(No Model.)

5 Sheets—Sheet 1.

M. N. FORNEY.

LOCOMOTIVE ENGINE.

No. 266,685.

Patented Oct. 31, 1882.

FIG. 1.

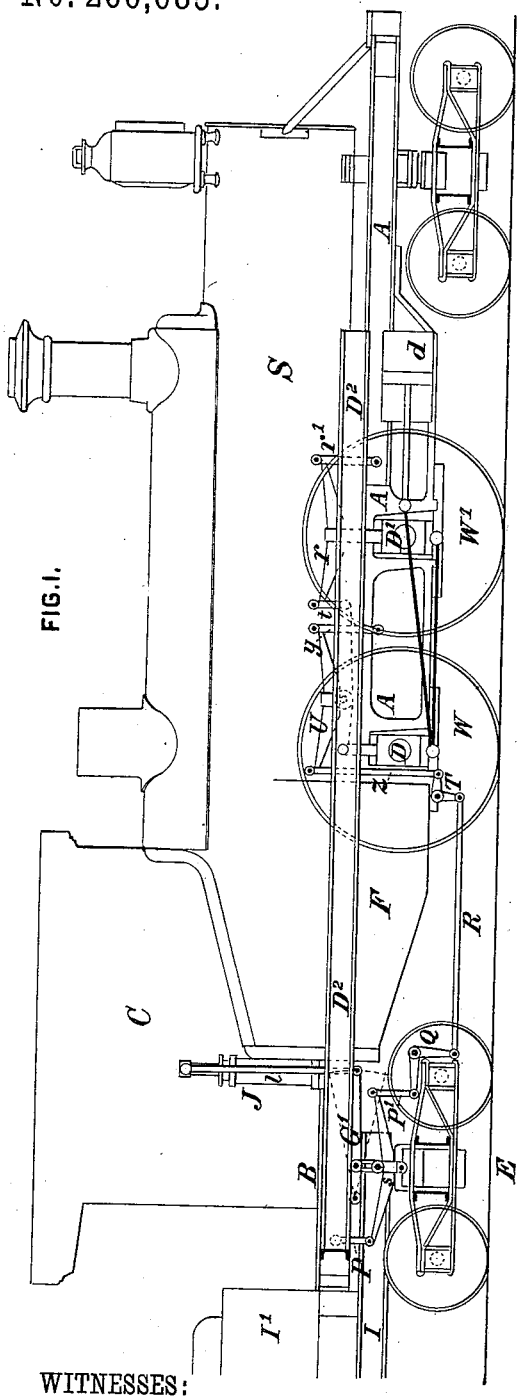
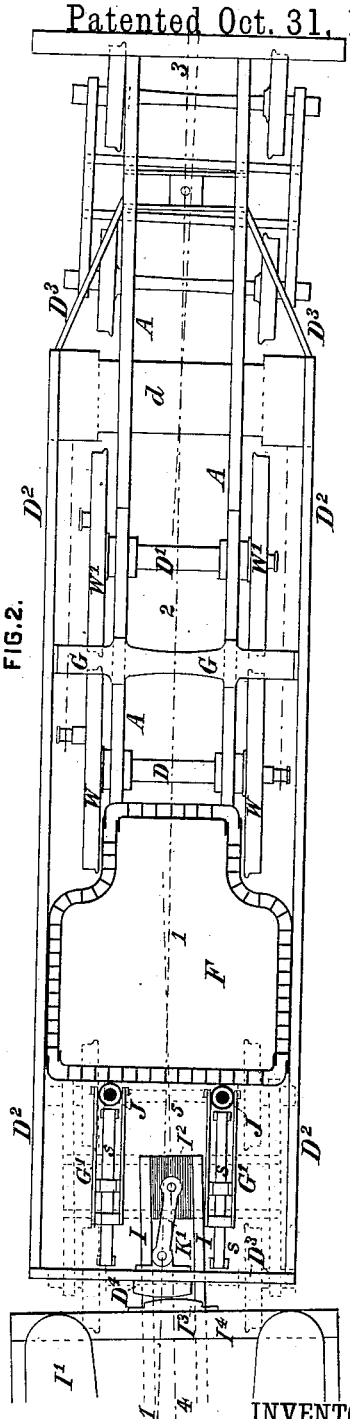


FIG. 2.



WITNESSES:

Geo. B. Collier

Geo. T. Kelly

INVENTOR

M. N. Forney.

by Collier & Bell,

ATTORNEYS.

(No Model.)

5 Sheets—Sheet 2.

M. N. FORNEY.

LOCOMOTIVE ENGINE.

No. 266,685. Patented Oct. 31, 1882.

FIG. 3.

