United States Patent

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[33] **Switzerland**
[31] **4461/62**

[54] **DUAL HYDRAULIC TRANSMISSION DIESEL LOCOMOTIVE**
3 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **105/96.2,** 74/665, 74/720.5, 105/98, 105/99, 105/130, 105/133, 105/199
[51] **Int. Cl.** **B61c 5/00,** B61c 9/14, B61c 9/26
[50] **Field of Search** .... 105/96.2, 62, 130, 108; 74/720(S), 665(IV); 105/62, 96.2, 98, 99, 133, 108, 130, 199; 74/720.5

[56] **References Cited**

UNITED STATES PATENTS

2,715,876	8/1955	Schneider.....................	105/96.2X
2,779,212	1/1957	Fell	105/96.2X
3,019,742	2/1962	Kershaw.......................	105/96.2
1,776,480	9/1930	Rayburn.......................	105/99X
2,918,830	12/1959	O'Leary	74/720.5

FOREIGN PATENTS

1,251,261	11/1959	France	105/96.2

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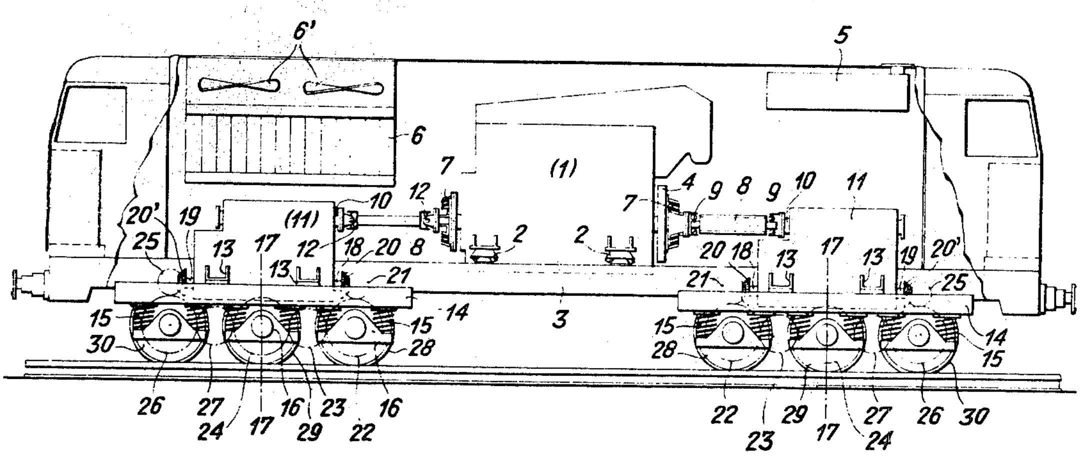
ABSTRACT: A locomotive having a bridging girder supported on spaced driving trucks and having a diesel engine on the bridging girder between the trucks with a power takeoff at each end connected to an hydraulic transmission for driving the respective truck.



