

Nov. 2, 1937.

G. B. WARREN

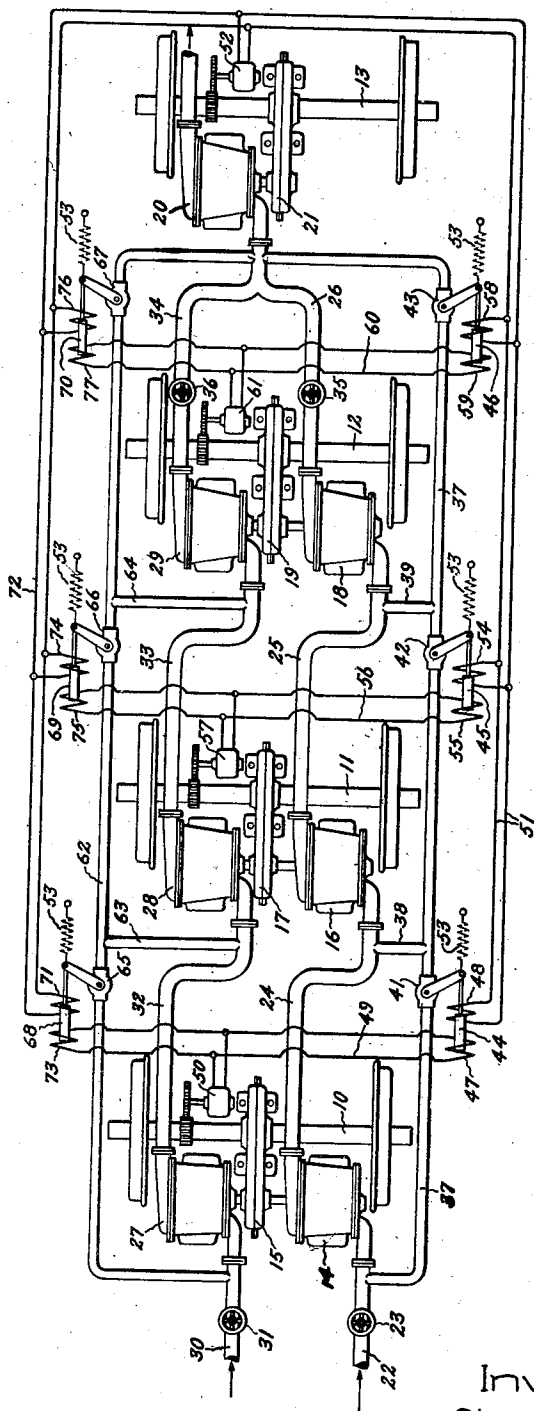
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LOCOMOTIVE TURBINE DRIVE

Filed Sept. 21, 1935

2 Sheets-Sheet 1

Fig. 1.



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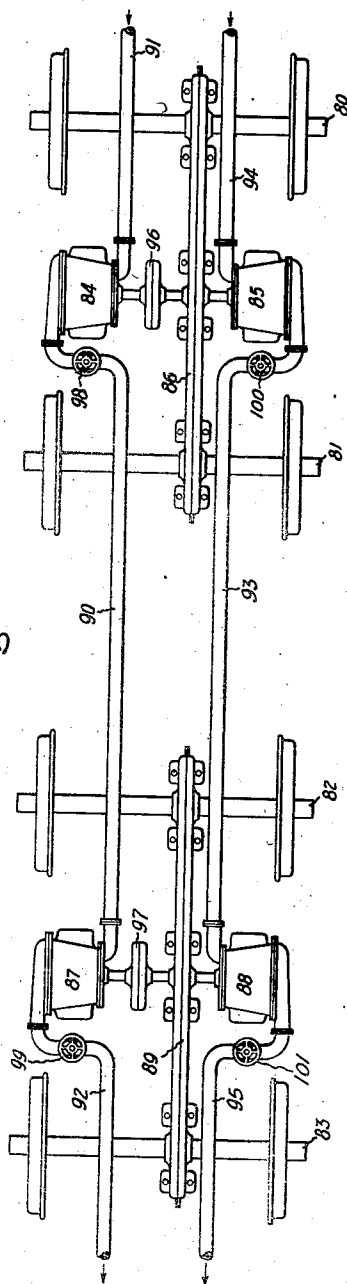
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Fig. 2.