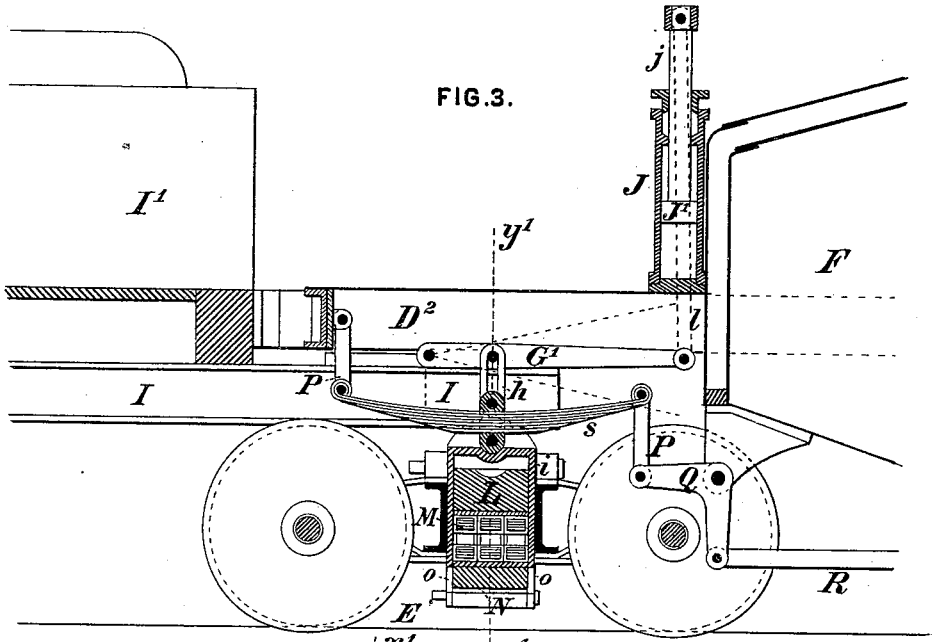
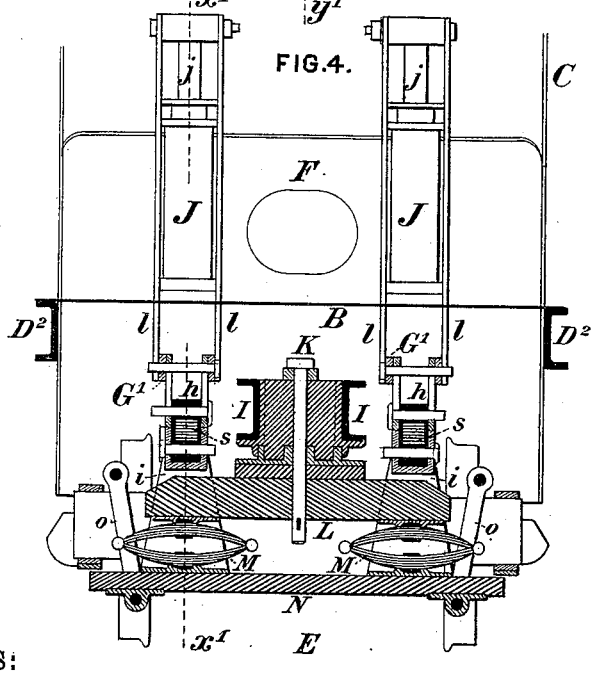


FIG. 4.



WITNESSES:

Geo. B. Collier

Geo. T. Kelly

INVENTOR

M. N. Forney,

by Collier & Bell,

ATTORNEYS.

(No Model.)

5 Sheets—Sheet 3.

M. N. FORNEY.

LOCOMOTIVE ENGINE.

No. 266,685. Patented Oct. 31, 1882.

FIG. 5.

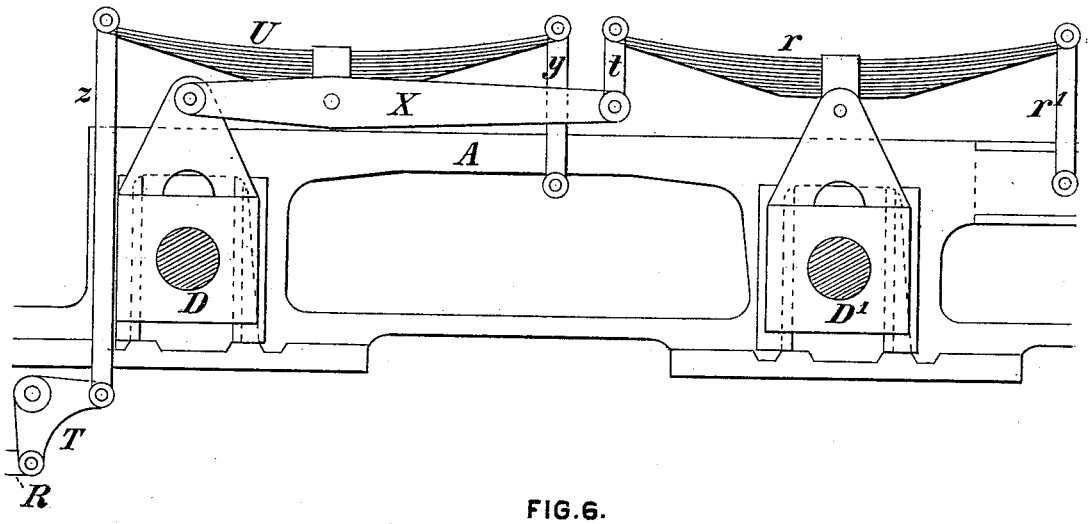


FIG. 6.