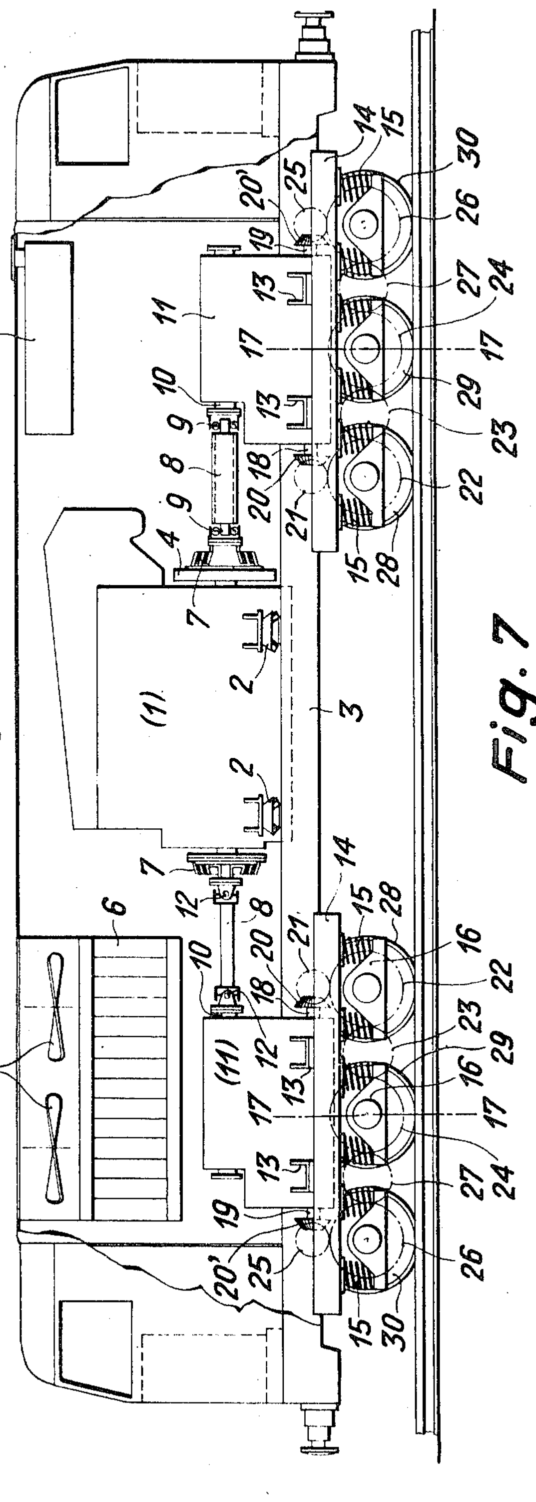


Fig. 1

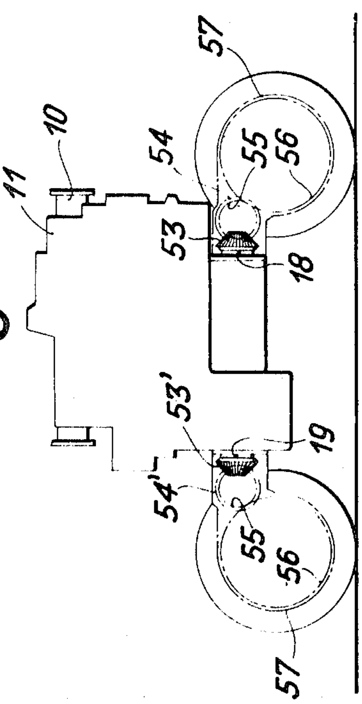


Fig. 7

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Fig. 2

