March 1, 1927. **1,619,705**

A. E. L. CHORLTON

INTERNAL COMBUSTION ENGINE LOCOMOTIVE

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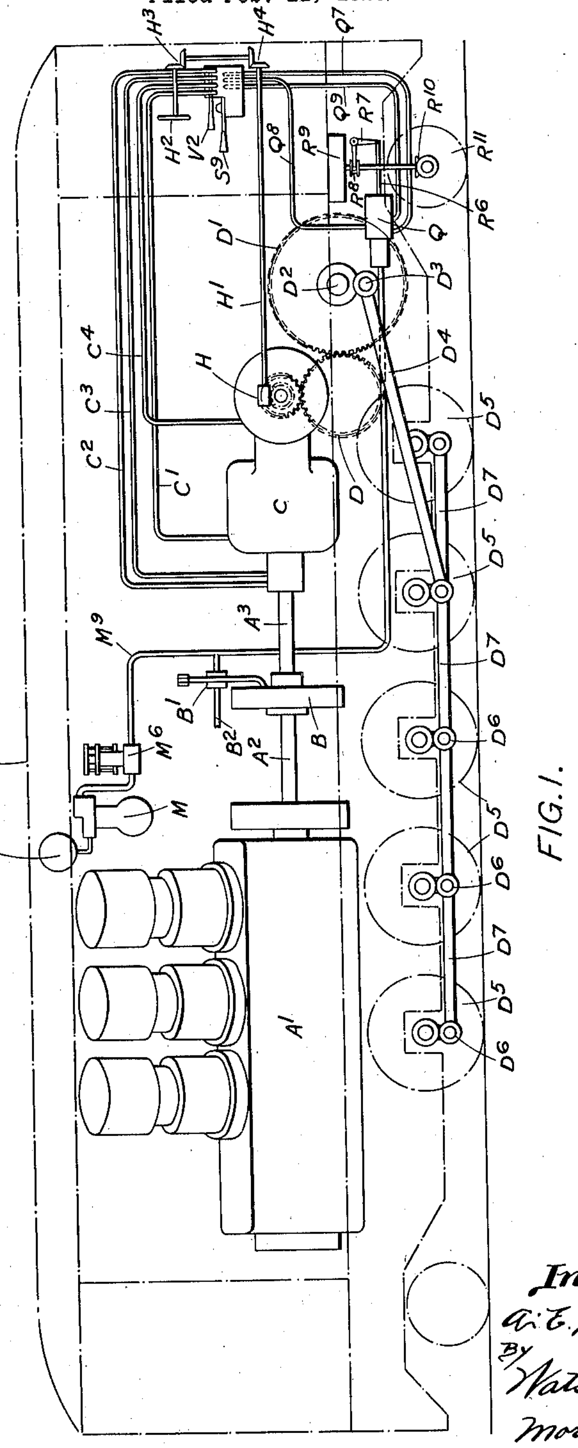

FIG. 1.

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INTERNAL COMBUSTION ENGINE LOCOMOTIVE

Filed Feb. 11, 1925

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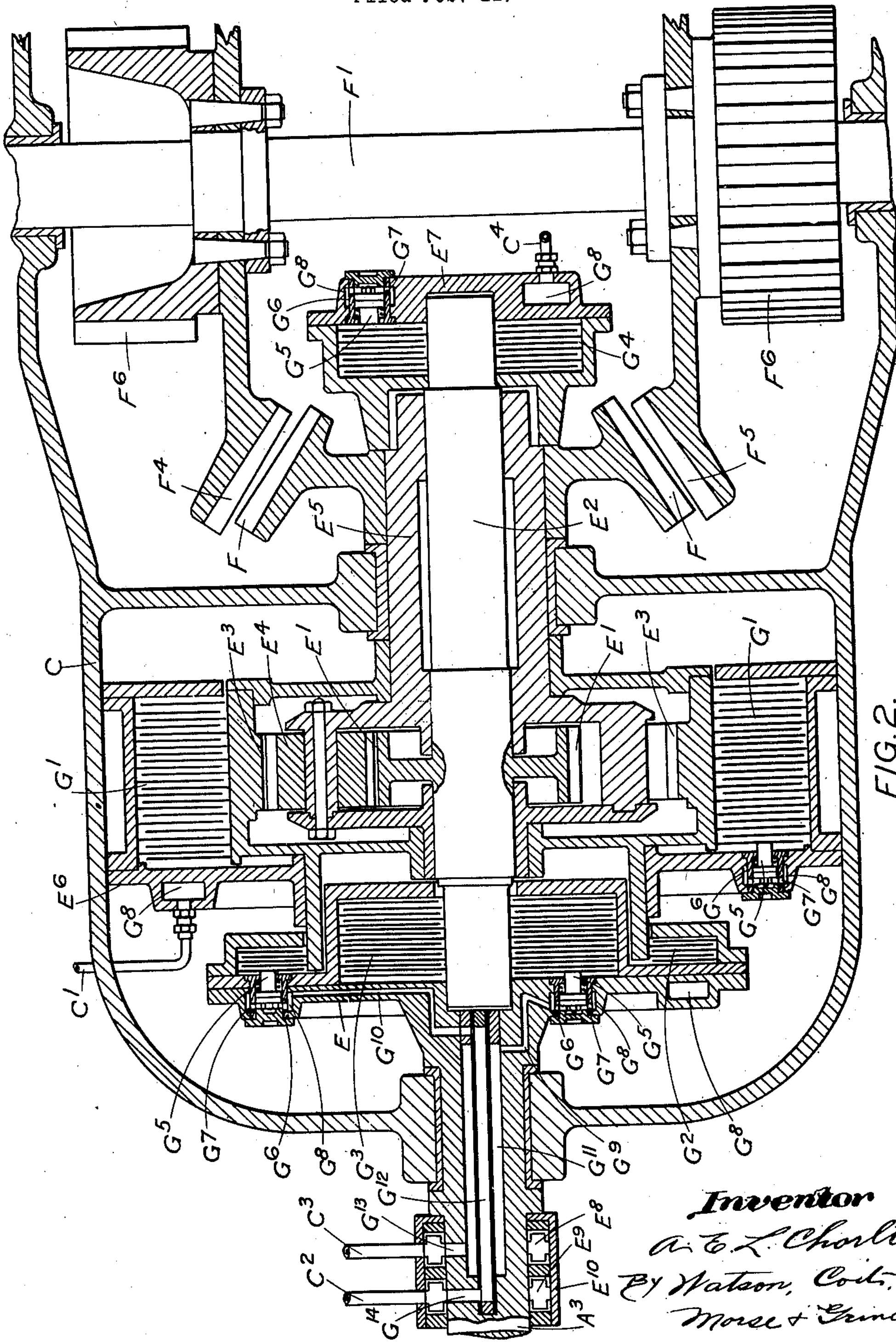

FIG. 2.

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INTERNAL COMBUSTION ENGINE LOCOMOTIVE

Filed Feb. 11, 1925

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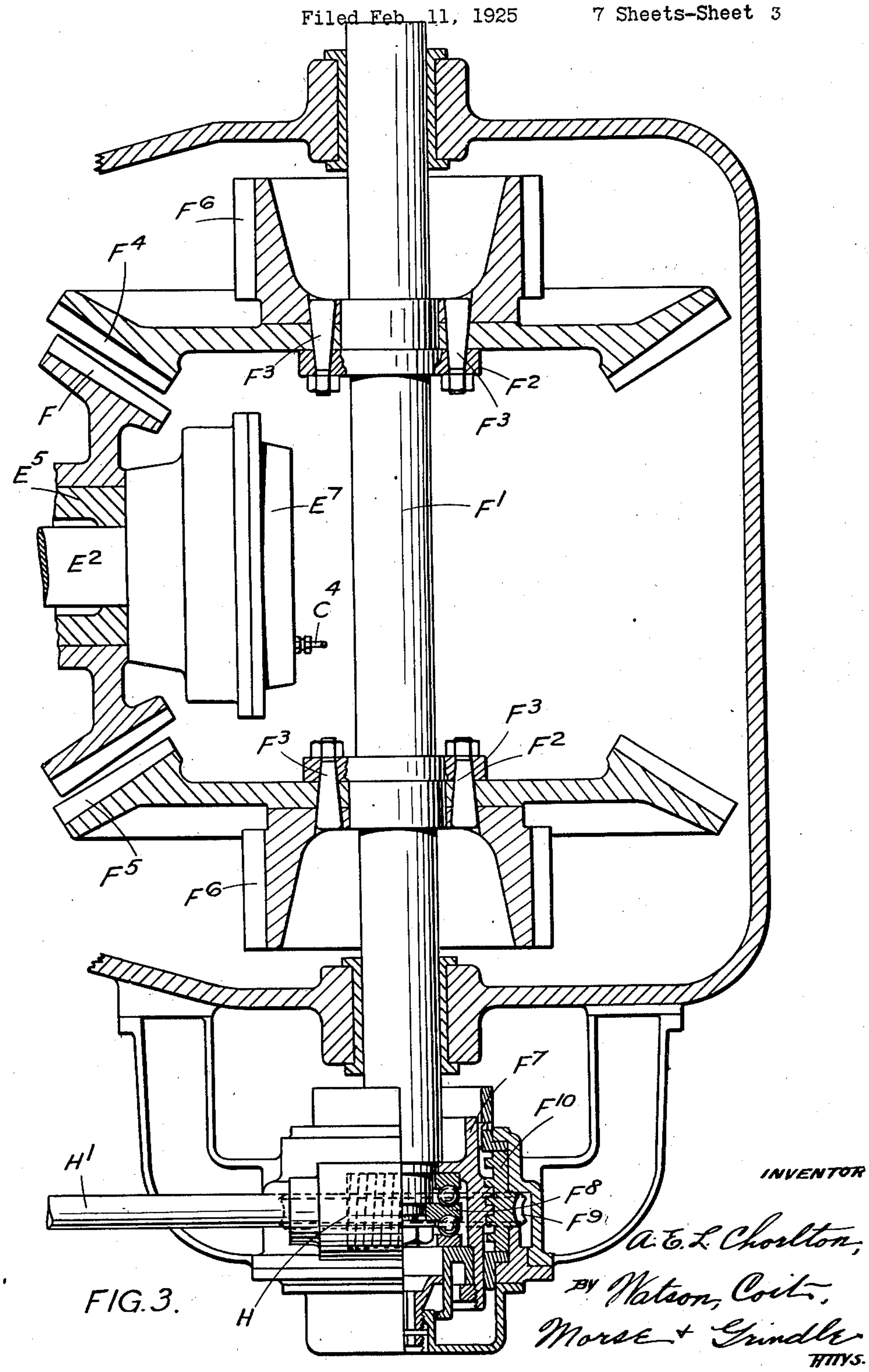

FIG. 3.