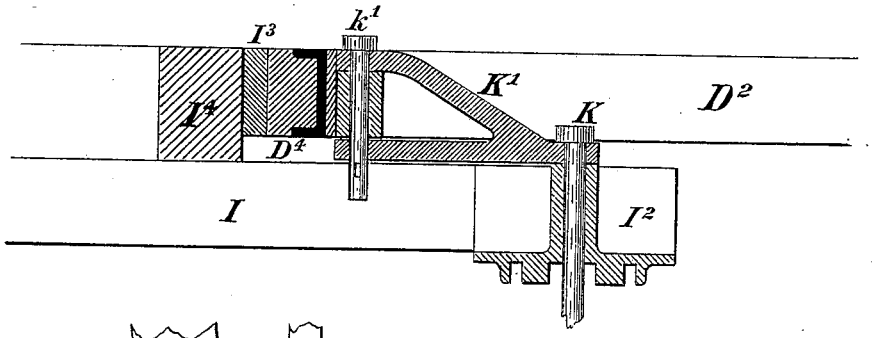
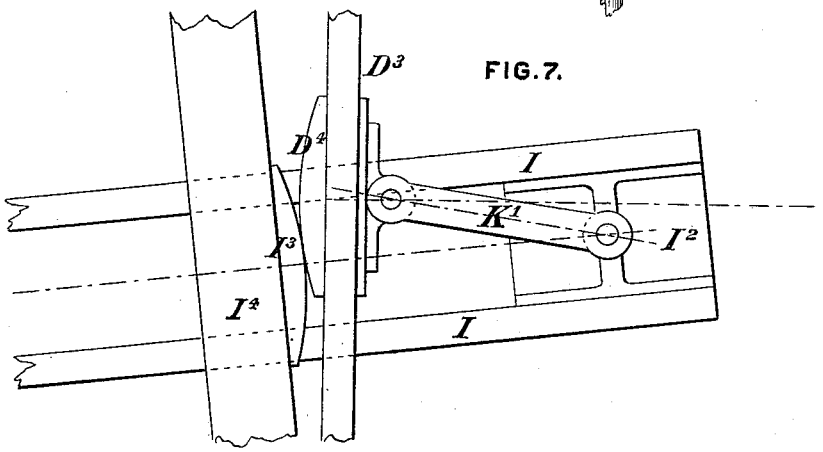


FIG. 7.



WITNESSES:

Geo. B. Collier

Geo. T. Kelly.

INVENTOR

M. N. Forney

by Collier & Bell,

ATTORNEYS.

(No Model.)

5 Sheets—Sheet 4.

M. N. FORNEY.

LOCOMOTIVE ENGINE.

No. 266,685. Patented Oct. 31, 1882.

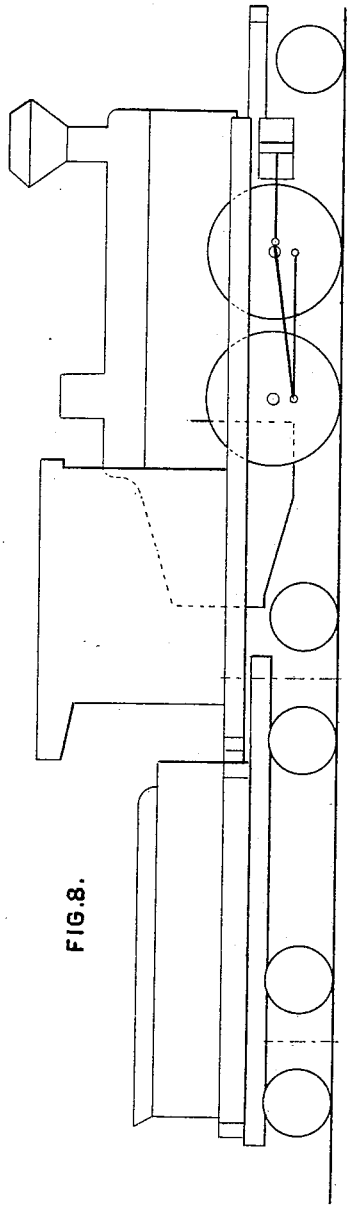


FIG. 8.

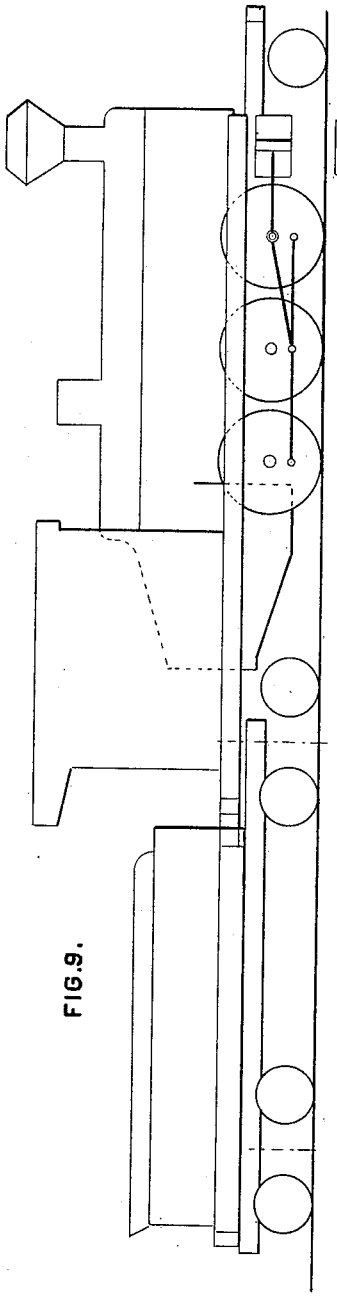


FIG. 9.