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LOCOMOTIVE TURBINE DRIVE

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New York

Application September 21, 1935, Serial No. 41,625

14 Claims. (Cl. 105—38)

The present invention relates to locomotive turbine drive; that is, to arrangements for driving a locomotive by elastic fluid turbine means. An elastic fluid turbine operates at its best efficiency at a certain speed; hence, the usual locomotive turbine drive for operating a locomotive through the intermediary of gearings between the turbine means and the axles has a low efficiency if the locomotive speed varies considerably, for instance, when a high speed locomotive is often operated at low speed.

The object of the present invention is to provide improved construction and arrangement for locomotive drives whereby a locomotive, more particularly the turbine drive, is operated at comparatively high efficiency. This is accomplished, in accordance with my invention, by the provision of at least two turbines or groups of turbines coupled to the axle or axles of the locomotive, one turbine for operation at high speed and the other turbine for operation at low speed. Preferably, however, I provide, in accordance with my invention, at least two groups of elastic fluid turbines, one group for operation at high speed of the locomotive and the other group for operation at low speed. For example, in the case where a locomotive is run at speeds up to seventy miles an hour, one such group of turbines may be operated at speeds from zero to forty-five miles an hour, and the other group above forty-five miles an hour. Each of the groups includes several turbines. In accordance with a further embodiment of my invention, these turbines are connected in series as regards the flow of elastic fluid therethrough, and each turbine of a group is coupled by speed reducing gearing means, which may be a reversing gearing, to a separate axle of the locomotive. In addition, means are provided for automatically or manually controlling the flow of fluid through each turbine in order to assure equal power of all axles.

For a better understanding of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawings.

In the drawings Fig. 1 illustrates a diagrammatic view of a locomotive turbine drive embodying my invention and Fig. 2 shows a modification according to my invention.

In the present instance, I have shown a locomotive with four drive axles 10, 11, 12 and 13. Two groups of elastic fluid turbines are provided for driving the axles. The first group includes a high pressure turbine 14 coupled to the axle 10

by a gearing 15, an intermediate high pressure turbine 16 coupled to the axle 11 by a gearing 17, an intermediate low pressure turbine 18 coupled to the axle 12 by a gear or gearing 19 and a low pressure turbine 20 for driving the axle 13 through a gearing 21. Elastic fluid is conducted to the high pressure turbine 14 through an inlet conduit 22 including a control valve 23. The turbines 14, 16, 18 and 20 are connected in series, the exhaust elastic fluid of the turbine 14 being conducted to the inlet of the turbine 16 by a conduit 24; the exhaust of the turbine 16 being conducted to the turbine 18 by a conduit 25; and the exhaust of the turbine 18 being conducted to the turbine 20 by a crossover conduit 26. The gearings 15, 17, 19 and 21 may be of any known design and they may include reversing means, such as are disclosed in the application of John H. Doran, Serial No. 30,084, filed July 6, 1935, and assigned to the same assignee as the present application.

The first group of turbines described above may be operated at low locomotive speeds; for instance, from start of the locomotive until speeds of the order of forty-five miles an hour are reached.

At speeds above forty-five miles an hour, the first group is at least partly disconnected or rendered inoperative and a second group is operated. This second group comprises a high pressure turbine 27 coupled to the axle 10 by the same gearing means 15 as the turbine 14. The arrangement may be such that the rotors of both turbines 14 and 27 are provided on the same shaft. A second or intermediate high pressure turbine 28 of the second group is similarly geared by the gearing means 17, and a third or intermediate low pressure turbine 29 of the second group is connected to the axle 12 by the gearing 19. This second group also includes the low pressure turbine 20, the latter being common to both groups, although two low pressure turbines might be provided. The turbines of the second group are also connected in series. Elastic fluid is conducted to the turbine 27 through a conduit 30 including a control valve 31. The exhaust of the turbine 27 is conducted to the turbine 28 by a crossover conduit 32; the exhaust of the turbine 28 is conducted to the turbine 29 by a crossover conduit 33, and the turbine 29 discharges through a conduit 34 into the low pressure turbine 20.