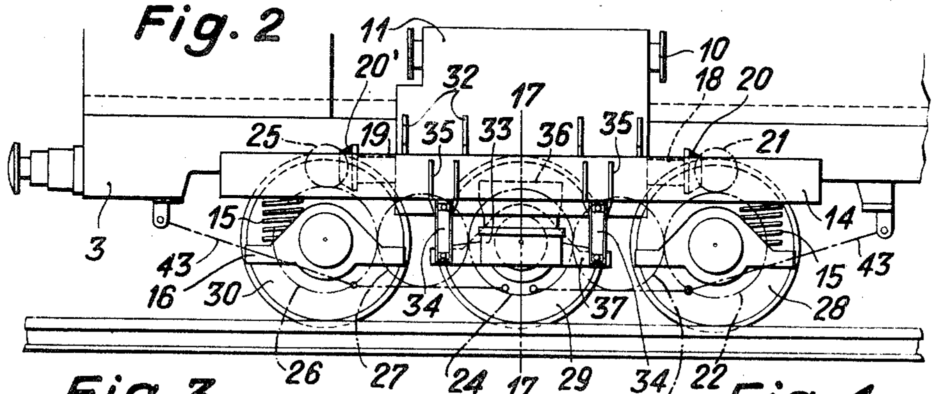


Fig. 3

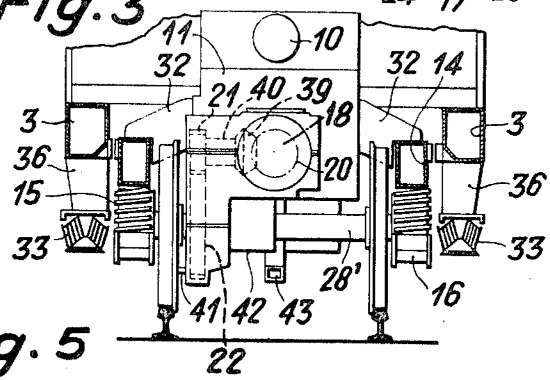


Fig. 4

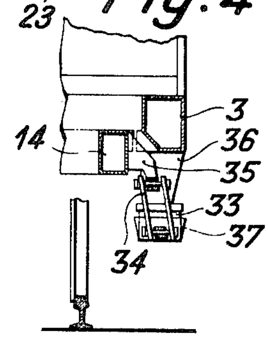
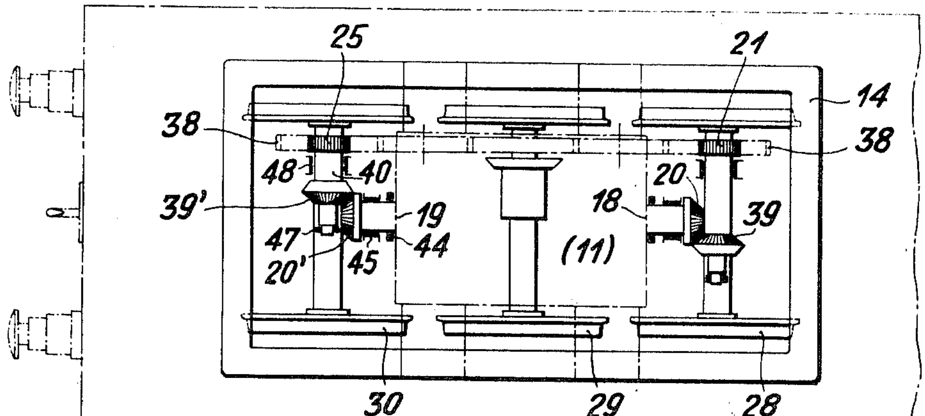