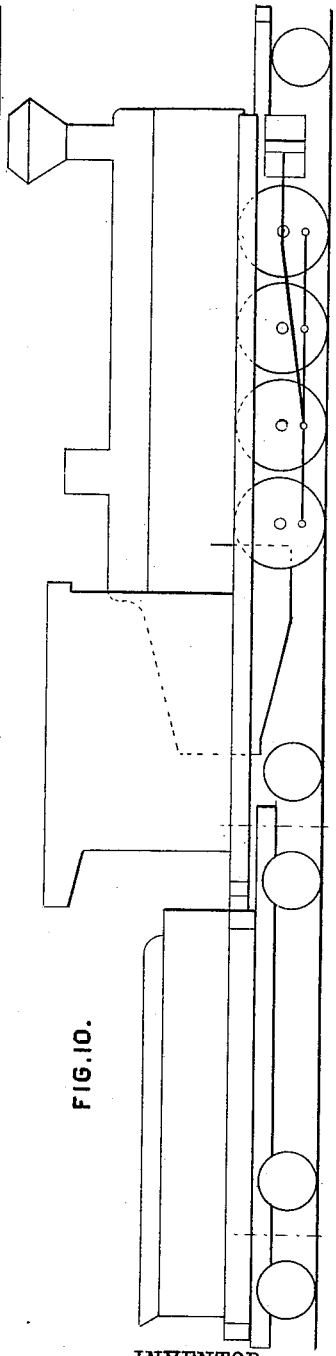


FIG. 10.

WITNESSES:

Geo. B. Collier

Geo. T. Kelly.

INVENTOR

M. N. Forney,

by Collier & Bell,

ATTORNEYS.

(No Model.)

5 Sheets—Sheet 5.

M. N. FORNEY.

LOCOMOTIVE ENGINE.

No. 266,685. Patented Oct. 31, 1882.

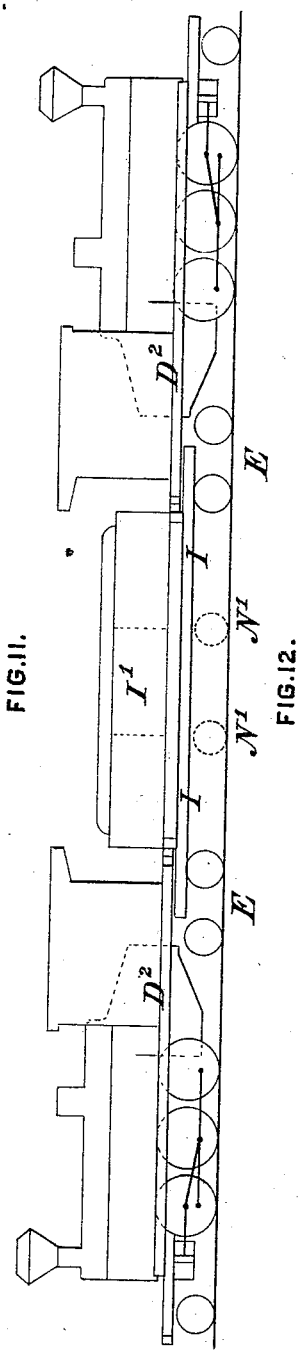


FIG. 11.

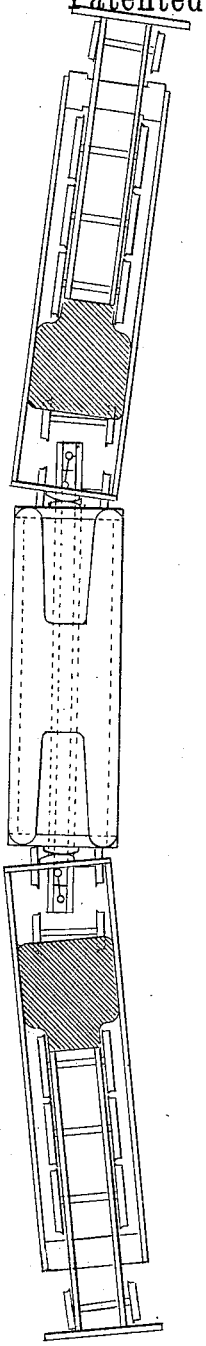


FIG. 12.

WITNESSES:

Geo. B. Collier

Geo. T. Kelly.

INVENTOR

M. N. Forney,

by Collier & Bell,

ATTORNEYS.

UNITED STATES PATENT OFFICE.

MATTHIAS N. FORNEY, OF NEW YORK, N. Y.

LOCOMOTIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 266,685, dated October 31, 1882.

Application filed August 26, 1882. (No model.)

To all whom it may concern:

Be it known that I, MATTHIAS N. FORNEY, of the city, county, and State of New York, have invented certain new and useful Improvements in Locomotive-Engines, of which improvements the following is a specification.

The objects of my invention are to attain in a locomotive-engine the advantages which result upon carrying part of the weight of the engine upon one or more trucks, and the use of a flexible wheel-base, together with the capacity of increasing the adhesion of the engine, as may from time to time be rendered necessary or desirable by the character of its duty, by placing upon the driving-wheels weight additional to that borne by them in ordinary service; also, to reduce to a minimum the distance between the centers of the driving-axles, and consequently the length of the coupling-rods, and to apply in an engine having such reduced driving-wheel base a fire-box as wide as or wider than the distance between the wheels; also, to enable two locomotive-engines to be operated in conjunction with a single tender with greater facility and advantage than have heretofore been practicable, said results being made attainable without necessitating the employment of any wheels additional to those which are at present ordinarily used in locomotives and tenders.