Means are provided for preventing back flow of elastic fluid through the turbines of one group during the operation of the other group. This means in the present instance has been shown as a back flow valve 35 in the conduit 26 between the turbines 18 and 20 and another back flow

valve 36 in the conduit 34 between the turbines 29 and 20. During operation of the first group, the valve 36 prevents back flow into the second group, and during operation of the second group, the valve 35 prevents back flow of elastic fluid into the first group or a part thereof. During operation of one group, the other group runs idle with the exception that the low pressure turbine 20, which is common to both groups and is operated at all speeds. As pointed out above, the back flow valves 35 and 36 prevent the back flow of elastic fluid so that during the operation of one group the other group runs idle at partial vacuum in the turbines. This is desirable in that it reduces considerably the friction losses.

In order to obtain best efficiency, it is important that the torque be uniformly distributed among the different axles to insure uniform speed of all axles in order to prevent slipping of one or more axles. To this end, I provide, in accordance with my invention, means for controlling the flow of elastic fluid through the individual turbines in order to insure uniform speed and hence uniform torque transmission to the different axles. The flow of elastic fluid through the different turbines is controlled by means of by-pass conduits including valve means for each turbine. In the present instance, I have shown a by-pass conduit 37 for the first group of turbines connected between the inlet conduit 22 and the crossover conduit 26, and having branches 38 and 39 connected to the crossover conduits 24 and 25, respectively. The conduit 37 with the branch 38 forms a by-pass with respect to the turbine 14, and the conduit 37 together with the branches 38 and 39 forms a by-pass for the turbine 16. The by-pass of the elastic fluid with respect to the individual turbines is controlled by means of valves 41, 42 and 43, respectively, disposed in the different sections of the conduit 37. No by-pass is provided with respect to the low pressure turbine 20 because the latter is dimensioned so that under normal operating condition with equal speed of all turbines, its torque is smaller than the torques of the other turbines. Hence, no slipping of the axle 13 can take place. If during operation it is found that the axle 10 slips, the operator opens the valve 41, whereby part of the steam conducted to the high pressure turbine 14 is by-passed across this turbine to the intermediate high pressure turbine 16. This reduces the power and hence the speed of the turbine 14 until the axle 10 reaches the speed of the other axle. Similarly, if the axle 11 slips; that is, runs, at higher speed than the other axles, the valve 42 is somewhat opened to by-pass elastic fluid across the turbine 16.

In order to attain best operating conditions, without depending upon the control of the by-pass valves by the operator, means are provided whereby such control is effective automatically. This means, as shown in the present instance, comprises an electromagnet 44 for the valve 41, and other electromagnets 45 and 46, for controlling the valves 42 and 43 respectively. Each electromagnet is energized by two differentially wound coils 47 and 48. The coil 47 is connected by a line 49 to a small electric generator 50 driven from the axle 10. The coil 48 is connected by a line 51 to another electric generator 52 driven by the axle 13. The fluxes produced by the opposing windings 47 and 48 compensate each other as long as the axles 10 and 13 run at equal speed. If, however, the axle 10 slips; that is, runs, at a higher speed than the axle 13, a resultant flux

is produced which pulls the electromagnet 44 towards the left against the biasing force of a spring 53, and thereby causes opening of the valve 41. The arrangement for automatically actuating the valves 42 and 43 is similar to that of the arrangement just described in connection with the valve 41. The electromagnet 45 for the by-pass valve 42 is energized or controlled by two coils, a coil 54 connected to the line 51 and another coil 55 connected by a line 56 to a small generator 57, driven from the axle 11. The electromagnet 46 for the by-pass valve 43 is energized by a coil 58 connected to line 51, and an opposing coil 59 connected by a line 60 to a small generator 51 driven from the axle 12.

Similar means are provided for automatically controlling the by-passing of elastic fluid with respect to the second group of generators. This means includes a bypass conduit 62 connected between the inlet conduit 30 of the turbine 21 and the crossover conduit 34. The conduit 62 has a branch 63 connected to the crossover conduit 32 and another branch 64 connected to the crossover conduit 33. The different sections of the conduit 62 include by-pass valves 65, 66, and 67 for controlling the by-passing of elastic fluid with regard to the turbines 21, 28, and 29, respectively. The by-pass valves are automatically controlled and biased towards closed position by springs 53. The valves are connected to electromagnets 68, 69, and 70, respectively. Each electromagnet is energized by two opposing coils. The electromagnet 68 is energized by a coil 71 connected through a line 72 to the aforementioned generator 52 driven from the axle 13. A coil 73 opposing the coil 71 is connected to the generator 50. The electromagnet 69 for the by-pass valve 66 is energized by a coil 74 connected to the line 72 and an opposing coil 75 connected through the aforementioned line 60 to the generator 57, and the electromagnet 70 is energized by a coil 76 connected to the line 72 and an opposing coil 77 connected by the line 60 to the generator 61 driven from the axle 12. With this arrangement, constant speed of all axles is assured. If at any time, one of the axles begins to speed up; that is, to slip, the by-pass valve of the corresponding turbine is automatically closed, and hence the torque transmitted from such turbine to the axle is reduced.