Fig. 5



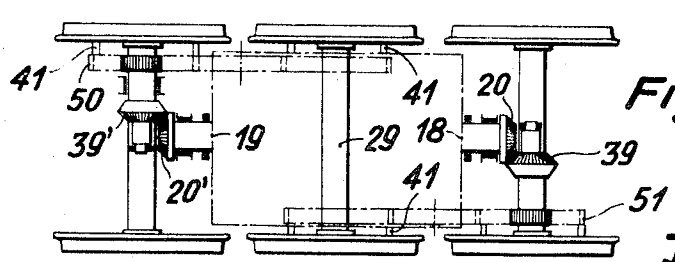


Fig. 6

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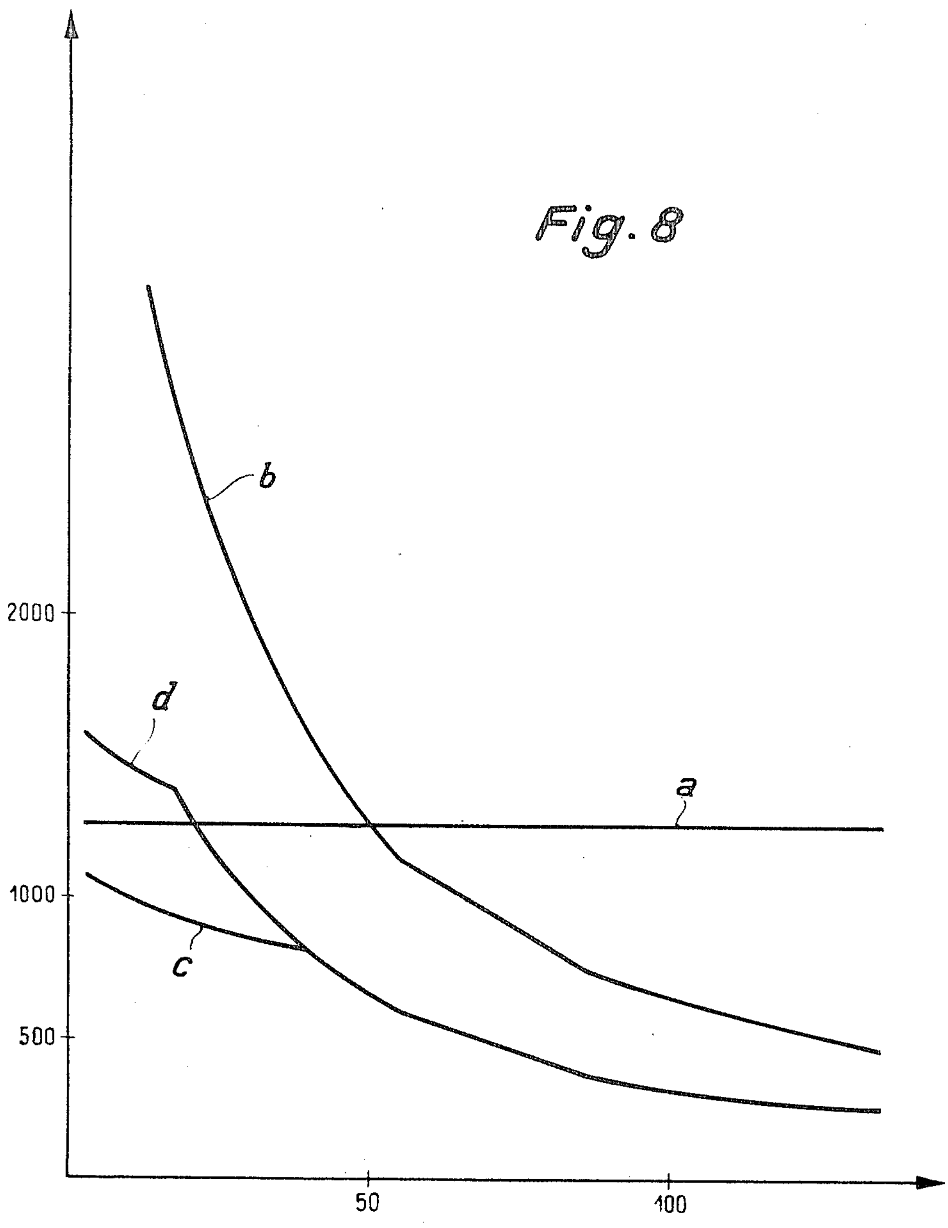
Fig. 8



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DUAL HYDRAULIC TRANSMISSION DIESEL LOCOMOTIVE

HEAVY DIESEL LOCOMOTIVE

This invention relates to a heavy diesel locomotive having two trucks and a diesel engine supported on the locomotive frame between the two trucks. The invention provides a diesel locomotive of this type in which a diesel engine, disposed with its crankshaft parallel to the longitudinal axis of the locomotive and hence parallel to the direction of locomotive travel, has its crankshaft coupled to the input shaft of a hydraulic transmission unit, this input shaft being also parallel to the direction of locomotive travel, and in which the transmission unit includes two output shafts, also parallel to the direction of locomotive travel, which are coupled by separate bevel gear drives to spur gear drive trains leading to the locomotive wheels.

In known heavy diesel locomotives of 1,000 hp. and up it has been customary in the past to use two diesel engines. Each of these has been provided with a separate hydraulic drive, the further speed change drives and in some cases the reversing gear being frequently disposed with the hydraulic drive in a housing within the locomotive frame and supported thereon. The power delivery from this unit is effected in turn by means of various articulated shaft or universal joint arrangements coupled to the spur gear drives which drive the locomotive driving axles.

The articulated shafts employed in such a construction require a certain space longitudinally of the locomotive, and this requirement has set a lower limit to the overall locomotive length. Consequently, with such a construction one soon approaches the limit of axle loading, by reason of the necessary longitudinal dimensions. In accordance with the present invention instead, by employing a single diesel engine taking advantage of the full longitudinal profile of the locomotive and having its crankshaft parallel to the direction of vehicle motion, and with the aid of the couplings from the engine to the transmission unit and from the latter to the locomotive axles presently to be described, it is possible to construct diesel locomotives of power ratings up to some 5,000 hp., with substantially shorter overall length.