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INTERNAL COMBUSTION ENGINE LOCOMOTIVE

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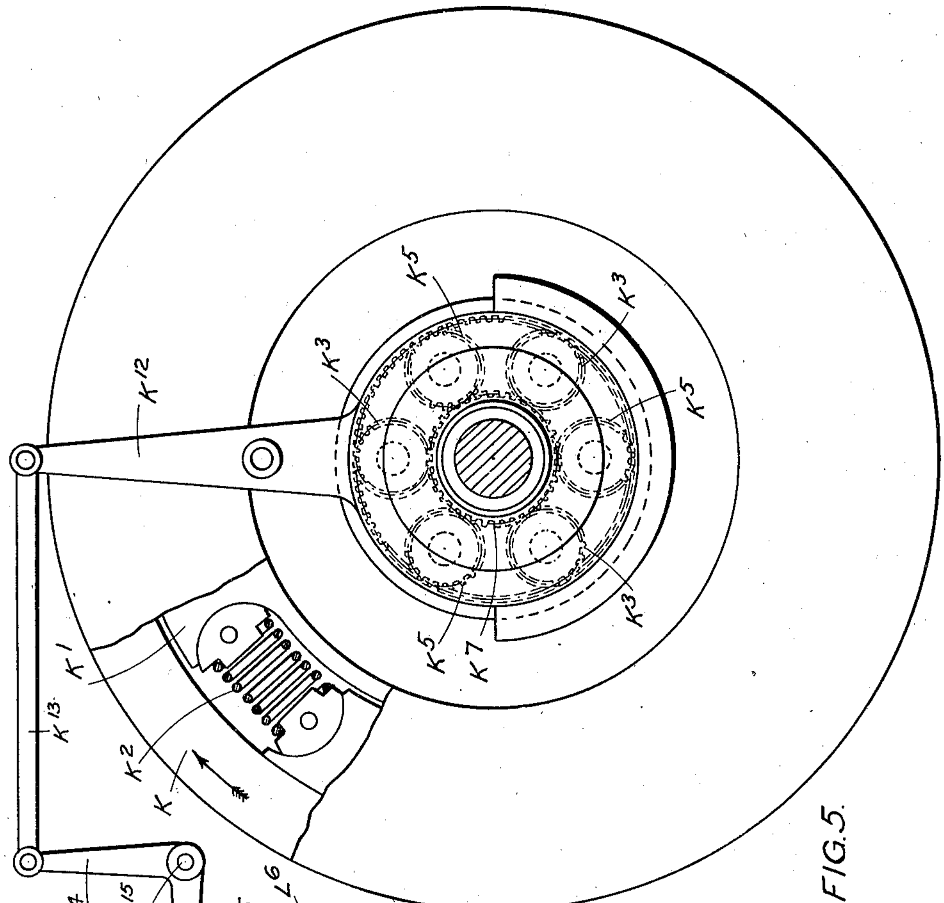

FIG.5.

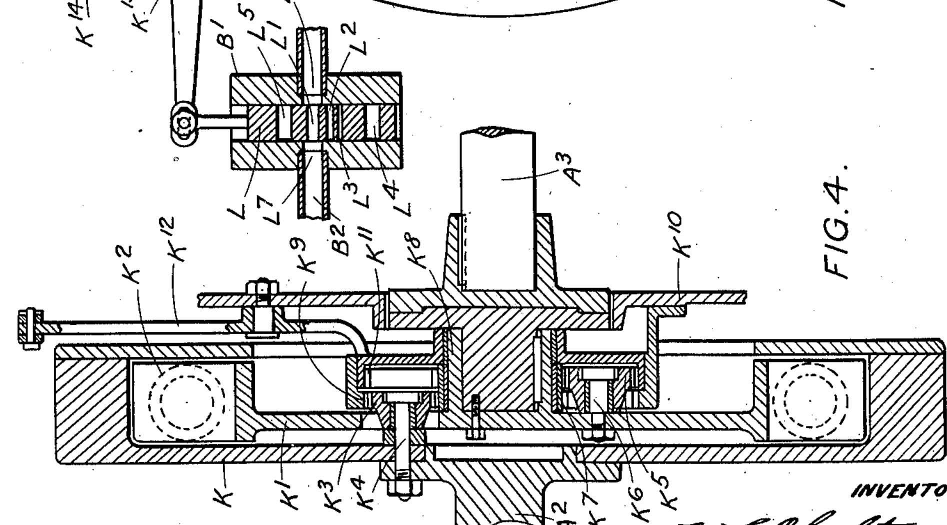

FIG.4.

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INTERNAL COMBUSTION ENGINE LOCOMOTIVE

Filed Feb. 11, 1925 7 Sheets-Sheet 5

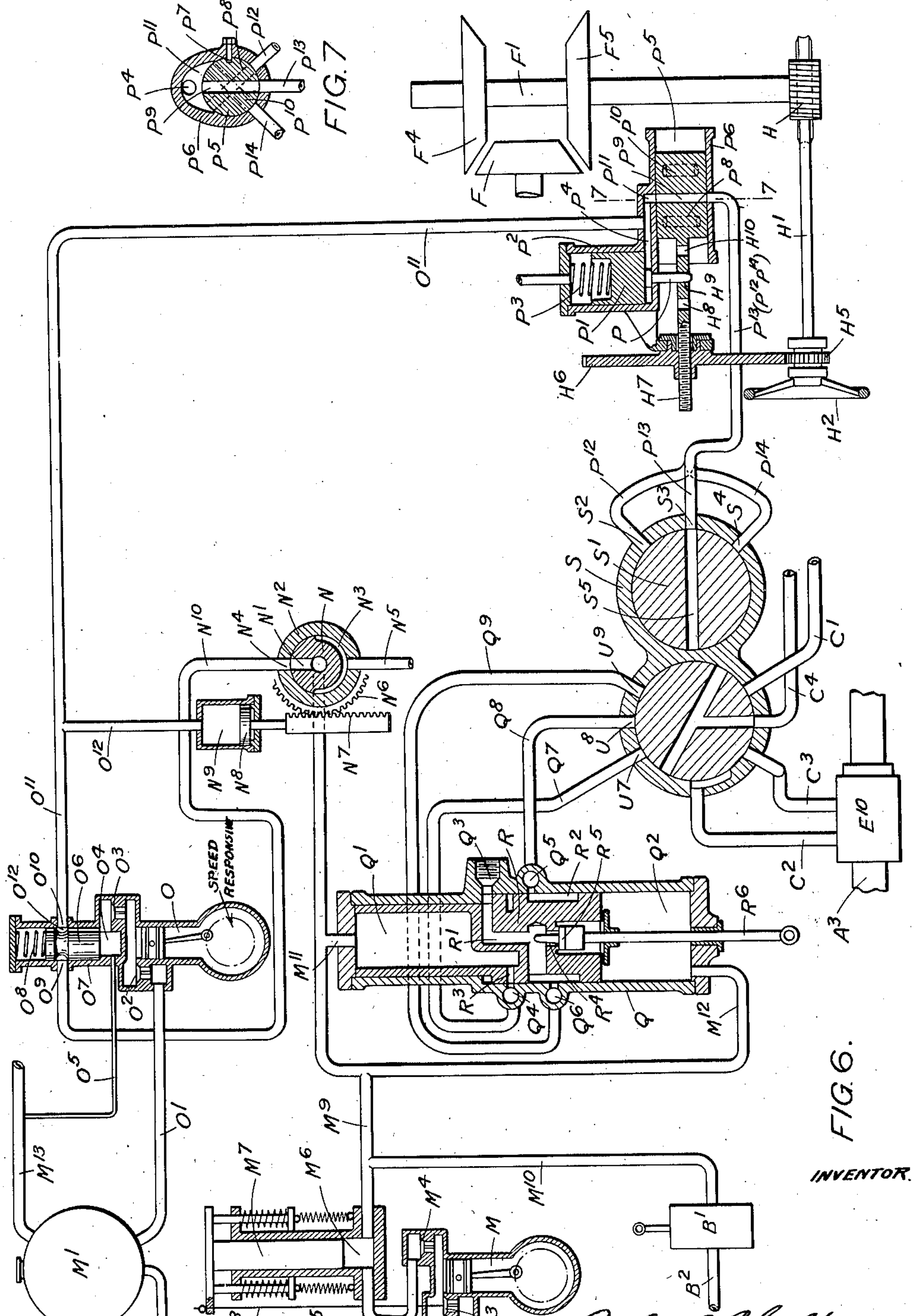

FIG. 7.

FIG. 6.

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INTERNAL COMBUSTION ENGINE LOCOMOTIVE

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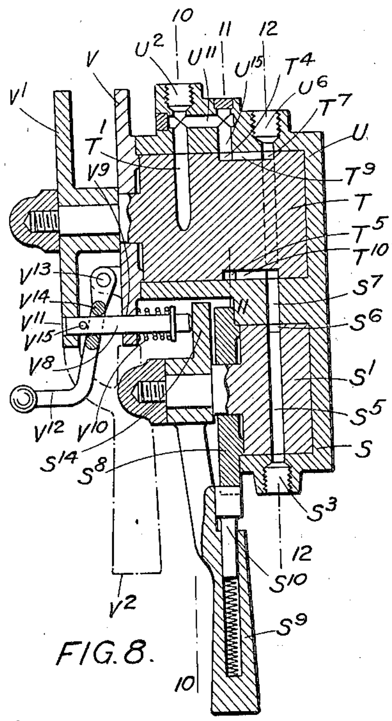

FIG. 8.

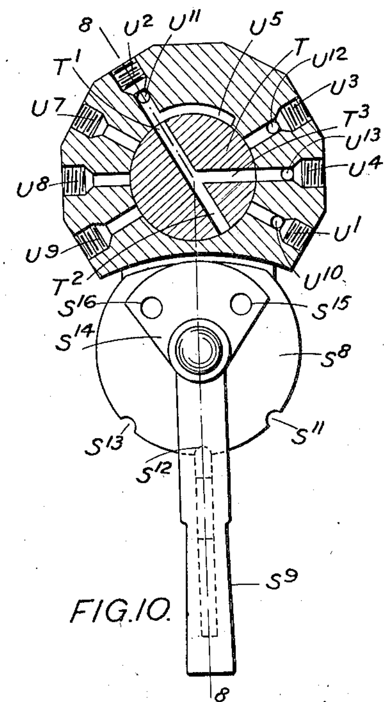

FIG. 10.

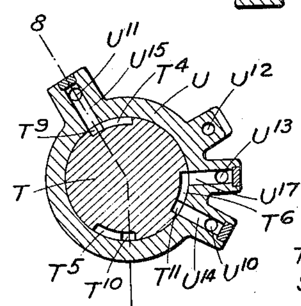

FIG. 11.

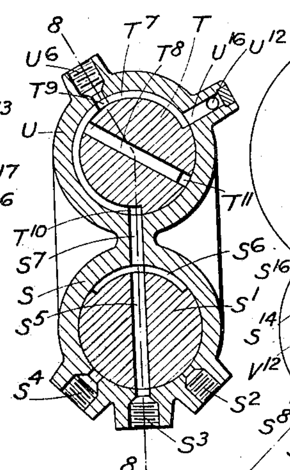

FIG. 12.