The arrangement of Fig. 2 comprises four axles 80, 81, 82 and 83. The axles 81, 82 form a first group of axles which group is driven by two turbines, a low speed, high pressure turbine 84 and a high speed, high pressure turbine 85. The two turbines 84, 85 are connected to the axles 80, 81 by common gearing means 86. The axles 82, 83 form a second group of axles driven by two other turbines, a low speed, low pressure turbine 87 and a high speed, low pressure turbine 88. The two low pressure turbines are connected to the axles 82, 83 by a single gearing means 89. The low speed turbines 84 and 87 are connected in series by a crossover conduit 90 between the exhaust of the high pressure turbine 84 and the inlet of the low pressure turbine 87. During operation elastic fluid is conducted to the high pressure turbine 84 by means of a conduit 91 whence the elastic fluid is discharged into the low pressure turbine 87, which latter has an exhaust conduit 92. Similarly, the high speed turbines 85 and 88 are connected in series by a crossover conduit 93 connected between the exhaust of the turbine 85 and the inlet of the turbine 88. The high pressure turbine 85 has an inlet conduit 75

94 and the low pressure turbine 88 has an exhaust conduit 95. At low speed the locomotive is driven by the first group of turbines 84, 87, and at high speed the locomotive is being operated by the second group of turbines 85 and 88.

Whereas in the arrangement described in connection with Fig. 1 the rotors of the low speed turbines are rotated during high speed operation, I provide in the present instance means whereby the rotors of the low speed turbines 84, 87 may run idle or remain stationary during high speed operation. To this end the shaft of the turbine 84 is coupled to the gearing 86 through a free wheeling or overrunning clutch 96, and similarly, the shaft of turbine 87 is connected to the gearing 89 through the intermediary of another free wheeling or overrunning clutch member 97. Any suitable known design of free wheeling clutches may be used. Thus with this arrangement the low speed turbines 84, 87 may remain stationary during operation of the second group of turbines 85, 88. This reduces or eliminates the friction losses during high speed operation of the locomotive.

Whereas in the arrangement of Fig. 1 slipping of the individual axles is reduced by the provision of bypass conduits including valves with respect to the turbines, I provide in the present instance a valve means in the exhaust conduit of each turbine for controlling the pressure drop and accordingly the load output of the individual turbine in response to slipping of such turbine. In the drawings a valve 98 is provided for controlling load output of the low speed, high pressure turbine 84 and another valve 99 is provided for controlling the load output of the low speed, low pressure turbine 87. Similar valve means 100 and 101 are arranged in connection with the high speed turbines 85 and 88 respectively.

Having described the method of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent in the United States is:

1. A locomotive drive arrangement including the combination of a plurality of axles, a turbine and a gearing for each axle, conduit means connecting the turbines in series, and bypass conduit means including valve means for the turbines to effect equal load output of the turbines.

2. A locomotive drive arrangement including the combination of a first and a second axle, a high pressure turbine and gearing for driving the first axle, a low pressure turbine and gearing for driving the second axle, means for conducting the exhaust of the high pressure turbine to the inlet of the low pressure turbine, and means for automatically bypassing elastic fluid across the high pressure turbine in response to slip of the first axle.

3. A locomotive drive arrangement including the combination of a plurality of axles and two groups of elastic fluid turbines, one group for operation at high locomotive speed and another group for operation at low locomotive speed, each group including a turbine for each axle, the turbines of each group being connected in series.

4. A locomotive drive arrangement including the combination of a first and a second axle, a high pressure elastic fluid turbine and gearing means for driving the first axle at low speed, another high-pressure turbine and gearing means

for driving the first axle at high speed, a low pressure turbine and gearing for driving the second axle at high and at low speed, conduit means connecting the inlet of the low pressure turbine to the exhaust of both high pressure turbines, and other conduit means including valves for conducting elastic fluid to either of the high pressure turbines.