It has been proposed heretofore to couple a locomotive diesel engine disposed parallel to the longitudinal axis of the locomotive (i.e. with the crankshaft of the diesel engine so disposed) with a preponderantly hydraulic drive transmission unit mounted in a housing on a locomotive truck and having input and output shafts transverse of the direction of locomotive travel. By the term "preponderantly hydraulic drive transmission unit" is meant a drive of known type, which may comprise for example two hydraulic torque converters, a hydraulic coupling, necessary speed change gears and, optionally, a reversing gear mechanism. Such a device will hereinafter be referred to as a hydraulic drive unit. Proposals of this kind, not yet published in the literature, provide an output from the hydraulic drive unit which is coupled to the locomotive axle gears without articulated shafts. Such a construction has the advantage that because of the small spacing of the wheels the trucks can be substantially shorter, without exceeding the permissible axle loadings even with high-power units.

This arrangement has however the disadvantage that the torque of the diesel engine which is delivered first to an articulated shaft must then be delivered to the input shaft of the hydraulic drive unit through bevel gears, since this input shaft is transverse to the longitudinal axis of the locomotive. The diesel engine torque, which is kept constant or nearly so at all locomotive speeds, must thus be transferred to the hydraulic drive unit through such a system of bevel gears. This entails heavy loading of this bevel gear drive and results in difficulties since the stresses to be transmitted approach the limit of what can be handled by a bevel gear drive. That is to say, it is difficult to effect continuous delivery of such heavy torques through a bevel gear coupling of this kind under all operating conditions. Moreover although it is relatively simple, in the case of such a unit disposed transversely of the longitudinal locomotive axis, to provide coupling from the power output of such a unit to a single pair of driving axles in a truck by means of a simple spur gear drive, when three driving axles are provided in each truck such an arrangement results in a complicated gearing mechanism including an undesirably large number of pinions.

According to the invention these disadvantages are surmounted by coupling one end of the longitudinally oriented crankshaft of the longitudinally disposed diesel engine via a coupling shaft with an input shaft of a hydraulic drive unit, this input shaft being likewise disposed longitudinally of locomotive, and further by coupling the other end of the diesel engine crankshaft via a further coupling shaft with the longitudinally disposed input shaft of an additional hydraulic drive unit, each of these coupling shafts including at least one elastic coupling, each of the hydraulic drive units having moreover two output shafts parallel to the longitudinal axis of the locomotive, and each of these two output shafts being coupled through a separate bevel gear drive to spur gears of the driving axles.

In another embodiment it is advantageous to dispose each of the two hydraulic drive units in the middle of a separate one of the trucks. This makes it possible to concentrate the weight of the hydraulic drive units over the center of the trucks. This produces a uniform loading of the truck axles and consequently an essentially equal utilization of the adhesion of the various locomotive wheels.

In a preferred embodiment each of the hydraulic drive units may be borne with its related bevel and spur gear drives in one of the trucks. In this way it may be achieved that the drive elements of each truck remain in fixed relative position and that the transmission of the rotational moment from the intermediate spur gears to the drive axles is effected substantially by universally yielding resilient drives. With this construction the masses fixed with reference to the drive axles are small, as is desirable, the masses associated with supply of torques to those axles being supported in the trucks.

Moreover it is not necessary that the shafts which couple the diesel engine with the hydraulic transmission units be jointed or articulated. Rather they may be shafts provided with two elastic couplings permitting angular and lateral displacements of the ends of those shafts.

If the two outputs of the primarily hydraulic transmission unit are constituted by a common delivery shaft, the latter may then have built into it an elastic intermediate element. In this way an undesired mutual influence via the spur gear drive on the forces delivered to the two outputs is avoided.