To these ends my invention consists in certain novel devices and combinations whereby a portion of the weight of the engine is supported adjustably upon the adjacent truck of the tender, so as to be capable of being transferred in greater or less degree, as required, to or from said truck, and caused to bear correspondingly upon the driving-axles; also, in a novel combination of main frames, spring arrangement, and supplemental frames with a fire-box as wide as or wider than the distance between the wheels; also, in the combination of a locomotive-engine, a tender, and connecting draw-gear, adapted to effect the application of the tractive resistance of the train to the engine in such manner as will tend to cause the movement of the latter to constantly conform, as nearly as may be, with the varying curvature of the road. The improvements claimed are hereinafter fully set forth.

Under the plan of locomotive-engine construction which is known as the "standard" or "American" pattern, and which has heretofore been in use to a larger extent than any other in the United States, the forward end of the engine is supported on a truck or "bogie" and the rear end on two or more pairs of driving-wheels, one pair being usually placed behind or beneath the fire-box. Where two pairs of driving-wheels only are employed one pair must of necessity be located at or adjacent to the rear end of the fire-box, in order to avoid an undue preponderance of overhanging weight, and if the remaining pair or pairs of driving-wheels be placed close to the first only a comparatively small and insufficient proportion of the total weight of the engine will be carried by the driving-wheels, and as a result the engine will be deficient in adhesion and an excess of weight will be carried by the forward truck. If, on the other hand, the front pair of driving-wheels is placed farther forward, so that they will carry a larger proportion of the weight, the objection obtains that the coupling-rods will be unduly long and the connecting-rods correspondingly short.

In the practice of my invention I locate all the driving-axles in front of the fire-box, and sustain the weight due to the overhang of the latter by supporting the rear end of the engine upon the front truck of the tender. The driving-axles can therefore be located as closely together as is admitted by the diameter of the wheels, and being, when so placed, adjacent to the longitudinal center of the engine, they naturally bear all the weight thereof, except that sustained in front and rear by the leading truck of the engine and the front truck of the tender, respectively. Consequently, if either of said supports be removed or relieved, the sustained weight thereby taken from it will be transferred to the driving-axles, and I enable such transfer of the front or rear overhanging weight to be made in whole or in part, as may become desirable under varying conditions of duty, by providing mechanism consisting of steam or air cylinders and pistons and proper connections, whereby the weight of the engine which is sustained by the front tender-truck, or a portion thereof, may be removed or relaxed there-

from and transferred to the driving-wheels, the adhesion of which may be thus increased or diminished from time to time, as required. The same or analogous mechanism may be applied to the front truck of the engine, so as to increase or diminish the weight carried thereon, or such mechanism may be applied to the driving-axles, so as to vary the weight carried by either or both the trucks. In order that the springs of the front tender-truck may not at times be unduly loaded, or at other times carry insufficient weight, I provide two separate sets of springs upon said truck, the one set to carry that portion of the weight of the tender which rests upon said truck, and the other or supplemental set to carry that portion of the weight of the engine which is at times supported by the tender-truck. The steam or air cylinders for varying the weight of the locomotive on the truck are connected with the supplemental set of springs, and act to compress or release them by the pressure of steam or air in the cylinders. It is designed that the tension of the supplemental springs shall ordinarily support that part of the weight of the locomotive which rests upon the front tender-truck; but when upon occasion it becomes desirable to increase the weight upon the driving-wheels the supplemental springs are compressed by the steam or air pistons, thus relieving said springs of part or all of the weight which they would otherwise carry, and to that extent increasing the weight on the driving-wheels.

Again, in locomotives of the class referred to, as heretofore constructed, the fire-box must either be unduly contracted in dimensions or enlarged to the required extent at the expense of attendant disadvantages. Experience has demonstrated the location of the frames and driving-axle journals upon the inside of the driving-wheels to be the most advantageous one, and such is the arrangement universally adopted in the United States. Under these circumstances the fire-box must either be placed between or on top of the frames, both of which plans are open to objection. In the first case the width of the fire-box in large boilers is of necessity considerably less than the diameter of the boiler, the result of which is that the circulation of the water on the sides of the fire-box is impeded and the general efficiency of the boiler and engine correspondingly diminished, the evil being aggravated on railroads of gages narrower than the standard. The second case involves a boiler unduly high or a fire-box correspondingly shallow, the objections to each of which conditions are obvious. In some instances the frames at the rear end of the engine have been placed at a greater distance apart than the main frames in which the driving-axles are carried, in order to admit of increasing the width of a fire-box located between said rear frames without raising the boiler or reducing the depth of the fire-box, the increased spread of the frames at the rear end being obtained by bending the main frames outward in rear of the hindmost driving-wheels or by the insertion of a cross-piece to which the front ends of the rear frames and the rear ends of the main frames are connected. The objection to this construction is that by reason of the interposition of the cross-piece or the lateral extensions of the main frames between the rear driving-wheels and fire-box the distance from the front of the fire-box to the center of the rear driving-axle cannot be less than substantially the same as half the diameter of the wheels, so that for a given length of engine the space available for length of fire-box is reduced by that amount. Such limitation is, as will hereinafter appear, avoided by my invention.