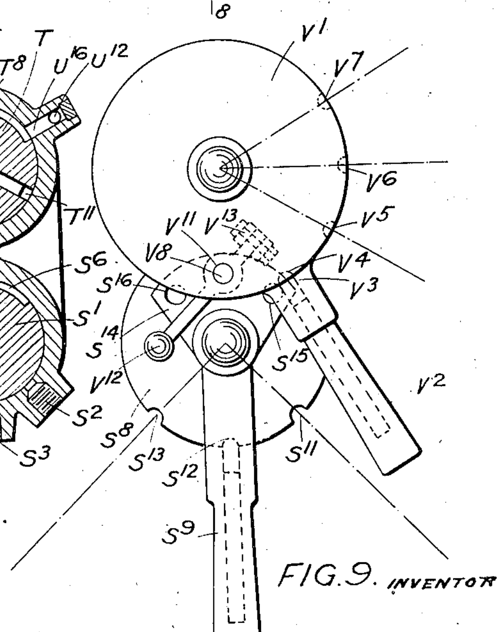

FIG. 9.

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INTERNAL COMBUSTION ENGINE LOCOMOTIVE

Filed Feb. 11, 1925 7 Sheets-Sheet 7

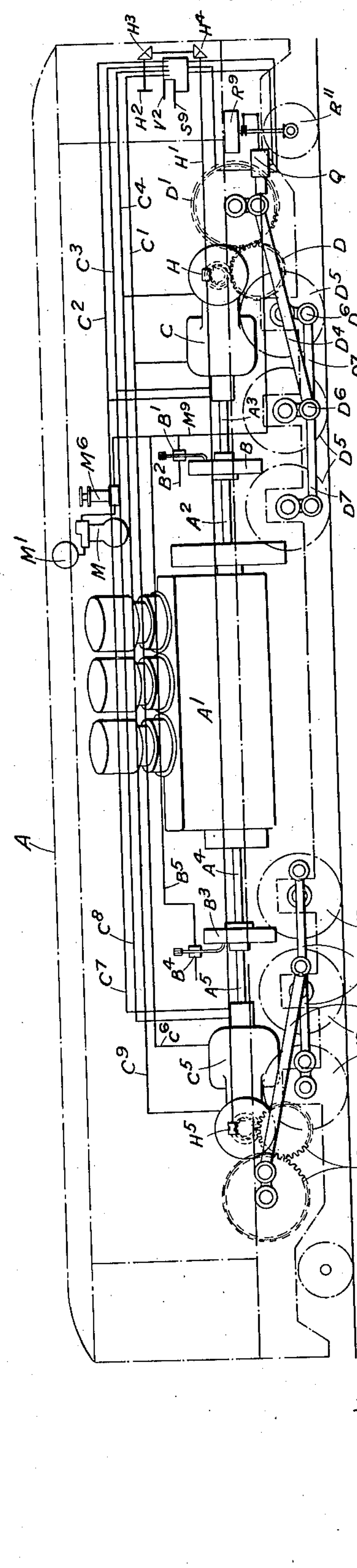

FIG. 13.

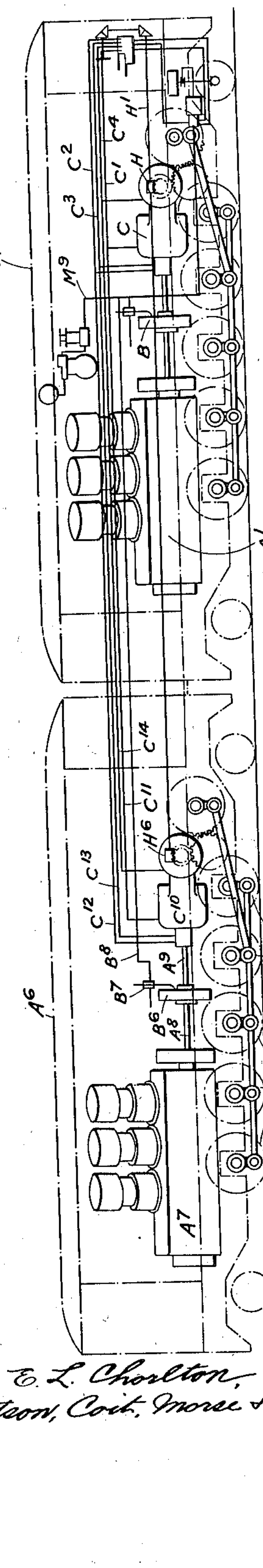

FIG. 14.

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Patented Mar. 1, 1927. **1,619,705**

UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION-ENGINE LOCOMOTIVE.

Application filed February 11, 1925, Serial No. 8,591, and in Canada November 29, 1923.

This invention relates to rail locomotives propelled by internal combustion engines of the heavy oil type.

The primary object of the invention is to provide such a combination of driving and transmission elements as will enable locomotives of large power to be constructed in such a manner that they will efficiently carry out their work and can be controlled by a single crew.

A further object is so to arrange the locomotive that very high power can be obtained with the desired flexibility of wheel base without exceeding the limits of size imposed by the loading gauge.

Another object is to provide transmission elements which will enable the locomotive to be driven in either direction at speeds variable within wide limits and yet will be capable of withstanding the heavy strains resulting from the high power to be transmitted. Thus in a preferred arangement the two chief transmission elements are the epicyclic variable speed gear controlled by plate clutches and the bevel reversing mechanism which respectively form the subject of the present applicant's prior applications for Letters Patent of the United States of America Serial No. 724,719 filed 7th July, 1924, and Serial No. 749,500 filed 12th November, 1924.

A still further object is to control the transmission elements in such a manner as to minimize risk of damage to the parts of the locomotive, and for this purpose a fluid pressure control system such as is described in the present applicant's prior application for Letters Patent of the United States of America Serial No. 657, filed 5th January, 1925, may be employed.

Yet another object is to protect the driving and transmission system from undue stresses due for example to overloads or sudden shocks by means for example of the device described in the present applicant's prior application for Letters Patent of the United States of America Serial No. 752,748 filed 28th November, 1924.

Another object is to combine all these elements together into a single high power internal combustion engine locomotive system wherein all the parts are as far as possible protected from damage.

Still further objects will be apparent from the following description of the accompanying drawings and from the appended claims. In these drawings,

Figure 1 is a diagrammatic general view of a preferred arrangement of locomotive according to the invention,

Figure 2 is a section through a preferred form of epicyclic variable speed gear,

Figure 3 is a section through a preferred form of bevel reversing mechanism,

Figures 4 and 5 are respectively a central section and an end view of a protective device employed in the transmission system;

Figure 6 is a general diagrammatic view of one form of fluid pressure control system,

Figure 7 is a section on the line 7—7 of part of Figure 6,

Fig. 8 is a central vertical section taken on the line 8—8 of Figure 10 showing in detail certain control valves shown in Figures 11 and 12;

Fig. 9 is a front elevation of the mechanism shown in Figure 8;

Fig. 10 is a section taken on line 10—10 of Figure 8;

Fig. 11 is a section taken on line 11—11 of Figure 8;

Fig. 12 is a section taken on line 12—12 of Figure 8, and

Figures 13 and 14 are views similar to Figure 1 of alternative arrangements by means of which higher power can be obtained.

With reference first to Figure 1 the locomotive frame is indicated in chain line at A. Within this frame is mounted an internal combustion engine A′ of the V-type operating on heavy oil. This engine A′ drives a driving shaft A^2 the other end of which is connected to a protective device indicated at B. This device B is illustrated in detail in Figures 4 and 5 and will be described fully with reference to those figures. From the device B an intermediate shaft A^3 leads to an epicyclic variable speed gear contained within a casing C, which also contains a bevel reversing mechanism. The gear and the reversing mechanism will be described in detail with reference to Figures 2 and 3. The drive is transmitted through pinions forming part of the reversing mechanism and pinions D to gear wheels D′ mounted on a transverse shaft D^2. This shaft D^2 carries at its ends cranks D^3 to each of which is pivoted one end of a connecting rod D^4. Each connecting rod D^4 drives a set of driving wheels D^5 which are coupled together by means of cranks D^6 and coupling rods D^7. The variable speed gear is controlled by means of a fluid pressure system which will be described in detail (together with the controlling devices for the reversing mechanism) with reference to Figures 6–12. The main parts of the fluid pressure system are shown diagrammatically in Figure 1 and such parts are indicated by the same reference letters as are employed in Figure 6.

A preferred form of epicyclic variable speed gear is illustrated in Figure 2 and comprises a driving member E mounted on the end of the shaft A^3, a sun wheel E′ carried on a shaft E^2 coaxial with the shaft A^3, an annulus E^3 and planet pinions E^4 rotatably mounted on a sleeve E^5 surrounding the shaft E^2, the sleeve E^5 carrying a bevel pinion F which forms the driving member of the bevel reversing mechanism. The gear is mounted within the casing C which also contains the reversing mechanism. The gear is controlled from the fluid pressure system by means of four plate clutches G′ G^2 G^3 G^4, which serve respectively for clutching the annulus E^3 to a fixed bracket E^6 carried by the casing C, the annulus E^3 to the driving member E, the shaft E^2 to the driving member E, and the shaft E^2 to a fixed bracket E^7 carried by the casing C. Each of the clutches G′ G^2 G^3 G^4 is controlled by means of a plunger G^5 working within a cylinder G^6 provided with ports G^7 in its wall. These ports G^7 communicate with a fluid chamber G^8. The two fluid chambers G^8 for the clutches G′ and G^4 are disposed respectively in the fixed brackets E^6 and E^7 and are supplied with the operating fluid through pipes C′ and C^4. The other two fluid chambers G^8 for the clutches G^2 G^3 are disposed within the driving member E and are supplied with fluid respectively through passages G^9 G^{10} within this member. The two passages G^9 G^{10} communicate respectively with the outer and inner of two concentric passages G^{11} G^{12} within the shaft A^3, the other ends of these passages G^{11} G^{12} being in communication through ports G^{13} G^{14} within two annular chambers E^8 E^9 in a fixed sleeve E^{10} surrounding the shaft A^3. Fluid is supplied to the annular chambers E^8 E^9 respectively from pipes C^2 C^3.

Thus when fluid is supplied under pressure through the pipes C′ C^3, the clutches G′ G^3 are caused to engage, and the gear is brought into its first speed position in which the annulus E^3 is held stationary and the sun wheel E′ is clutched to the driving member E. If the pressure on the clutches G′ G^3 is relieved and fluid is supplied through the pipes C^2 C^4 the gear will be brought into its second speed position, in which the annulus E^3 is clutched to the driving member E by means of the clutch G^2 and the sun wheel E′ is held stationary by means of the clutch G^4. In the direct drive position the clutches G^2 G^3 are engaged by means of fluid supplied through the pipes C^2 C^3 so that the annulus E^3 and the sun wheel E′ are both clutched to the driving member E.

