the locomotive decreases in revolutions per minute, and the motor-temperature rise thereby increases to the point that limits the capacity of the locomotive. The excessive heat thus quickly generated frequently burns out the motor, and induces rapid deterioration of other parts of the electrical equipment of the locomotive.

In the absence of electric motors, and by the use of the electromagnetic torque couplings in the electromechanical locomotive of the type herein described, these noted objectionable conditions are eliminated.

While I have illustrated a conventional two cycle internal combustion engine in the drawings and omitted the details of construction and operation of the engine, I preferably employ an upright engine of the reciprocating type, and for enhanced maneuverability of the locomotive thus equipped the engine may be of the reversible type.

For main line service a locomotive of this illustrated type is required to possess a capacity of not less than two thousand to three thousand horse power. Under present demands in the main line service of railways a capacity of six thousand horse power, or more, is frequently necessary.

To meet such demands two locomotives are coupled together, as at 15' in Figure 13, so that they may travel in either direction. For convenience the locomotives are indicated by the arrow as traveling toward the right, and the rear locomotive will be coupled to a train of cars at 15. The use of the two flexible vestibules interposed between the back-to-back locomotives provides passageway for the crews, and communication for other purposes, as for instance installation of the automatically coupled contacts between the electrical systems of the two locomotives, and also between three or more locomotive units when coupled together.

The rear locomotive, which is shown as traveling backward, is provided with a reversible prime mover or Diesel type engine D', and, while this engine D' and its drive shaft 29' are operating in reverse, the drive shaft 29' of course is turning in the same direction as the drive shaft 29, and the power transmitted from both drive shafts operates both propulsion shafts 58 and 58' and both locomotives in the same direction.

Inasmuch as the engine D' is reversible, the reversing unit R and its accessories in the leading locomotive are dispensed with in the equipment of the rear locomotive.

In the electrical equipment of both the locomotives, the generators G and G' are reversible, and the generator G' is operating with the same rotary movement and generating the same elec-

trical currents as that of the generator G of the leading locomotive. These two generators may be coupled together as indicated in Figure 14, or they may be operated separately, it being understood that provision is made for reversing the generators, so that generator G' may operate in reverse while the two locomotives are coupled in Figure 13.

Both locomotives are operable under single control, when detached, the leading locomotive by lever 18 and rheostat 17; and the rear locomotive by its lever 18' and rheostat 17' in connection with the low speed coupling L and the high speed coupling H. When coupled in tandem relation both locomotives are under multiple electrical control from the engineer's station in either locomotive depending upon which is the leading locomotive.

In Figure 14 the low speed electromagnetic slip coupling or torque coupling L, and the high speed coupling H are shown, and the outer or impelling members of these couplings are mechanically revolving as a unit from the driving shaft 29'. A selected coupling is energized by current from the generator G' under control of the lever 18', or under multiple control from either lever 18 or 18' depending upon which locomotive is leading.

Through the instrumentality of the tubular concentric driven shafts and their gears the propulsion shaft 58' is rotated; gears 47' and 59' for low speed, and gears 49' and 60' for high speed, transmitting power from the tubular drive shafts to the propulsion shaft.

If and when a third locomotive unit is coupled between the two locomotives, the intermediate unit is usually equipped with a vestibule at each of its opposite ends, to maintain continuity in the streamlining effect as well as for passageway between adjoining locomotives, for multiple connecting systems, and other purposes, and all of the locomotive units are under multiple control from the leading locomotive, i. e. either one of the outer locomotive units. Under such arrangements it will be apparent that the use of a turntable, or other means for turning around a locomotive, or for turning a number of coupled locomotive units, is dispensed with.

Various other changes, modifications, and alterations may be made in the installations of my invention, for instance, for light work, or for speeds lower than approximately fifty to sixty miles per hour, the various high speed accessories designated as H, including the electromagnetic slip coupling and its electric controls may be dispensed with in order to simplify construction and to reduce the cost of manufacture and maintenance in operating rail-cars, buses, and similar vehicles.

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

1. In an electromechanical coupling unit for transmitting power and including a plurality of spaced impellers, the combination with a drive shaft having a driving head rigid with one of the impellers and detachable joints rigidly uniting adjoining impellers, a plurality of driven tubular shafts concentric with the drive shaft, a rotor rigid with each driven shaft, and selective electrical means for energizing a selected coupling.

2. In an electromechanical power transmitting mechanism including a central drive shaft and concentric tubular driven shafts, the combina-

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tion of a plurality of laterally spaced impellers, a drive-head rigid with the drive shaft and bolted to an end impeller, flanged joint-sleeves between and bolted to adjoining impellers, a complementary rotor rigid with each driven shaft, and electrical control means for energizing a selected impeller.

3. In an electromechanical power transmitting mechanism including a central drive shaft and concentric tubular driven shafts, the combination of a plurality of spaced impellers, a flanged drive head on the drive shaft, an end impeller bolted to said head, said impellers including a cylindrical shell and open side plates, joint-sleeves between adjoining impellers forming hubs on a tubular driven shaft, said sleeves having attaching flanges bolted to adjoining side plates, a complementary rotor rigid with each driven shaft, and electrical control means for energizing a selected impeller.

4. In an electromechanical power transmitting mechanism including a supporting frame, a central drive shaft journaled in the frame and concentric tubular driven shafts journaled on the drive shaft, an end head on the drive shaft and an end impeller detachably united with said head, a plurality of spaced impellers, detachable hubs

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uniting adjoining impellers and mounted on the tubular shafts, bearings mounted in the frame and supporting said hubs, a complementary rotor rigid with each driven shaft, and electrical control means for energizing the impellers selectively.

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