In the accompanying drawings, Figure 1 is a diagrammatic side view, in elevation, of a locomotive-engine embodying my invention; Fig. 2, a plan or top view of the same with the waist of the boiler removed and the fire-box in section; Fig. 3, a vertical longitudinal section through the front tender-truck at the line *x x* of Fig. 4; Fig. 4, a vertical transverse section through the same at the line *y y* of Fig. 3; Fig. 5, a side view in elevation of the driving-spring arrangement; Fig. 6, a vertical longitudinal central section through the draw-bar and its connections; Fig. 7, a plan or top view of the same in the position occupied when the engine and tender are passing around a curve of comparatively short radius; Figs. 8, 9, and 10, side elevation diagrams, illustrating the application of my invention to engines having two, three, and four pairs of driving-wheels, respectively; and Figs. 11 and 12, diagrams in side elevation and in plan, respectively, showing two locomotive-engines arranged in accordance with my invention to operate in connection with a single tender.

The main frames A A of the engine are placed, as in the ordinary construction, inside the driving-wheels W W′, and are provided with proper jaws or pedestals to receive the journal-boxes of the driving-axles D D′, which are located between the fire-box F and smoke-box S. Instead of being carried backward in a direct line to the rear end of the engine, as in the general practice heretofore, the main frames A A terminate at the front of the fire-box, and the cab C, foot-board B, and overhanging weight of the fire-box F are carried by a pair of supplemental frames, D^2, placed upon the outside of the driving-wheels. Said supplemental frames extend backward for a sufficient distance to admit of the use of a foot-board of proper dimensions and of being supported, as hereinafter described, by the front truck, E, of the tender, and are rigidly secured at their forward ends to the main frames A A by one or more cross or connecting pieces, G, located in front of the driving-axle D nearest to the fire-box. The supplemental frames D^2 may, if desired, be extended sufficiently far forward to be attached to the

cylinder-castings *d*, and may also be connected at their front ends to the main frames by diagonal braces D^3 or otherwise.

The employment of outside supplemental frames, located and connected as described, enables the front of the fire-box to be brought closely up to the rear driving-axle and to the tires of the wheels thereof, so as to render available all the space behind said axle and between the tires not required for clearance, and permits the fire-box to be widened out behind the rear driving-wheels, so as to occupy the full width of the space between the outside or supplemental frames, as shown in Fig. 2, thus admitting of the use of a fire-box of much larger dimensions than is practicable under the ordinary construction, while retaining the advantage of locating the main frames and driving-axle journals inside the wheels. Where, as heretofore constructed, the main frames are extended to the rear end of the engine along the sides of the fire-box, it becomes necessary, in order to obtain the greatest available width for the latter, to keep the frames as far apart as the distance between the wheels will permit, and there ensues a consequent limitation of the length of the driving-axle journals, as, if the latter be made of such length as is desirable, the frames must be placed on one side of or out of the center of the journal-bearings. By my improvements the main frames may be placed as close together as desired, and therefore the driving-axle journals can be lengthened to any extent not exceeding half the distance between the hubs of the wheels without any attendant disadvantage.

The employment of a fire-box occupying all the space between the rear driving-wheels and behind the rear driving-axle is not, however, admissible with a system of driving-springs and their accessories as usually heretofore arranged, for the reason that in such case sufficient room would not be afforded for the rear pair of springs and their hangers to be located above the axle. Where the springs are placed below the axle they are inconvenient of access, liable to be displaced in the event of derailment of the engine, and require to be taken down to admit of the removal of the boxes and axles, for which reason preference has been given almost universally in American practice to the location of the springs above the axles. I render the same practicable, in connection with a fire-box of the form and location last above referred to, by the construction shown in Fig. 1, and on a larger scale in Fig. 5.

Referring to said figures, the springs *r* of the forward pair of driving-wheels are placed in the usual position above the driving-boxes thereof, so that the main frames A may be suspended from the front hangers, *r'*, of the springs *r* at a point as far forward as is desirable, and undue preponderance of weight beyond the point of support be avoided. An equalizing-lever, X, is suspended at its front end by a link, *t*, from the rear end of each forward spring, *r*, and is connected at its rear end to a stirrup, *u*, supported by the journal-box of the rear driving-axle, D. The rear driving-springs, U, are so placed as to bear upon the equalizing-levers X at a distance of about one-third their length from their rear ends, and the ends of the springs U are supported by hangers *y z*, the forward hangers, *y*, being connected to the frames A in the usual manner, and the rear hangers, *z*, which pass downward closely adjacent to the rear ends of the main frames, being coupled to bell-crank levers T, the purpose of which will be presently described.

The hangers may be inclined so as to impart greater longitudinal stability to the springs, if desired, and the lower ends of the rear hangers, *z*, may be connected directly to the frames in cases where the further improvements relative to the variation of adhesive weight which are hereinafter set forth are not embodied.

It will be apparent that the adoption of the foregoing construction necessarily involves considerable overhanging weight at the rear end of the engine, and to promote steadiness and safety in running proper means for the support of such overhanging weight should be provided. This end may be attained by placing a pair of trailing wheels or a trailing truck behind or beneath the fire-box; but the expense of the construction and maintenance of one or more additional pairs of wheels, boxes, and accessories is objectionable. Further, there are frequent occasions, as in starting a train or running up a heavy grade, when it becomes desirable to transfer the whole or a portion of the overhanging weight to the driving-wheels in order to increase their adhesion. Where this weight is carried on one or more pairs of wheels whose special duty it is to support it, if it be removed in whole or a considerable part, sufficient weight may not be left upon said wheels to keep them upon the track. In lieu, therefore, of supporting the rear overhanging weight of the engine by trailing wheels, I utilize the forward truck of the tender for that purpose and provide means for the transfer of said weight from said truck to the driving-wheels, and vice versa, which will now be described.