As has been mentioned the casing C which encloses the gear also contains the bevel reversing mechanism. This mechanism, part of which is shown on the right hand side of Figure 2, is illustrated in Figure 3, and comprises a transverse shaft F′ having two flanges F^2, to each of which is secured by means of bolts F^3 a bevel pinion F^4 or F^5 and a spur wheel F^6. The shaft F′ is movable in the direction of its length and the two bevel pinions F^4 F^5 are so spaced apart that either of them can be brought into engagement with the bevel wheel F when the shaft is moved. In the position shown the reversing mechanism is in its neutral position in which neither bevel pinion is in mesh with the wheel F. The spur wheels F^6 serve to transmit the drive to the pinions D (Figure 1) and are made of such width as to engage with these pinions throughout the axial movement of the shaft.

The mechanism for moving the shaft F′ axially comprises a sleeve F^7 which is connected to one end of the shaft by means of double thrust bearings F^8 and is held against rotation whilst yet being free to move axially with the shaft. The sleeve F^7 is screw-threaded externally to engage with a nut member F^{10} which carries a worm wheel F^9. The worm wheel F^9 is operated by means of a worm H on a shaft H′. Thus when the shaft H′ is rotated in one direction it will cause the nut member F^{10} to rotate and thereby to move the sleeve F^7 and the shaft F′ axially so as to bring the bevel pinion F^4 into engagement with the bevel wheel F. This corresponds to the forward drive position. Similarly rotation of the shaft H′ in the other direction will bring the mechanism into the reverse drive position in which the bevel pinion F^5 engages with the bevel wheel F.

Other constructions of variable speed gear and reversing mechanism may be employed, but it is to be noted that the particular constructions illustrated in Figures 2 and 3 are specially designed to withstand the stresses caused by the high powers to be transmitted. Thus the employment of plate clutches which allow a variable degree of slip between the clutch members for controlling the gear, and also the employment of bevel pinions rigidly mounted on an axially movable shaft in the reversing mechanism greatly increase the strength of the system.

It is desirable, however, to provide means for protecting the transmission system from undue stresses resulting for example from overloads or sudden shocks and for this purpose a torque limiting device is included in the system. This device is indicated by the reference letter B in Figure 1 and is shown in detail in Figures 4 and 5. The device comprises two coaxial wheels K K′ which are connected together by springs K^2 and are mounted respectively on the driving shaft A^2 and the intermediate shaft A^3 which leads to the variable speed gear. Mounted on spindles K^4 journalled in the wheel K are a set of planet pinions K^3, a similar set of planet pinions K^5 being carried on spindles K^6 journalled in the wheel K′. Both sets of planet pinions K^3 K^5 mesh with a common sun wheel K^7 which is freely rotatable on the hub K^8 of the wheel K′. A toothed annulus K^9 meshes with the planet pinions K^3 and is carried by a fixed bracket K^{10}, whilst the other planet pinions K^5 mesh with a second toothed annulus K^{11} carried by an arm K^{12} connected at its outer end by means of a link K^{13} to one arm of a lever K^{14} pivoted at K^{15}, the other arm of this lever K^{14} serving to operate a valve B′. It will be seen that variations in the torque transmitted will cause relative rotation between the wheels K K′, which will in turn cause movement of the arm K^{12} owing to the differential arrangement of the mechanism.

The valve B′ controls a relief passage B^2 in the fluid pressure system and consists of a piston valve L provided with a series of ports L′ L^2 L^3 L^4 L^5 which register with ports L^6 L^7 in the containing cylinder B′. The ports L′ L^2 L^3 L^4 L^5 are of varying sizes and register in turn with the ports L^6 L^7 as the valve is moved. The port L′ registers with the ports L^6 L^7 when the wheels K K′ are in their no-torque or zero position, this port being of such a size as to allow only a partial relief of the fluid pressure. Thus when the locomotive is at rest the piston L will be in the position shown and when it is desired to start the locomotive a certain amount of fluid pressure is allowed to pass to operate the gear (in the manner to be described later), this pressure being sufficient to cause a partial engagement of the plate clutches whilst a certain amount of slipping is allowed to occur between the individual plates of the clutch. This partial engagement allows a relatively small amount of torque to be transmitted and this torque in turn causes a small amount of relative rotation between the wheels K K′, which will move the piston valve L until the port L^2 is in register with the ports L^6 L^7. This port L^2 is of smaller diameter than the port L′ and the fluid pressure is consequently relieved less, so that the clutches of the gear engage somewhat more tightly. This further engagement allows still further torque to be transmitted and the consequent further relative rotation of the wheels K K′ brings the still smaller port L^3 into register with the ports L^6 L^7. The degree of engagement of the plates of the clutches is thus still further increased with a corresponding increase in the torque, until finally the piston L moves far enough to close the ports L^6 L^7 altogether and the clutches are subjected to full pressure. It will be seen that with this arrangement the gradual progressive engagement of the clutches is ensured. If the locomotive is subjected to an overload or a sudden shock which causes a sudden increase in the torque beyond a predetermined maximum value, the piston valve L will move over until the port L^4 registers with the ports L^6 L^7. This port L^4 is of full diameter and causes the complete relief of the fluid pressure in the system thereby disengaging any clutches of the gear which may be engaged and cutting out the gear. If on the other hand the torque is reversed due to the shaft A^3 tending to drive the shaft A^2, the wheel K′ over-runs the wheel K, and if this reverse torque exceeds a predetermined limit the piston valve L will move until the port L^5 is brought into register with the ports L^6 L^7, thus again relieving the fluid pressure in the system and cutting out the gear.

The general arrangement of the fluid pressure control system illustrated in Figure 6 and also in part in Figure 1 will now be described. A reciprocating pump M draws fluid from a supply tank M′ through a pipe M^2 and a suction valve M^3 and delivers it under pressure past a delivery valve M^4 into a pipe M^5 leading to a cylinder M^6 which forms part of a pressure regulating device. Within this cylinder M^6 is a spring-controlled piston M^7 which acts on a rod M^8 connected to the suction valve M^3. If the fluid pressure in the pipe M^5 exceeds a predetermined value dependent upon the tension of the springs controlling the piston M^7, this piston will rise in its cylinder and will open the suction valve M^3. So long as the valve M^3 is held open no fluid will be delivered through the valve M^4 and the pressure in the pipe M^5 will fall again, thus causing the piston M^7 to return to its normal position and to allow the suction valve M^3 to close.

From the cylinder M^6 the fluid is supplied under pressure through a pipe M^9 to an internal passage N′ in a rotary valve N rotatable within a casing N^2. The pipe M^9 has also three branch pipes M^{10} M^{11} M^{12} of which the first M^{10} leads to the valve B′ controled by the torque limiting device, whilst the other two M^{11} M^{12} lead to a valve device to be described later. The rotary valve

N is provided with a recess N^3 extending part of the way round the valve, and the passage N′ and the recess N^3 cooperate with ports N^4 N^5 in the casing N^2. The valve N carries a toothed sector N^6 engaging with a toothed rack N^7 connected to a piston N^8 which can move in a cylinder N^9. The rack N^7 is also connected to some part of the mechanism (not shown) for actuating the locomotive brakes and occupies the position shown when the brakes are applied. In this position the pressure fluid is supplied through the passage N′ to the port N^4, whilst when the brakes are released, the rack N^7 moves to its uppermost position and rotates the valve N until the port N^4 is opened through the recess N^3 to the relief port N^5.

The port N^4 communicates with a pipe N^{10} which leads to a device which prevents the flow of fluid through this pipe except when the locomotive is at rest. This device consists of a reciprocating pump O driven in accordance with the road speed of the locomotive. The pump O draws fluid from the reservoir M′ through a pipe O′ and a suction valve O^2, and delivers it past a delivery valve O^3 into a chamber O^4 from which a by-pass passage O^5 leads back to the reservoir M′. The pressure set up in the chamber O^4 acts on a piston O^6 moving in a cylinder O^7 against the action of a spring O^8. The pipe N^{10} leads to a port O^9 in the cylinder wall, this port being disposed opposite to an outlet port O^{10} which communicates with a pipe O^{11}. The piston O^6 has an annular recess O^{12} which registers with the two ports O^9 O^{10} when the locomotive is at rest.

Thus as soon as the locomotive starts to move the pump O will deliver fluid under pressure to the chamber O^4, this pressure acting to raise the piston O^6 and cut off communication between the ports O^9 O^{10}. The fluid will leak slowly through the by-pass passage O^5, and as the locomotive speed increases the fluid will be forced at increasing velocity through this by-pass. The pressure of the spring O^8 and the cross-section of the by-pass passage are such that even very slow motion of the locomotive will be sufficient to raise the piston O^6 and to close the ports O^9 O^{10}. When the locomotive road speed falls the pressure in the chamber O^4 will also fall, until finally when the locomotive comes practically to rest the recess O^{12} will open communication between the ports O^9 O^{10} and will allow fluid to pass through into the pipe O^{11}.

The pipe O^{11}, which has a branch pipe O^{12} leading into the cylinder N^9, leads to an interlocking device for the reversing mechanism. This mechanism as has been described above is operated by means of a worm H on a shaft H′. This shaft H′ is rotated by means of a hand wheel H^2 either directly as shown in Figure 6 or through bevel gearing H^3 H^4 as shown in Figure 1. The hand wheel H^2 carries a pinion H^5 meshing with a gear wheel H^6, the hub of which is internally screwthreaded to engage with the screwthreaded end of a rod H^7. The rod H^7 has three holes H^8 H^9 H^{10} one or another of which is adapted to receive a locking pin P carried by a piston P′ which is moved in a cylinder P^2 against the action of a spring P^3 by the pressure in a chamber P^4 into which the pipe O^{11} opens. The rod H^7 also carries a piston P^5 which can move in a cylinder P^6 and is held against rotation by means of a key P^7 (see Figure 7). The piston P^5 has three suitably disposed internal passages P^8 P^9 P^{10}, one or another of which registers at one end with a recess P^{11} in the cylinder wall communicating with the chamber P^4. In the position shown (which corresponds to the neutral position of the reversing mechanism) the passage P^9 is in register with the recess P^{11} and its other end registers with the end of a pipe P^{13}. When the piston P^5 is moved to the right and the pin P is in the hole H^8, the passage P^8 connects the recess P^{11} with a pipe P^{12}, and a corresponding movement to the left brings the passage P^{10} into register with the recess P^{11} and the end of a pipe P^{14}. These two positions correspond respectively to the forward drive and the reverse drive positions of the reversing mechanism. The other ends of the pipes P^{12} P^{13} P^{14} are controlled by a reversing valve to be described later.