The invention will now be further described with reference to the accompanying drawings in which:

FIG. 1 is a longitudinal sectional view through a locomotive according to the invention;

FIG. 2 is a side elevation of one of the trucks of the locomotive of FIG. 1;

FIG. 3 is a transverse end view of the truck of FIG. 2;

FIG. 4 is a detailed view of part of the structure of FIG. 3;

FIG. 5 is a partial plan view of the truck of FIG. 2;

FIG. 6 is a partial plan view of another embodiment of the truck of the locomotive of the invention;

FIG. 7 is a view in side elevation of a hydraulic drive unit having spur gear drive as employed in a truck having two driving axles; and

FIG. 8 is a diagram useful in explaining the operation of the invention.

In FIG. 1 the diesel engine for driving the locomotive is schematically indicated at 1, where it is shown as being of the supercharged-type. It is supported on elastic mountings 2 from the frame or bridge girder 3 of the locomotive. The crankshaft of the engine is parallel to the longitudinal axis of the locomotive and has a flywheel 4 affixed at one end thereof. The crankshaft is moreover provided with means for delivery of power at each end. Reference character 5 indicates the muffler and reference character 6 indicates the radiator for dissipation of heat from the engine cooling water. Fans therefor are indicated at 6'. Other customary elements of a diesel engine installation have been omitted from the drawing as unnecessary. At each end of the engine crankshaft there is provided an elastic coupling or power takeoff 7 which connects through a shaft 8 provided with universal joints to the input shaft 10 of a hydraulic drive unit 11, one such unit being provided at each end of the engine, for each truck of the locomotive. The two hydraulic drive units or transmissions 11 both face in the same direction. In this connection it is immaterial whether the universal joints are of the crossarm or balltype as shown respectively at 12 and at 9, at the left- and right-hand sides of the engine 1 in FIG. 1.

According to another embodiment of the invention there may be employed, in place of the shafts 8 with universal joints, shafts having two elastic couplings provided to accommodate axial and lateral misalignments.

The hydraulic drive units 11, shown in outline only, contain each one or more hydraulic torque converters, the necessary associated gearing, and optionally a hydraulic coupling and a reversing gear of the toothed wheel type. The particular construction of the transmission unit 11 is not of the essence of the present invention and it may comprise other and different components from those just recited, for example three torque converters in place of the two converters and one coupling just mentioned.

The drive units 11 are supported at mountings 13 from the truck frames 14. For each truck, the frame 14 thereof rests via springs 15 on the drive axle journal boxes 16 of that truck. The coupling between the locomotive frame 3 and the truck frames 14 is not shown in detail in FIG. 1. It can be carried out in conventional manner. The line 17–17 indicates for each truck the axis of rotation thereof with respect to the remainder of the locomotive.

The output of the transmission unit 11, parallel to the direction of locomotive travel, comprises shafts 18 and 19 extending from sides of the transmission facing lengthwise of the locomotive and bearing output bevel gears 20 and 20'. Each of these meshes with a second bevel gear (not shown in FIG. 1) mounted on a shaft oriented transversely to the direction of locomotive travel. These transverse shafts carry pinions 21 and 25 which mesh respectively with spur gears 22 and 26 on the end axles of the six wheel trucks shown in FIG. 1. The spur gear 22 meshes with a pinion 23 which in turn meshes with a spur gear 24 on the middle locomotive axle of the truck. A pinion 27 is in mesh with the axle spur gears 26 and 24. The gears 21—27 constitute a spur gear train. Since this gear train forms a closed circuit into which drive can be communicated from either end of the transmission unit 11 via outputs 18 and 19, an elastic element can, of course, be included in this gear train. If the inputs and outputs 18 and 19 of the drive unit 11 are on a common shaft, it is convenient to include an elastic element in that shaft.

In the embodiment according to FIG. 1, the drive units 11, the bevel gear drives connecting to their outputs 18, 19 and the spur gear trains 21—27 are as to each unit 11 borne in the frame 14 of a separate one of the trucks. The transmission of the torque from the gear trains 21—27 to the locomotive wheels 28, 29 and 30 is effected by means of universally compliant spring couplings not shown in FIG. 1.