Referring to Figs. 1 to 4, inclusive, it will be seen that the tender-frames I are extended sufficiently far in advance of the front of the tank I' to provide a bearing for the front tender-truck, E, forward of the rear ends of the supplemental engine-frames D^2, and beneath the rearward projection of the foot-board B, so that both the supplemental engine-frame and the tender-frame may rest upon said truck, which will always carry a determined portion of the weight of the tender sufficient to insure its keeping the track, while, as will presently appear, it is likewise caused to support a variable additional weight—to-wit, the whole or a portion of the rear overhanging weight of the

engine. The tender-frames I are connected by the king-bolt K to the bolster L of the truck E, and the bolster L is supported on springs M, resting on a spring-plank, N, which is suspended by swing-hangers *o* from the truck-frame, in the ordinary manner. The rear overhanging weight of the engine is supported by springs *s*, which are connected at their rear ends, by links P, to the supplemental frames D^2 of the engine, and at their forward ends by links P′, to bell-crank levers Q, pivoted at their centers to lugs or bearings attached to the fire-box or supplemental frames and coupled by rods R to the bell-crank levers T, Figs. 1 and 5, to which, as before stated, the hangers *z* of the rear driving-springs, U, are connected. By such connection the weight carried by the springs *s* and U, respectively, is equalized when disturbed by inequalities in the track. The springs *s* bear at their centers on stirrups *i*, supported on the spring-plank N, which has the capacity of lateral motion within the range permitted by the swing-hangers *o*, and the truck-bolster L can also roll in the bearings of the springs M. The rear end of the engine and the front end of the tender are therefore adapted to move laterally on the truck, either simultaneously or independently one of the other.

A steam or compressed-air cylinder, J, is secured upon the foot-board B of the engine, and the rod *j* of its piston J′ is coupled by links *l* to the forward end of a lever, G′, which is pivoted at its rear end to the supplemental frame D^2 of the engine, and coupled intermediately by a link, *h*, to the center of one of the springs *s*. By the admission of steam or compressed air to the cylinders J, below the pistons J′, the tension on the springs *s* will be relieved proportionately to the pressure applied. The pressure of the rear overhanging weight of the engine is thereby correspondingly relieved from the bolster of the tender-truck E, and the weight thus removed from said truck is consequently transferred in corresponding degree to the driving-wheels of the engine. In case the effect of the applied pressure exceeds the weight of the rear end of the engine resting on the tender-truck a portion of the weight of the tender may be thereby transferred to the driving-wheels. Inasmuch as the application of a greater or less proportion of additional weight may be desirable under varying conditions of duty, provision is made to that end by the use of a differential piston, to which steam or compressed air may be admitted upon either one or both sides. The piston-rod *j* is made of such diameter that its transverse area will be about one-half that of the piston J′. It therefore follows that if the operating-fluid be admitted upon both sides of the piston the pressure thereon will be that due to the area of the rod, while if pressure be exerted upon the lower side of the piston only its effect will be that due to the entire area of the piston. This construction, in connection with proper valves or cocks, provides a ready and convenient means of regulating the degree of applied weight.

The engine and tender are shown in Fig. 2 as in the positions they would occupy upon a curved track, the dotted line 1 2 3 indicating the center line of the engine and the dotted line 4 5 that of the tender, the center line of the track intersecting that of the engine at the centers of the driving-axles and falling outside of it at the rear end of the engine, and the center line of the tender being inclined to that of the engine. Under such conditions it will be seen that the resistance of the train, which is exerted upon the engine in the direction of the center line of the tender, tends to draw the rear end of the engine toward the inside of the curve and to force the front end against the outer rails, thereby incurring liability of the engine to leave the track. To prevent the exertion of such action, the draw-bar K′ is reversed in direction relatively to those heretofore used—that is to say, its front end is coupled to the front end of the tender-frame and its rear end to the rear end of the engine-frame. The draw-bar is consequently subjected to compressive instead of tensile strain during the exertion of tractive force in a forward direction by the engine, and is, by the lateral movement of the rear end of the engine-frame, inclined in reverse direction to that of the center line of the tender. The strain upon the draw-bar has consequently, in passing around a curve, a tendency to push the rear end of the engine outwardly and the front end inwardly, thus acting to move the engine in the direction of the curve and enabling it to follow the sinuosities of the track with greater ease and safety. As shown in Figs. 6 and 7, the front end of the draw-bar K′ is coupled by the king-bolt K to a casting, I^2, secured to the front ends of the tender-frames I, and having lower bearings to form a center plate for the truck E. The rear end of the draw-bar is coupled by a pin, *k*′, to the back bar, D^3, of the supplemental engine-frames D^2. Chafing-plates D^4 I^3 are secured to the bar D^3 and to a transverse beam, I^4, upon the tender-frame, respectively.

The forward end of the engine may be carried on a four-wheeled truck, as in Figs. 1 and 2, or on a two-wheeled track, as in Figs. 8 to 12, inclusive; or it may be supported upon a single pair of wheels having no lateral motion, if preferred; or leading-wheels may be wholly dispensed with and the front end of the engine carried by the front pair of driving-wheels. Two, three, or four pairs of coupled wheels may be employed, as shown in Figs. 8, 9, and 10, respectively, or a greater number, if required, in exceptional cases. The tender may either be supported upon two separate trucks, or its rear end can be supported upon one or more pairs of wheels so connected to its frame as not to be capable of lateral or vibratory motion.