Thus if the reversing mechanism is in its neutral position and the locomotive is at rest with the brakes applied, fluid is forced through the pipe O^{11} and will enter the chamber P^4, which is in communication with the pipe P^{13} through the passage P^9. If the other end of this pipe P^{13} is closed the fluid will raise the piston P′ in the cylinder P^2 thereby withdrawing the pin P from the hole H^9 with which it is in engagement. The rod H^7 is now free to move and the hand wheel H^2 is rotated to bring the reversing mechanism into the forward (or reverse) drive position. This brings the hole H^8 (or H^{10}) under the pin P and also the passage P^8 (or P^{10}) into register with the recess P^{11} and the end of the pipe P^{12} (or P^{14}). By this time as will be explained later the other end of the pipe P^{12} (or P^{14}) has been opened to relief, and consequently the pressure in the chamber P^4 will be relieved and the piston P′ will fall bringing the pin P into the hole H^8 (or H^{10}).

It will be noticed that when fluid passes through the pipe O^{11} to raise the piston P′, it will also flow into the cylinder N^9 and will hold the piston N^8 in its lowermost position. This prevents the locomotive brakes from being released until the pressure in the pipe O^{11} is relieved, i. e. until the reversing mechanism has been fully operated. It will also be noticed that fluid cannot pass into the pipe O^{11} to allow the operation of the reversing mechanism until the brakes have been applied (in order to bring the passage N′ into register with the port N^4) and until the locomotive has come to rest.

Returning now to the fluid supply pipe M^9 it will be remembered that this pipe is provided with two branch pipes M^{11} M^{12}. These pipes lead to a device which controls the supply of fluid for the operation of the variable speed gear automatically in accordance with the road speed of the locomotive. This device comprises a stepped cylindrical valve casing Q, to the smaller and larger ends Q′ Q^2 of which fluid is supplied respectively through the two pipes M^{11} and M^{12}. The casing Q also contains in its larger part four ports Q^3 Q^4 Q^5 Q^6, of which the first Q^3 is a relief port whilst the other three Q^4 Q^5 Q^6 are connected to pipes Q^7 Q^8 Q^9 which serve respectively for the supply of fluid to the gear for the first speed position, the second speed position and the third speed or direct drive position. Within the two parts of the cylinder Q is a stepped piston R having an internal passage R′ permanently in communication with the relief port Q^3. The larger part of the piston is also provided with two annular recesses R^2 and R^3, of which one R^2 is permanently in communication with the internal passage R′, whilst the other R^3 is open to the smaller end Q′ of the cylinder. The passage R′ communicates through an orifice R^4 with the larger end Q^2 of the cylinder and this orifice is controlled by a pilot valve R^5 the stem R^6 of which is connected to one arm of a crank lever R^7 (see Figure 1). The other arm of the crank lever R^7 engages with the collar R^8 of a centrifugal governor R^9 the shaft of which is driven in accordance with the road speed of the locomotive by means for example of gearing R^{10} driven from a non-driven road wheel R^{11}.

Thus so long as the pilot valve R^5 keeps the orifice R^4 closed the piston R will remain in its end position (as shown) owing to the differential action of the pressures in the two ends of the cylinder Q. In this position the pressure fluid can flow through the recess R^3 and the port Q^4 into the pipe Q^7, which corresponds to the first speed position of the gear. If now the road speed increases, the governor R^9 acts on the crank lever R^7 and withdraws the pilot valve R^5 a short distance. This opens the orifice R^4 and relieves the pressure in the larger part Q^2 of the cylinder, so that the piston R will move along the cylinder under the action of the pressure in the smaller part Q′ until the orifice is again closed or very nearly closed by the pilot valve. A balance of pressures acting on the two sides of the piston will exist when the orifice R^4 is slightly open, the small leak through this orifice being just sufficient to counteract the normal difference of pressures on the two sides of the piston. Thus as the locomotive speed increases the piston R will follow the pilot valve R^5 and will open in turn the ports Q^5 Q^6 which correspond to the second speed and direct drive positions of the gear, the two ports not open to the pressure fluid from the smaller end of the cylinder at any moment being in communication with the relief port Q^3. A decrease in road speed will cause the pilot valve to close the orifice R^4 and the difference in pressures will move the piston back again until the balance is restored.

This device thus provides an automatic control of the supply of pressure fluid to the gear, and acts in conjunction with a hand-operated distributing valve to control the speed changes in the gear. This distributing valve is combined into a single unit with the reversing valve above referred to, and is illustrated in detail in Figures 8–12 now to be described. Figures 8 and 9 are respectively a central section and a plan of the two valves, and Figures 10, 11 and 12 are horizontal sections on the lines 10—10, 11—11 and 12—12 respectively of Figure 8. For sake of clearness of description the plane of section in Figure 8 is bent and follows the lines 8—8 shown in Figures 10, 11 and 12.

The reversing valve will first be described. This valve comprises a rotary valve member S′ disposed within a cylindrical casing S. The casing contains three ports S^2 S^3 S^4 which are in communication respectively with the three pipes P^{12} P^{13} P^{14}, and the valve member S′ has a passage S^5 which registers at one end with one or another of the ports S^2 S^3 S^4. At the other end the passage S^5 opens into a recess S^6 in the valve member, this recess being always in communication with a passage S^7 in the casing. This passage S^7 is permanently in communication with a relief port as will be described later. The valve member S′ projects through a fixed cover plate S^8 for the cylinder S and carries at its end a reversing hand lever S^9 by means of which the member S′ is rotated. This lever S^9 is provided with a spring-controlled detent S^{10} which engages in one or another of three notches S^{11} S^{12} S^{13} in the edge of the cover plate S^8 according to whether the valve member S′ is in its forward drive position, its neutral position or its reverse drive position. The valve member S′ also carries on the side opposite to the hand lever S^9 a flat plate S^{14} having two holes S^{15} S^{16}. These holes are provided for the purpose of interlocking the reversing lever with the gear lever as will be described later.

The distributing valve comprises a rotary valve member T disposed within a cylindrical casing U which is formed integral with the casing S of the reversing valve. The valve member T and the casing U are provided with a number of passages and ports arranged in three parallel planes, sections through these planes being shown respectively in Figures 10, 11 and 12. The casing U contains eight ports of which four U' U^2 U^3 U^4 in the plane of Figure 10 are connected to the four pipes C' C^2 C^3 C^4 leading to the plate clutches of the gear, the port U^2 being extended laterally as shown at U^5 in Figure 10. The fifth port U^6 is a relief port and is disposed in the plane of Figure 12, whilst the remaining three ports U^7 U^8 U^9 in the plane of Figure 10 communicate respectively with the three pipes Q^7 Q^8 Q^9 leading from the valve device Q. From the ports U' U^2 U^3 U^4 longitudinal passages U^{10} U^{11} U^{12} U^{13} lead to four more ports U^{14} U^{15} U^{16} U^{17}, of which one U^{16} is disposed in the plane of Figure 12 whilst the other three U^{14} U^{15} U^{17} are disposed in the plane of Figure 11.

The rotary valve member T is provided in the plane of Figure 10 with three radial passages T' T^2 T^3, of which the first T' is adapted to register with one or another of the ports U^5 U^7 U^8 U^9 whilst the other two register selectively with the ports U' U^2 U^3 U^4 according to the position of the valve member. The valve member is also provided in the plane of Figure 11 with three recesses T^4 T^5 T^6, and in the plane of Figure 12 with a recess T^7 and a passage T^8, one end of which opens into the recess T^7. The recess T^7 is permanently open to the relief port U^6 and is of such a length as to register with the passage S^7 from the reversing valve. The recesses T^4 T^5 T^6 are all connected with the recess T^7 by longitudinal passages T^9 T^{10} T^{11} (the last opening into the end of the passage T^8 instead of directly into the recess T^7).

In the neutral position shown the passage T' does not register with any of the pressure fluid supply ports U^7 U^8 U^9, and the four delivery ports U' U^2 U^3 U^4 are all open to relief respectively through the passages U^{10} U^{14} T^6 T^{11} T^8 T^7 U^6, U^{11} U^{15} T^4 T^9 T^7 U^6, U^{12} U^{16} T^7 U^6, U^{13} U^{17} T^6 T^{11} T^8 T^7 U^6. When the valve member is rotated one step counterclockwise, the passages come into a position corresponding to the first speed position of the gear. The supply port U^7 is now connected through the passages T' T^2 T^3 with the delivery ports U' U^8, the connections from these two ports to the relief port U^6 being broken whilst the ports U^2 U^4 are still open to relief. In the second speed position the supply port U^8 is connected to the delivery ports U^2 U^4 (the former through the extension U^5) and the relief connections to these two ports are broken, whilst a fresh connection to relief for the ports U' U^3 is established respectively by the recess T^5 registering with the port U^{14} and by the passage T^8 registering with the port U^{16}. In the direct drive position the supply port U^9 is connected to the delivery ports U^2 U^3, the ports U' U^4 being both open to relief through the recess T^5. The valve member T projects through a fixed cover plate V on the casing U and carries a plate V' on which is mounted a hand lever V^2. This gear lever V^2 carries a spring-pressed detent indicated at V^3 and arranged in a manner similar to the detent S^{10} in the reversing lever S^9, the detent V^3 engaging in one or another of four notches V^4 V^5 V^6 V^7 in the edge of the cover plate V and thereby holding the member T securely in its four operative positions as described above.

A mechanical interlock is provided between the gear lever V^2 and the reversing lever S^9. This consists of a pin V^3 passing through a hole V^9 in the cover plate V and pressed by a spring V^{10} towards the plate S^{14} carried by the reversing lever S^9. This pin V^8 is in such a position that, when the reversing lever is moved into its forward drive position or its reverse drive position, the spring V^{10} will force the pin into the hole S^{15} or the hole S^{16} so that the reversing lever will be locked in its position. The pin V^8 is of such a length that when it engages in one or another of the holes S^{15} S^{16}, its upper end is just clear of the lower surface of the plate V' so that this plate is free to be rotated. When however the pin V^8 is not in one of the holes S^{15} S^{16} its lower end rests on the surface of the plate S^{14} and its upper end then projects into a hole V^{11} in the plate V', thus locking the gear lever in position. The hole V^{11} is so disposed that when locked the gear lever is in its neutral position. An additional hand lever V^{12} is provided for the purpose of lifting the pin V^8 out of the hole S^{15} (or S^{16}) when it is desired to operate the reversing lever. This lever V^{12} is pivoted at V^{13} to the cover plate V and carries a collar V^{14} surrounding the pin V^8, this collar engaging with a small projection V^{15} on the pin V^8. It will be seen that this interlocking mechanism prevents the gear lever from being moved from its neutral position except when the reversing lever is in one or another of its two driving positions, and also prevents the reversing lever from being operated except when the gear lever is in its neutral position.

Throughout the description of the control system various ports and pipes have been referred to as relief ports and pipes, as for example the ports or pipes B^2 N^5 Q^3 U^6. These pipes are shown in the drawings as open-ended pipes, but it will be understood that they are all connected to a pipe M^{13} leading into the fluid supply reservoir M'.