FIGS. 2 to 5 illustrate further details of the embodiment of the invention of FIG. 1. FIG. 2 shows fragmentarily the springs 15 by means of which the driving axles are supported and fixed beneath the truck. The drive units 11 are shown in FIGS. 2, 3 and 5 as being supported from the truck frames 14 by means of support members 32. The locomotive frame 3 rests via struts 36 on springs 33, which in turn are supported on coupling pieces 37 which rest on hangers 34, depending from struts 35 affixed to the truck frames 14. (see FIG. 4.) This support of the locomotive frame from the truck frames is so arranged that a differential rotation can occur about the axis 17–17 between each truck and the locomotive frame.

FIG. 3 shows in elevation the bevel gear 20 on the output shaft 18 of one transmission unit 11. This bevel gear meshes with a bevel distributor gear 39, on a shaft 40 extending transversely of the direction of locomotive travel. The pinion 21 of the spur gear train 21—27 is affixed to this shaft. Reference character 41 identifies one of the universally compliant spring couplings, schematically shown, by means of which the torque is communicated from the gear train 21—27 to the locomotive wheels 28—30. The axles 28' to 30' of the drive wheels 28—30 are disposed in hollow shafts so that they can execute differential movements with respect to the truck frames. The hollow shaft for the axle 28' is identified at 42 in FIGS. 3 and 5.

Transmission of the tractive effort from the truck frame 14 to the locomotive frame is effected by means of the tractive effort coupling schematically indicated at 43 (FIG. 2).

In the single-sided drive shown in FIG. 5, the gear train 21—27 collectively indicated by reference character 38 has all of the gear elements thereof on the same side of the truck. The shaft 19 of the transmission unit 11 is supported in bearings 44 and 45 (FIG. 5). This shaft 46 carries a bevel gear 20' which meshes with the bevel distributor gear 39' on the shaft 40, supported in bearings 47 and 48. Shaft 40 also has affixed thereto the gear train pinion 25. The coupling of the torque from the output 18 of unit 11 via the bevel gears 20 and 39 to the pinion 21 is effected in the same manner (FIG. 5). If the torque outputs 18 and 19 of the unit 11 are effected by means of a common shaft, the elastic intermediate element then required is advantageously provided in this shaft.

In the arrangement according to FIG. 6 the torque delivered at the output 19 passes via bevel gears 20' and 39' to the spur gear train indicated by means of the collective reference character 50. The output torque from the output 18 passes via bevel gears 20 and 39 to the gear train 51 which is disposed on the side of the truck opposite that of gear train 50. Gear train 50 provides coupling between the middle and left truck axles in FIG. 6, while gear train 51 provides coupling between the middle and right-hand truck axles in that FIG. In such an arrangement, even if the outputs 18 and 19 of the drive unit 11 take the form of the two ends of a common shaft, no elastic coupling element is required in that common shaft since the function thereof is taken over by the universally compliant spring drives 41 of the middle locomotive axle 29, each coupling the output of one of the gear trains 50 and 51 to axle 29.

FIG. 7 illustrates an embodiment of the invention in which a hydraulic drive unit 11, disposed longitudinally of the locomotive, delivers power at two outputs 18 and 19 to the axles of a four-wheel truck. The two outputs 18 and 19 couple through bevel gears 53, 54 and 53', 54' respectively to separate spur gear trains comprising in each case a pinion 55 and a spur gear 56. Reference character 57 identifies housings enclosing these spur gear trains.

The reduced stressing of the elements achieved by the use of two bevel gear drives at the output of the hydraulic drive unit, as contrasted with that existing in the prior art structure employing a single-bevel gear drive at the input to such a unit is indicated in FIG. 8. In this FIG. the ordinate represents torque whereas the abscissae represent locomotive speed.