5. A locomotive drive arrangement including the combination of a first and a second axle, a first and a second high pressure elastic fluid turbine and gearing means for alternately driving the first axle from the first and the second high pressure turbine, a low pressure turbine and other gearing means for driving the second axle, conduit means connecting the inlet of the low pressure turbine to the exhaust of both high pressure turbines, conduit means for separately conducting elastic fluid to the high pressure turbines, and means preventing back flow of elastic fluid to either of the high pressure turbines during operation of the other high pressure turbine.

6. A locomotive drive arrangement including the combination of a first and a second axle, a high pressure elastic fluid turbine and gearing means for driving the first axle at low speed, another high pressure turbine and gearing means for driving the first axle at high speed, a low pressure turbine and gearing for driving the second axle, conduit means connecting the inlet of the low pressure turbine to the exhaust of both high pressure turbines, and means for automatically bypassing elastic fluid across one of the high pressure turbines in response to slip of the first axle.

7. A locomotive drive arrangement including the combination of a plurality of axles, two groups of series connected elastic fluid turbines, each group including a turbine for each axle, and means for controlling the flow of elastic fluid through the turbines comprising bypass conduit means and valve means for each turbine.

8. A locomotive drive arrangement including the combination of a plurality of axles, two groups of series connected elastic fluid turbines, each group including a turbine for each axle, means for controlling the flow of elastic fluid through the turbines comprising bypass conduit means and valve means for each turbine, and means for automatically positioning the by-pass valve means in response to speed changes of one axle relative to another axle.

9. A locomotive drive arrangement including the combination of a first and a second axle, a high pressure elastic fluid turbine and gearing for driving the first axle at low speed, another high pressure turbine and gearing means for driving the first axle at high speed, a low pressure turbine and gearing for driving the second axle, conduit means connecting the inlet of the low pressure turbine to the exhaust of both high pressure turbines, a bypass conduit including a valve for each high pressure turbine, and means controlling the valve comprising an electromagnet connected to the valve, an energizing coil for the electromagnet, a small generator driven by the first axle connected to the first energizing coil, a second energizing coil for the electromagnet opposed to the first coil and another generator driven by the second axle and connected to the second energizing coil.

10. A locomotive drive arrangement including the combination of a first and a second group of axles, means including a low speed and a high

speed high pressure turbine for driving the first group of axles, other means including a low speed and a high speed low pressure turbine for driving the second group of axles, means connecting the low speed turbines in series, and other means connecting high speed turbines in series.

11. A locomotive drive arrangement including the combination of a first and a second axle, means including a low speed and a high speed high pressure turbine for driving the first axle, means including a low speed and a high speed low pressure turbine for driving a second axle, crossover conduit means between the low speed turbines, other crossover conduit means between the high speed turbines connecting the turbines in series, and valve means in the crossover conduit means for controlling the high pressure turbines in order to effect uniform torque transmission to the different axles.

12. A locomotive drive arrangement including the combination of a first axle, a second axle, first and second gearing means for the axles, a low speed and a high speed high pressure turbine connected to the first gearing means for driving the first axle, a low speed and a high speed low pressure turbine connected to the second gearing means for driving the second axle, free wheeling clutch means interposed between the low speed turbines and the corresponding gearing means to permit idling of the low speed turbines during high speed operation, and means

for controlling the load output of the high pressure turbines to permit uniform torque transmission to the different axles.

13. A locomotive drive arrangement including the combination of a first axle means, a second axle means, means including a high pressure high speed elastic fluid turbine and a high pressure low speed elastic fluid turbine for driving the first axle means, means including a low pressure high speed elastic fluid turbine and a low pressure low speed elastic fluid turbine for driving the second axle means, a crossover conduit connecting the high speed turbines in series, and another crossover conduit connecting the low speed turbines in series.

14. A locomotive drive arrangement including the combination of a first axle means, a second axle means, means including a high pressure high speed elastic fluid turbine and a high pressure low speed elastic fluid turbine for driving the first axle means, means including a low pressure high speed elastic fluid turbine and a low pressure low speed elastic fluid turbine for driving the second axle means, a crossover conduit connecting the high speed turbines in series, another crossover conduit connecting the low speed turbines in series, and means for controlling the load output of the high pressure turbines to effect equal load output of the high pressure and low pressure turbines.

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