The whole system is shown in the position occupied when the locomotive is at rest. When it is desired to start up, the first step is to operate the reversing mechanism into its forward or reverse drive position. This is effected by moving the reversing lever S^9 round to the desired position, when the pin V^8 will be pressed down into the hole S^{15} or S^{16} so as to release the gear lever V^2. The movement of the reversing lever brings the reversing valve member S′ into such a position that the pipe P^{12} (or P^{14}) is opened to relief through the passage S^5, the end of the pipe P^{13} being closed. Since the brakes are still applied and the locomotive is at rest, pressure fluid is being forced through to the pipe O^{11}, and consequently as soon as the pipe P^{13} is closed the piston P′ will be raised thereby withdrawing the pin P from the hole H^9. The hand wheel H^2 is now rotated to bring the reversing mechanism into the desired driving position, and this brings the hole H^8 (or H^{10}) under the pin P and also the passage P^8 (or P^{10}) into register with the recess P^{11} and the end of the pipe P^{12} (or P^{14}). Since this pipe is now open to relief owing to the operation of the reversing valve, the piston P′ will fall, the pin P falling into the hole H^8 (or H^{10}) and locking the reversing mechanism. At the same time pressure is relieved from the cylinder N^9, so that the driver is now free to release his brakes.

After the brakes have been released the gear lever V^2 is moved over into its first speed position. Since the pipe Q^7 is open to the fluid supply when the piston R is in its zero position, the movement of the gear lever V^2 opens the fluid supply passages to the plate clutches G′ G^3 of the epicyclic gear. As has already been explained, the wheels K K′ of the torque limiting device are at this stage in their no-torque position and the fluid pressure is partially relieved through the port L′, but the pressure of the fluid is still sufficient to cause a partial engagement of the clutches G′ G^3, a certain amount of slipping occurring between the plates of the clutches. The locomotive consequently begins to move and the torque builds up, so that the wheels K K′ of the torque limiting device move relatively to one another and finally close the relief passage. Full pressure is now applied to the clutches G′ G^3 and the locomotive is now running in first gear.

The driver must now watch his speed indicator and as soon as the locomotive road speed reaches a predetermined value (which corresponds to the value at which the piston R closes the port Q^4 and opens the port Q^5) he must move the gear lever V^2 over to the second speed position. The movement either of the piston R or of the gear lever V^2 will relieve the supply of pressure to the clutches G′ G^3 and will thus cut out the gear. Whilst the gear is cut out no torque will be transmitted, and consequently the wheels K K′ of the torque limiting device will move to their zero position and partially relieve the pressure in the fluid system. The driver must now reduce the speed of the engine (by means for example of an accelerator pedal) to the value appropriate for the change into second gear. The movement of the piston R and the gear lever V^2 has also opened the fluid supply passages to the clutches G^2 G^4, and consequently these clutches will be partially engaged, some slipping being allowed to occur. By the time that the engine speed has been reduced to the desired value the wheels K K′ of the torque limiting device will have reached their normal running position with the relief passage closed. Full pressure is now applied to the clutches G^2 G^4 and the locomotive is now running in second gear.

The driver must move the gear lever V^2 into the direct drive position, when the locomotive road speed reaches the value at which the piston R closes the port Q^5 and opens the port Q^6. This will transfer the supply of pressure fluid from the clutches G^2 G^4 to the clutches G′ G^3 and the change of gear will be effected in a manner similar to that already described for the change from first gear to second gear.

If the driver fails to move the gear lever V^2 when the speed reaches the appropriate value for the change either into second gear or into direct drive, the movement of the piston R will relieve the pressure on the clutches in engagement and will cut out the gear. The locomotive road speed will then gradually fall until the appropriate fluid supply passages are again opened by the movement of the piston R and the locomotive will then gradually come into gear again. The driver will then have another opportunity of effecting the desired gear change when the speed again reaches the value at which the change should have been made.

If on the other hand the driver moves the gear lever too soon, i. e. before the piston R has moved far enough to open the next port, it will be impossible to effect the change (unless the locomotive happens to be running down hill so that its road speed will increase to the desired value while the gear is cut out) and the gear lever must be moved back to its previous position and kept there until the appropriate speed has been reached.

When the locomotive is running, say, in direct drive and its load increases, as for example when going uphill, the road speed will fall. If the speed falls far enough for the piston R to close the port Q^6 and to open the port Q^5, the driver must move the gear lever V^2 back to the second gear position. This will first of all cut out the gear and cause the wheels of the torque limiting device to assume their no-torque position, thus partially relieving the fluid pressure in the newly opened supply passages to the clutches G^2 G^4. The partial engagement and consequent slipping of these clutches will continue until the engine speed has been raised relative to the road speed to the value appropriate to second gear. A change down to first gear will be effected in a similar manner.

If when running in direct drive it is desired to stop the locomotive without passing through the intermediate gears, the driver moves his gear lever right back to the neutral position. This completely removes the pressure on all the clutches and the locomotive will gradually come to rest.

If it is desired to reverse the locomotive, the gear lever V^2 must be brought to its neutral position and the brakes must be applied. The hand lever V^{12} must now be raised so that the locking pin V^8 is withdrawn from the hole S^{15} and passes into the hole V^{11}, the reversing lever S^9 then being moved round to its reverse drive position. When the hand lever V^{12} is released the pin V^8 will now be forced into the hole S^{16} so as to lock the reversing lever against further motion. This movement of the reversing lever has the effect of closing the end of the pipe P^{12} and opening the pipe P^{14} to relief. The application of the brakes has meanwhile brought the piston N^8 into its lower position (as shown) in the cylinder N^9 and has also rotated the valve N so that the pipe N^{10} is open to the fluid supply through the passage N′. When the locomotive comes to rest the fluid will flow through to the pipe O^{11}, and since the far end of the pipe P^{12} is closed the pressure will raise the piston P′ and withdraw the pin P from the hole H^8. The reversing mechanism can now be adjusted into the reverse drive position by rotating the hand wheel H^2. When the adjustment is completed the passage P^{10} in the piston P^5 connects the pipe P^{14} with the chamber P^4, and since the end of the pipe P^{14} is open to relief, the pressure in the chamber P^4 will be relieved and the piston P′ will fall, the pin P passing into the hole H^{10} and thus locking the reversing mechanism in its new position. At the same time the pressure in the cylinder N^9 will be relieved and it is therefore possible to release the brakes and to start up the locomotive in the reverse direction in the manner above described. The adjustment of the reversing mechanism into the neutral position is effected in a similar manner, but it is to be noted that when this adjustment is made the locking pin V^8 will remain in the hole V^{11} and will thus lock the gear lever V^2 in its neutral position.

It should be mentioned that during any adjustment of the reversing mechanism, the torque limiting device will be in its no-torque position, since the gear is cut out and the pressure in the system will therefore be partially relieved. The arrangement is however such that this reduced pressure is quite sufficient to operate the piston P′.

The operation of the torque limiting device and its action in cutting out the gear when the torque exceeds a predetermined maximum or when the torque is reversed and the reverse torque exceeds a predetermined value has already been described. It will be appreciated that the provision of this device and the various interlocks in the control system together with the employment of slipping plate clutches in the gear minimizes the risk of damage to the parts of the transmission system.

To enable higher power to be obtained the transmission system of the locomotive may be duplicated. Such an arrangement is illustrated in Figure 13, which is a diagrammatic view similar to Figure 1 but in which the internal combustion engine is disposed centrally within the locomotive frame and has a complete transmission system at each end. The arrangement of the transmission system at the right hand end is identical with that already described with reference to Figure 1 and the same reference letters are employed, only those parts which differ from Figure 1 being described.

In this arrangement the engine A′ has a second driving shaft A^4 at the end remote from the shaft A^2. This shaft A^4 leads to a second torque limiting device B^3, from which a shaft A^5 leads to a second epicyclic gear contained within a casing C^5 which also contains a bevel reversing mechanism. The drive from the reversing mechanism is transmitted through gearing D^8 and connecting rods D^9 to sets of driving wheels D^{10} coupled together by coupling rods D^{11}. The arrangement of all the elements of the transmission system on the left hand side of the figure is identical with that on the right hand side.

The two transmission mechanisms are simultaneously controlled by the same fluid pressure system. For this purpose the only modification necessary to the fluid system is the duplication of certain of the pipes. Thus for the control of the gear contained within the casing C^5, four pipes C^6 C^7 C^8 C^9 are provided, these four pipes branching respectively from the four pipes C′ C^2 C^3 C^4 which control the gear in the casing C, so that when for example fluid is supplied through the pipes C′ C^3 for the actuation of the clutches G′ G^3, fluid will simultaneously flow through the pipes C^6 C^8 and will actuate the corresponding clutches of the second gear.

For the control of the second reversing mechanism the shaft H′ is extended beyond the worm H and carries a second worm H^5 which controls the second reversing mechanism in exactly the same manner as the worm H controls the first. Thus rotation of the hand wheel H^2 will simultaneously adjust both reversing mechanisms.

The second torque limiting device B^3 serves to actuate a valve B^4 which controls a relief passage B^5 branches from the pipe M^9. Thus if either torque limiting device comes into action it will relieve the pressure in the whole fluid system.

Figure 14 shows an arrangement in which, to obtain higher power and yet keep the size of the locomotive within relatively small limits, the locomotive is divided up into two units each having an internal combustion engine and a complete transmission system. As far as the internal combustion engines and the transmission systems are concerned, each unit is constructed and arranged exactly in the manner described with reference to Figure 1 and the same reference letters are employed for the right-hand unit as in that figure.

The left hand unit comprises a frame A^6 within which is mounted an internal combustion engine A^7 driving a shaft A^8, which in turn drives through a torque limiting device B^6 a shaft A^9 leading to a gear contained within a casing C^{10} which also contains a reversing mechanism. The drive from the reversing mechanism is transmitted to a set of coupled track wheels D^{12} by mechanism exactly corresponding to that described with reference to Figure 1. The internal combustion engine A^7 and the whole transmission system are exactly similar to those employed in the right hand unit and therefore also to those employed in the arrangement shown in Figure 1.

The two transmission systems are simultaneously controlled by a single fluid pressure system contained in the right hand unit, and (except for the duplication of certain pipes) this fluid pressure system is identical with that shown in Figure 1. Thus the four pipes C' C^2 C^3 C^4 are provided respectively with branch pipes C^{11} C^{12} C^{13} C^{14} which control the gear contained within the casing C^{10}, so that the two gears are similarly and simultaneously controlled. The shaft H' is extended beyond the worm H and carries at its end a worm H^6 controlling the bevel reversing mechanism contained within the casing C^{10}, so that the two reversing mechanisms will be simultaneously actuated. The torque limiting device B^6 actuates a valve B^7 controlling a relief pipe B^8 branched from the pipe M^9, so that when either torque limiting device comes into action the pressure in the whole fluid system is relieved.