Curve *a* shows, for a particular locomotive, the torque output of the diesel engine which is delivered to the hydraulic drive unit provided for coupling the diesel engine to one of the locomotive trucks. It is seen to be substantially independent of speed. The output torque from the hydraulic drive unit is shown at curve *b*. When the hydraulic drive unit has its input shaft transverse to the direction of locomotive travel, as in the prior art, the output torque *a* of the engine is delivered to the drive unit by means of a pair of bevel gears, and the output torque *b* from the drive unit is delivered to the drive gear train of the truck wheels by means of a set of spur gears. When in accordance with the invention instead the hydraulic drive unit has its input shaft parallel to the crankshaft of the diesel engine, the torque *a* of the engine is delivered to the hydraulic drive unit through a shaft coupling not involving bevel gears and the output torque from the hydraulic drive unit appears at two output shafts, also parallel to the long dimension of the locomotive. The torque at each of these output shafts conforms to the curve *c* of FIG. 8, for the case of a locomotive employing four-wheel trucks and it conforms to the curve *d* in the case of a locomotive employing six-wheel trucks. Curve *c* shows that in the case of four-wheel trucks the arrangement according to the invention requires transmission through bevel gears, at the output of the hydraulic drive unit, of a torque which is at all locomotive speeds lower than that (curve *a*) which must be transmitted through bevel gears at the input side of the hydraulic drive unit in the arrangements of the prior art. In the case of a locomotive employing six-wheel trucks, the bevel-gear-transmitted torque at each output of the hydraulic drive unit of the invention is seen to be likewise lower than that involved in the input bevel gear transmission of the prior art under all operating conditions except for the short interval during which the locomotive builds up a speed of some 25 km. per hour when starting from rest.

While the invention has been described herein in terms of a number of preferred embodiments, it is not limited thereto, the scope of the invention being rather set forth in the appended claims.

I claim:

1. A locomotive comprising trucks and a bridge girder connecting said trucks and having an engine mounted thereon, a power takeoff on each end of the engine, a first pair of drive shafts each connecting one of the power takeoffs with an hydraulic transmission carried by the locomotive, and a second pair of drive shafts each connecting one hydraulic transmission with a distributor gear on a truck whereby power from the engine is transmitted to the trucks to drive said locomotive, the second pair of drive shafts being connected to sides of the hydraulic transmissions, which sides both face in the same direction lengthwise of the locomotive, said hydraulic transmissions facing in the same direction lengthwise of the locomotive.

2. A diesel locomotive comprising a frame, two three-axle, six-wheeled trucks supporting said frame, a diesel engine supported in said frame with its crankshaft disposed longitudinally of said frame, a separate hydraulic drive unit supported in each of said trucks, an input shaft and two output shafts in each of said drive units, said input and output shafts being disposed longitudinally of said frame, a separate flexible coupling means coupled between said crankshaft and the input shaft to each of said drive units, a first gear train including a beveled gear attached to each of said output shafts, a second beveled gear meshing with one of each of said first beveled gears, a shaft extending transversely of said crankshaft securely attached to each of said second beveled gears, and pinion gears carried by each transverse shaft, a second gear train comprising spur gears coupled to each of said axles and idle gears positioned between the spur gears and meshing therewith, said respective gear trains so arranged that said pinion gears mesh with said spur gears, and a flexible coupling between each spur gear and said truck wheels.

3. A diesel locomotive comprising a frame, two three-axle, six-wheeled trucks supporting said frame, a diesel engine supported in said frame with its crankshaft disposed longitudinally of said frame, a separate hydraulic drive unit supported in each of said trucks, an input shaft and two output shafts in each of said drive units, said input and outputs shafts being disposed longitudinally of said frame, an intermediate shaft coupled between said crankshaft and the input shaft to each of said drive units, two universal joints in each of said intermediate shafts, a first gear train including a beveled gear attached to each of said output shafts, a second beveled gear meshing with one of each of said first beveled gears, a shaft extending transversely of said crankshaft securely attached to each of said second beveled gears and pinion gears carried by each transverse shaft, a second gear train comprising spur gears coupled to each of said axles and idle gears, positioned between the spur gears and meshing therewith, said respective gear trains so arranged that said pinion gears mesh with said spur gears, and a flexible coupling between each spur gear and said truck wheels.