In many instances—as on heavy mountain-grades, or under other exceptional circum-

stances—it is impossible to obtain sufficient power from a single engine to perform the duty required, and in such cases two engines are coupled together and attached to the front of the train, or one is attached to the front and the other to the rear or in some other position in the train. The hauling of a train by two engines, separated one from the other, is attended with liability to accident, for the reason that it is difficult for the men who run them to communicate one with the other with promptness and certainty. Figs. 11 and 12 illustrate the application of my invention to the operation of two engines with a single interposed tender, each end of the frames I of which and each of its trucks E are connected with the frame-and-spring arrangement of the adjacent engine in the manner hereinbefore described. The tender may be supported solely upon the two trucks E E; or intermediate supporting-wheels, N′ N′, or a truck may be added, as indicated in dotted lines.

I am aware that the combination of inside and outside frames was known in a locomotive-engine prior to my invention, and also that a fire-box extended laterally to a width greater than the distance between the wheels was not new at the date thereof. I do not therefore broadly claim either said combination or said specific device.

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

1. The combination, substantially as set forth, of a locomotive-engine, a tender, and a truck or bogie, which is adapted to support a portion of the weight of both the engine and tender, and to which the engine and tender are connected with the capacity of movement about a pivot or vertical axis upon the truck independently each of the other.

2. The combination, substantially as set forth, of a locomotive-engine, a tender, and a truck or bogie adapted to support a portion of the weight of both the engine and tender, these members being combined for joint operation, so that either the engine or the tender, or both, shall have the capacity of lateral movement on or in relation to the truck.

3. The combination, substantially as set forth, of a locomotive-engine, a tender coupled thereto by a connection which is flexible both vertically and horizontally, and a truck or bogie which is adapted to support a portion of the weight of both the engine and tender.

4. The combination, substantially as set forth, of a locomotive-engine having all its driving-axles located between the fire-box and the cylinders, a tender coupled thereto, and a truck or bogie which is adapted to support a portion of the weight of both the engine and tender.

5. The combination, substantially as set forth, of a locomotive-engine, a tender, a truck or bogie adapted to support a portion of the weight of both the engine and tender, and mechanism whereby the weight of the engine supported by said truck can be removed or relieved to a greater or less degree therefrom at will during the operation of the engine.

6. The combination, substantially as set forth, of a locomotive-engine, a tender, a truck or bogie adapted to support a portion of the weight of both the engine and tender, and mechanism for varying the load upon the leading truck of the engine at will during operation.

7. The combination, substantially as set forth, of a locomotive-engine, a tender, a truck or bogie adapted to support a portion of the weight of both the engine and tender, and two separate sets of springs bearing upon said truck, and carrying respectively such portions of the weight of the tender and the weight of the engine as are applied to said truck.

8. The combination, substantially as set forth, of a locomotive-engine, a tender, a truck or bogie adapted to support, through separate sets of springs, respectively, portions of the weight of the engine and of the tender, and a steam or air cylinder having its piston connected with the springs of said truck, which support the weight of the engine, these members being combined for joint operation to enable the weight of the engine to be removed or relieved in greater or less degree from said springs at the will of the operator.

9. The combination, substantially as set forth, of a locomotive-engine, a tender, a truck or bogie adapted to support portions of the weight of the engine and of the tender, and a steam or air cylinder having a piston of substantially different areas on its opposite sides, said piston being adapted to receive pressure either upon its greater area or on both sides, and being connected with the truck which supports part of the weight of the engine.

10. The combination, substantially as set forth, of a locomotive-engine, a tender, a truck or bogie adapted to support a portion of the weight of both the engine and tender, and equalizing mechanism between the driving-wheels and said truck for transferring weight from the former to the latter, or vice versa.

11. In a locomotive-engine, the combination, substantially as set forth, of a pair of main frames located inside the driving-wheels, a pair of supplemental frames located outside the driving-wheels and connected rigidly to the main frames in advance of the rear driving-axle, and a fire-box the forward portion of which is located between the rear driving-wheels, and which is laterally extended in rear thereof to a width greater than the distance between the driving-wheels.

12. In a locomotive-engine, the combination, substantially as set forth, of an equalizing-lever having one of its ends supported upon an axle-box and the other by a spring, which rests upon an adjoining axle-box and sustains the weight carried thereby, and a spring which is connected at its ends to the engine-frame, and which forms a fulcrum or bearing for the equalizing-lever.

13. The combination, substantially as set

forth, of a locomotive-engine, a tender, and a draw-bar, connected at its rear end to the engine and at its front end to the tender, these members being so combined as that, first, the lateral movement of the engine on a curve will incline the draw-bar from its connection with the tender toward the outside of the curve; and, second, that the forward tractive force of the engine will induce a compressive strain on the draw-bar and a tendency to force the rear end of the engine outwardly and the front end inwardly in passing around a curve.

14. The combination, substantially as set forth, of two locomotive-engines and an interposed tender, each end of which is supported by a truck or bogie adapted to sustain a portion of the weight of the adjacent engine.

MATTHIAS N. FORNEY.

Witnesses:
J. SNOWDEN BELL,
FREDK. B. MILES.