It will be understood that the particular arrangements described have been given by way of example only and that modifications may be made without departing from the scope of the invention.

What I claim as my invention and desire to secure by Letters Patent is:—

1. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a bevel reversing mechanism so connected to the gear that the full range of speeds of the gear is available either in the forward or in the reverse direction of motion, a set of coupled track wheels, means for transmitting the drive from the internal combustion engine through the variable speed gear and the reversing mechanism to the track wheels, and a fluid pressure system for controlling the plate clutches of the gear.

2. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a plurality of epicyclic variable speed gears, plate clutches controlling the gear ratio of each gear, a bevel reversing mechanism associated with each gear, a set of coupled track wheels associated with each gear, means for transmitting the drive from the internal combustion engine to each set of coupled track wheels through its variable speed gear and its reversing mechanism, and a fluid pressure system for simultaneously controlling the plate clutches of all the gears.

3. An internal combustion engine locomotive, comprising a plurality of internal combustion engines of the heavy oil type, at least one epicyclic variable speed gear connected to each engine, plate clutches controlling the gear ratio of each gear, a bevel reversing mechanism associated with each gear, a set of coupled track wheels associated with each gear, means for driving each set of coupled track wheels from an internal combustion engine through its variable speed gear and its reversing mechanism, and a fluid pressure system for simultaneously controlling the plate clutches of all the gears.

4. An internal combustion engine locomotive including in combination a plurality of locomotive units, each unit comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, plate clutches controlling the gear ratio of each gear, a bevel reversing mechanism, a set of coupled track wheels, and means for transmitting the drive from the internal combustion engine to the track wheels through the variable speed gear and the reversing mechanism, and a fluid pressure system for simultaneously controlling the plate clutches of all the variable speed gears.

5. An internal combustion engine locomo-

tive, comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a bevel reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the internal combustion engine through the variable speed gear and the reversing mechanism to the track wheels, a fluid pressure system for controlling the plate clutches of the gear, and means whereby the fluid pressure system is controlled partly by hand and partly automatically in accordance with the road speed of the locomotive.

6. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a bevel reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the internal combustion engine through the variable speed gear and the reversing mechanism to the track wheels, a fluid pressure operated device for controlling the plate clutches of the gear, a controlling device for the reversing mechanism, and means for interlocking the two controlling devices with one another whereby the reversing mechanism cannot be operated except when the gear is in its neutral position and the gear cannot be adjusted from its neutral position except when the reversing mechanism is in one or other of its operative driving positions.

7. An internal combustion engine locomotive comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a fluid pressure system for controlling the plate clutches, means for transmitting the drive from the engine to the gear, a set of coupled track wheels, a bevel wheel driven by the gear, a transverse shaft, two bevel pinions fixed rigidly on the transverse shaft and so positioned that either of them can be brought into engagement with the bevel wheel, means for moving the transverse shaft axially, and means for transmitting the drive from the transverse shaft to the track wheels.

8. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, an epicylic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a bevel reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the internal combustion engine through the variable speed gear and the reversing mechanism to the track wheels, a fluid pressure system for controlling the plate clutches of the gear, a device for actuating the reversing mechanism by hand, and means for locking this actuating device except when the locomotive is at rest.

9. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a fluid pressure system for controlling the plate clutches, means for transmitting the drive from the engine to the gear, a set of coupled track wheels, a bevel wheel driven by the gear, a transverse shaft, two bevel pinions fixed rigidly on the transverse shaft and so positioned that either of them can be brought into engagement with the bevel wheel, means for transmitting the drive from the transverse shaft to the track wheels, worm gearing by means of which the transverse shaft can be moved axially, a hand-wheel for actuating the worm gearing, and fluid pressure operated means for locking the hand wheel except when the locomotive is at rest.

10. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a bevel reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the internal combustion engine through the variable speed gear and the reversing mechanism to the track wheels, a fluid pressure system for controlling the plate clutches of the gear, a hand lever for controlling the supply of pressure fluid to the plate clutches, a controlling device for the reversing mechanism, fluid pressure operated locking means for this controlling device, a hand lever for controlling the supply of pressure fluid to the locking means, and means for interlocking the two hand levers with one another whereby the reversing mechanism is locked against operation except when the gear is in its neutral position and the gear cannot be adjusted from its neutral position except when the reversing mechanism is locked in one or another of its operative driving positions.

11. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a bevel reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the internal combustion engines through the variable speed gear and the reversing mechanism to the track wheels, a fluid pressure system for controlling the plate clutches of the gear, a governor driven in accordance with the road speed of the locomotive, a con-

trol valve actuated by the governor, and a hand-operated distributing valve which operates in conjunction with the control valve to control the fluid pressure system.

12. An internal combustion engine locomotive, including in combination an internal combustion engine of the heavy oil type, a transmission unit, a set of coupled track wheels, a driving shaft through which power is supplied from the engine to the transmission unit, and means for transmitting power from the transmission unit to the track wheels, the transmission unit comprising a casing, an epicyclic variable speed gear mounted within the casing and driven from the driving shaft, plate clutches operative on the elements of the gear to control the gear ratio thereof, a bevel wheel mounted on the driven element of the gear and two bevel pinions adapted selectively to engage with the bevel wheel and constituting therewith a reversing mechanism contained within the casing.

13. An internal combustion engine locomotive including in combination an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a bevel reversing mechanism, a set of coupled track wheels, a driving shaft through which power is supplied from the engine to the gear, and means for transmitting power from the driven element of the gear through the reversing mechanism to the track wheels, the gear comprising a loose sun wheel, a loose internally toothed annulus, a set of planet pinions meshing with the sun wheel and the annulus, a driven element carrying the planet pinions, and four plate clutches operative to control the gear ratio of the gear, two of these clutches being operative respectively to couple the annulus and the sun wheel to the driving shaft whilst the other two are operative respectively to hold the annulus and the sun wheel against rotation.

14. An internal combustion engine locomotive including in combination an internal combustion engine of the heavy oil type, a driving shaft through which power is supplied therefrom, an epicyclic variable speed gear train comprising a loose sun wheel, a loose internally toothed annulus, and a set of planet pinions meshing with the sun wheel and the annulus, a driven member carrying the planet pinions of the gear, a bevel reversing mechanism comprising a bevel wheel mounted on the driven member of the gear, a transverse shaft movable in the direction of its axis, and two bevel pinions rigidly fixed on the transverse shaft and adapted to engage selectively with the bevel wheel, a fixed casing containing the gear and the reversing mechanism, four plate clutches contained within the casing and the operative to control the gear ratio of the gear these clutches when operated respectively acting to couple the sun wheel to the driving shaft, the annulus to the driving shaft, the sun wheel to the fixed casing and the annulus to the fixed casing, a fluid pressure system for selectively controlling the four plate clutches, and means for transmitting the drive from the transverse shaft of the reversing mechanism to the track wheels.

15. An internal combustion engine locomotive including in combination an internal combustion engine of the heavy oil type, a driving shaft through which power is supplied therefrom, an epicyclic variable speed gear train comprising a loose sun wheel, a loose internally toothed annulus, and a set of planet pinions meshing with the sun wheel and the annulus, a driven member carrying the planet pinions of the gear, a bevel reversing mechanism, means for transmitting the drive from the driven member of the gear through the reversing mechanism to the track wheels, four plate clutches operative to control the gear ratio of the gear, two of these clutches being operative respectively to couple the annulus and the sun wheel to the driving shaft whilst the other two are operative respectively to hold the annulus and the sun wheel against rotation, a fluid pressure system for operating the plate clutches, and a hand-operated distributing valve for selectively controlling the supply of pressure fluid from the system to the four plate clutches.

16. An internal combustion engine locomotive including in combination an internal combustion engine of the heavy oil type, a driving shaft through which power is supplied therefrom, an epicyclic variable speed gear train comprising a loose sun wheel, a loose internally toothed annulus, and a set of planet pinions meshing with the sun wheel and the annulus, a driven member carrying the planet pinions of the gear, a bevel reversing mechanism, means for transmitting the drive from the driven member of the gear through the reversing mechanism to the track wheels, four plate clutches operative to control the gear ratio of the gear two of these clutches being operative respectively to couple the annulus and the sun wheel to the driving shaft whilst the other two are operative respectively to hold the annulus and the sun wheel against rotation, a fluid pressure system for selectively operating the four plate clutches, and means whereby the supply of pressure fluid to the clutches is controlled partly by hand and partly automatically in accordance with the road speed of the locomotive.

17. An internal combustion engine locomotive including in combination an internal combustion engine of the heavy oil type, a driving shaft through which power is supplied from the engine, a casing, an epicyclic variable speed gear mounted within the

casing and driven from the driving shaft, plate clutches operative on the elements of the gear to control the gear ratio thereof, a bevel wheel mounted on the driven element of the gear, two bevel pinions adapted selectively to engage with the bevel wheel and constituting therewith a reversing mechanism contained within the casing, a transverse shaft to which the two bevel pinions are rigidly fixed, a hand-operated device for moving the transverse shaft in the direction of its axis whereby either of the bevel pinions can be brought into engagement with the bevel wheel, fluid pressure operated locking means for this device, a hand lever for controlling the supply of pressure fluid to the locking means, a fluid pressure system for controlling the plate clutches of the gear, a hand lever for controlling the supply of pressure fluid to the plate clutches, means for interlocking the two hand levers with one another, a set of coupled track wheels, and means for transmitting the drive from the transverse shaft to the track wheels.

18. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a variable speed gear, a fluid pressure system for controlling the gear ratio of the gear, a reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the engine through the gear and the reversing mechanism to the track wheels, a device connected to one member of the transmission system comprising two parts between which relative movement is produced by variations in the torque transmitted through the member to which the device is connected, and means whereby such relative movement is caused to control the fluid pressure system.

19. An internal combustion engine locomotive comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a driving shaft through which power from the engine is supplied to the gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a fluid pressure system for selectively controlling the plate clutches of the gear, a bevel reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the gear through the reversing mechanism to the track wheels, a device connected to the driving shaft comprising two flexibly connected parts between which relative movement is produced by variations in the torque transmitted through the shaft, and means whereby such relative movement is caused to vary the pressure in the fluid pressure system.

20. An internal combustion engine locomotive including in combination an internal combustion engine of the heavy oil type, a variable speed gear, a driving shaft through which power is supplied from the engine to the gear this shaft being divided into two parts, a fluid pressure system for controlling the gear ratio of the gear, a reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the gear through the reversing mechanism to the track wheels, a device forming an operative driving connection between the two parts of the driving shaft and comprising two coaxial wheels carried respectively by these two parts and a spring connection between the two wheels, differential mechanism operated in accordance with the relative movement between the two wheels, and means whereby the differential mechanism is caused to control the fluid pressure system.

21. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, a plurality of plate clutches operative to control the gear ratio of the variable speed gear, a bevel reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the internal combustion engine through the variable speed gear and the reversing mechanism to the track wheels, a fluid pressure system for controlling the plate clutches of the gear, a governor driven in accordance with the road speed of the locomotive, a control valve actuated by the governor, a hand-operated distributing valve which operates in conjunction with the control valve to control the fluid pressure system, a device connected to one member of the transmission system comprising two flexibly connected parts between which relative movement is produced by variations in the torque transmitted through the member to which the device is connected, and means whereby such relative movement is caused to control the pressure in the fluid pressure system.

22. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a plurality of epicyclic variable speed gears, plate clutches controlling the gear ratio of each gear, a bevel reversing mechanism associated with each gear, a set of coupled track wheels associated with each gear, means for transmitting the drive from the internal combustion engine to each set of coupled track wheels through its variable speed gear and its reversing mechanism, a fluid pressure system for simultaneously controlling the plate clutches of all the gears, a hand-operated device for simultaneously actuating all the reversing mechanisms, and means for locking this actuating device except when the locomotive is at rest.

23. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a plurality of epicyclic variable speed gears, plate clutches controlling the gear ratio of each gear, a

bevel reversing mechanism associated with each gear, a set of coupled track wheels associated with each gear, means for transmitting the drive from the internal combustion engine to each set of coupled track wheels through its variable speed gear and its reversing mechanism, a fluid pressure system for simultaneously controlling the plate clutches of all the gears, and means whereby the fluid pressure system is controlled partly by hand and partly automatically in accordance with the road speed.

24. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a plurality of epicyclic variable speed gears, plate clutches controlling the gear ratio of each gear, a bevel reversing mechanism associated with each gear, a set of coupled track wheels associated with each gear, means for transmitting the drive from the internal combustion engine to each set of coupled track wheels through its variable speed gear and its reversing mechanism, a fluid pressure system for simultaneously controlling the plate clutches of all the gears, a governor driven in accordance with the road speed of the locomotive, a control valve actuated by the governor, a distributing valve which operates in conjunction with the control valve to control the fluid pressure system, a hand lever for actuating the distributing valve, a device for simultaneously actuating all the reversing mechanisms, fluid pressure operated locking means for this actuating device, a hand lever for controlling the supply of pressure fluid to the locking means, and means for interlocking the two hand levers with one another.

25. An internal combustion engine locomotive, including in combination a plurality of locomotive units, each unit comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, plate clutches controlling the gear ratio of each gear, a bevel reversing mechanism, a set of coupled track wheels, and means for transmitting the drive from the internal combustion engine to the track wheels through the variable speed gear and the reversing mechanism, a fluid pressure system for simultaneously controlling the plate clutches of all the variable speed gears, a governor driven in accordance with the road speed of the locomotive, a control valve actuated by the governor, and a hand-actuated distributing valve which operates in conjunction with the control valve to control the fluid pressure system.

26. An internal combustion engine locomotive including in combination a plurality of locomotive units, each unit comprising an internal combustion engine of the heavy oil type, an epicyclic variable speed gear, plate clutches controlling the gear ratio of each gear, a bevel reversing mechanism, a set of coupled track wheels, and means for transmitting the drive from the internal combustion engine to the track wheels through the variable speed gear and the reversing mechanism, a fluid pressure system for simultaneously controlling the plate clutches of all the variable speed gears, a distributing valve for controlling the fluid pressure system, a hand lever for actuating the distributing valve, a device for simultaneously actuating all the reversing mechanisms, fluid pressure operated locking means for this actuating device, a hand lever for controlling the supply of pressure fluid to the locking means, and means for interlocking the two hand levers with one another.

27. An internal combustion engine locomotive including in combination a plurality of locomotive units, each unit comprising an internal combustion engine of the heavy oil type, a variable speed gear, a driving shaft through which power is supplied from the engine to the gear, a reversing mechanism, a set of coupled track wheels, means for transmitting the drive from the gear through the reversing mechanism to the track wheels, and a torque-limiting device connected to the driving shaft and consisting of two parts between which relative movement is produced by variations in the torque transmitted through the shaft, a fluid pressure system for simultaneously controlling the gear ratios of all the gears, and means whereby relative movement between the parts of any of the torque-limiting devices is caused to control the fluid pressure system.

28. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a variable speed gear, means for transmitting the drive from the engine to the gear, a set of coupled track wheels, a bevel wheel driven by the gear, a transverse shaft, two bevel pinions fixed rigidly on the transverse shaft and so positioned that either of them can be brought into engagement with the bevel wheel, means for transmitting the drive from the transverse shaft to the track wheels, worm gearing by means of which the transverse shaft can be moved axially, a hand-wheel for actuating the worm gearing, a controlling device for locking the hand-wheel against operation, a device for controlling the gear ratio of the variable speed gear, and means for interlocking the two controlling devices with one another.

29. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a variable speed gear, means for transmitting the drive from the engine to the gear, a set of coupled track wheels, a bevel wheel driven by the gear, a transverse shaft, two bevel pin-

ions fixed rigidly on the transverse shaft and so positioned that either of them can be brought into engagement with the bevel wheel, means for transmitting the drive from the transverse shaft to the track wheels, hand-operated means for moving the transverse shaft axially, a device for locking such hand-operated means, a hand-lever for controlling the locking device, a hand-lever for controlling the gear ratio of the variable speed gear, and a mechanical interlock between the two hand-levers.

30. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a variable speed gear, means for transmitting the drive from the engine to the gear, a set of coupled track wheels, a bevel wheel driven by the gear, a transverse shaft, two bevel pinions fixed rigidly on the transverse shaft and so positioned that either of them can be brought into engagement with the bevel wheel, means for transmitting the drive from the transverse shaft to the track wheels, hand-operated means for moving the transverse shaft axially, a controlling device for locking such hand-operated means, a fluid-pressure operated device for controlling the gear-ratio of the variable speed gear, and means for interlocking the two controlling devices with one another.

31. An internal combustion engine locomotive, including in combination an internal combustion engine of the heavy oil type, a transmission unit, a set of coupled track wheels, a driving shaft through which power is transmitted from the engine to the transmission unit, and means for transmitting power from the transmission unit to the track wheels, the transmission unit comprising a casing, a variable speed gear mounted within the casing and driven from the driving shaft, a bevel wheel mounted on the driven element of the gear, two bevel pinions adapted selectively to engage with the bevel wheel and constituting therewith a reversing mechanism contained within the casing, a device for controlling the gear-ratio of the variable speed gear, a controlling device for the reversing mechanism, and means for interlocking the two controlling devices with one another whereby the reversing mechanism cannot be operated except when the gear is in its neutral position and the gear cannot be adjusted from its neutral position except when the reversing mechanism is in one or another of its operative driving positions.

32. An internal combustion engine locomotive, including in combination an internal combustion engine of the heavy oil type, a transmission unit, a set of coupled track wheels, a driving shaft through which power is transmitted from the engine to the transmission unit, and means for transmitting power from the transmission unit to the track wheels, the transmission unit comprising a casing, an epicyclic variable speed gear train contained within the casing and consisting of a loose sun wheel, a loose internally toothed annulus, and a set of planet pinions meshing with the sun wheel and the annulus, a driven member carrying the planet pinions, two plate clutches operative respectively to couple the sun wheel and the annulus to the driving shaft, two plate clutches operative respectively to hold the sun wheel and the annulus against rotation, a bevel wheel mounted on the driven member of the gear, and two bevel pinions adapted selectively to engage with the bevel wheel and constituting therewith a reversing mechanism contained within the casing.

33. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a variable speed gear, a driving shaft through which power is transmitted from the engine to the gear, a reversing mechanism, a set of coupled track wheels, means for transmitting power from the gear through the reversing mechanism to the track wheels, a device connected to the driving shaft comprising two flexibly connected parts between which relative movement is produced by variations in the torque transmitted through the shaft, and means whereby such relative movement beyond a predetermined maximum is caused to disconnect the gear from the driving shaft.

34. An internal combustion engine locomotive, including in combination an internal combustion engine of the heavy oil type, a driving shaft through which power is supplied therefrom, an epicyclic variable speed gear train comprising a loose sun wheel, a loose internally toothed annulus, and a set of planet pinions meshing with the sun wheel and the annulus, two plate clutches operative respectively to couple the sun wheel and the annulus to the driving shaft, two plate clutches operative respectively to hold the sun wheel and the annulus against rotation, a driven member carrying the planet pinions, a reversing mechanism, a set of coupled track wheels, means for transmitting power from the driven member through the reversing mechanism to the track wheels, a device connected to the driving shaft and comprising two flexibly connected parts between which relative movement is produced by variations in the torque transmitted through the shaft, and means whereby such relative movement is caused to control the amount of slip permitted between the individual plates of the clutches.

35. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a set of coupled track wheels, a transmission system including a variable speed gear, means for trans-

mitting the drive from the engine through the transmission system to the track wheels, means whereby the gear ratio of the variable speed gear is controlled partly by hand and partly automatically in accordance with the road speed of the locomotive, a device connected to one member of the transmission system comprising two parts between which relative movement is caused by variations in the torque transmitted through the member, and means whereby such relative movement beyond a predetermined maximum is caused to cut out the gear and thereby to disconnect the engine from the track wheels.

36. An internal combustion engine locomotive, including in combination an internal combustion engine of the heavy oil type, a plurality of variable speed gears, a bevel reversing mechanism associated with each gear and comprising a bevel wheel driven by the gear, a transverse shaft, two bevel pinions rigidly mounted on the transverse shaft and adapted selectively to engage with the bevel wheel, and worm gearing for moving the transverse shaft axially, a set of coupled track wheels associated with each reversing mechanism, means for transmitting the drive from the engine through the gears and the reversing mechanisms to the track wheels, means for simultaneously controlling the gear ratios of all the gears, and a hand-operated device for actuating the worm gearings whereby all the reversing mechanisms are simultaneously actuated.

37. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a plurality of variable speed gears, a reversing mechanism associated with each gear, a set of coupled track wheels associated with each gear, means for transmitting the drive from the engine through the gears and the reversing mechanisms to the track wheels, a device for simultaneously controlling the gear ratios of all the gears, a device for simultaneously controlling all the reversing mechanisms, and means for interlocking the two controlling devices with one another whereby the reversing mechanisms can not be actuated except when the gears are in their neutral positions and the gears cannot be adjusted from their neutral positions except when the reversing mechanisms are in one or another of their operative positions.

38. An internal combustion engine locomotive, comprising an internal combustion engine of the heavy oil type, a plurality of transmission systems each including a variable speed gear, a set of coupled track wheels associated with each transmission system, means for transmitting the drive from the engine through each transmission system to its track wheels, means for simultaneously controlling the gear ratios of all the variable speed gears, a device connected to one member of a transmission system comprising two parts between which relative movement is caused by variations in the torque transmitted through the member, and means whereby such relative movement beyond a predetermined maximum is caused to cut out all the gears and thereby to disconnect the engine from the track wheels.

In testimony whereof I have signed my name to this specification.

ALAN ERNEST LEOFRIC CHORLTON.