

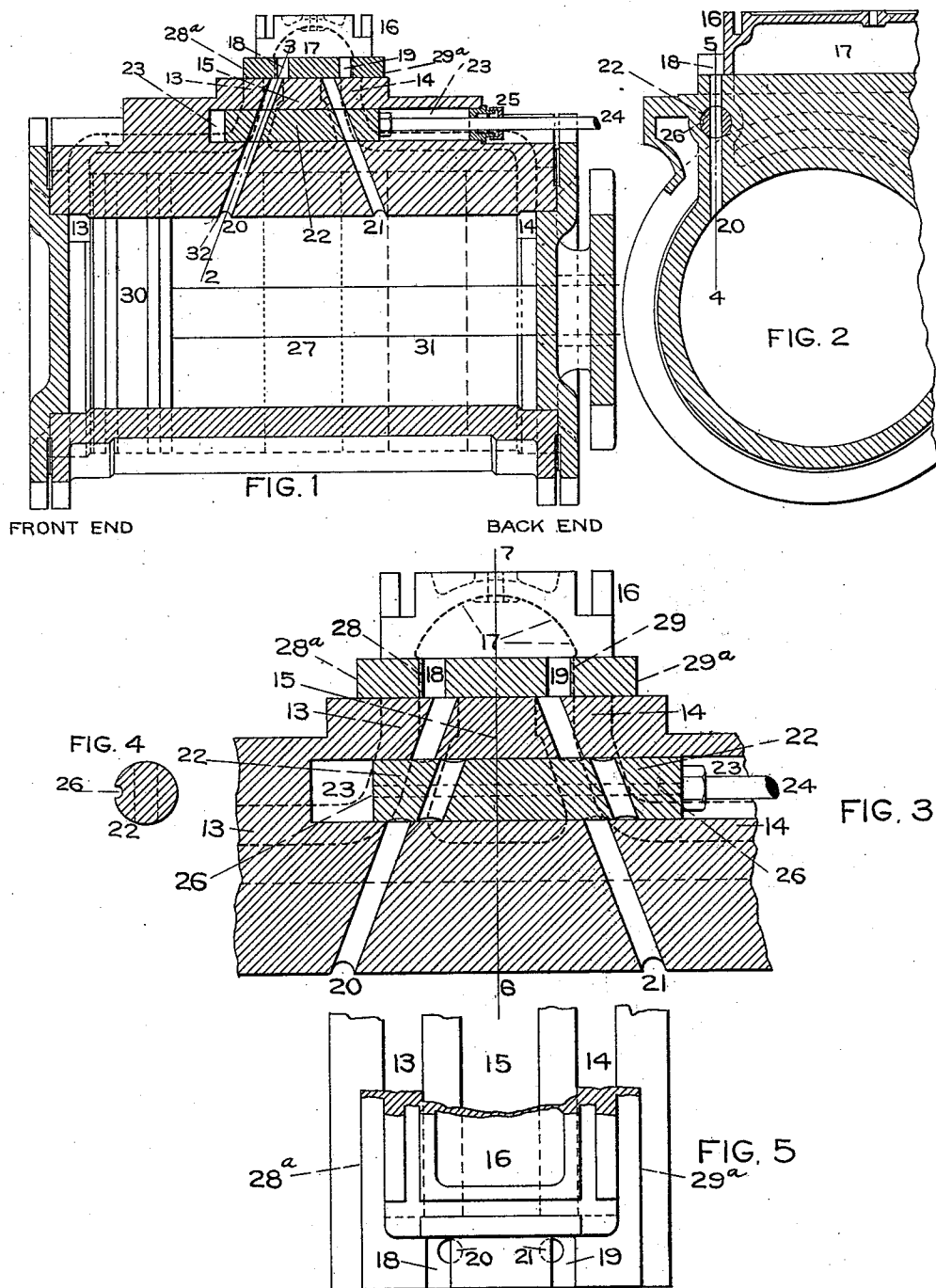
(No Model.)

3 Sheets—Sheet 1.

F. A. HAUGHTON.
LOCOMOTIVE.

No. 536,622.

Patented Apr. 2, 1895.



H. O. Haughton
H. Mac Carthy
WITNESSES

Frank A. Haughton
INVENTOR

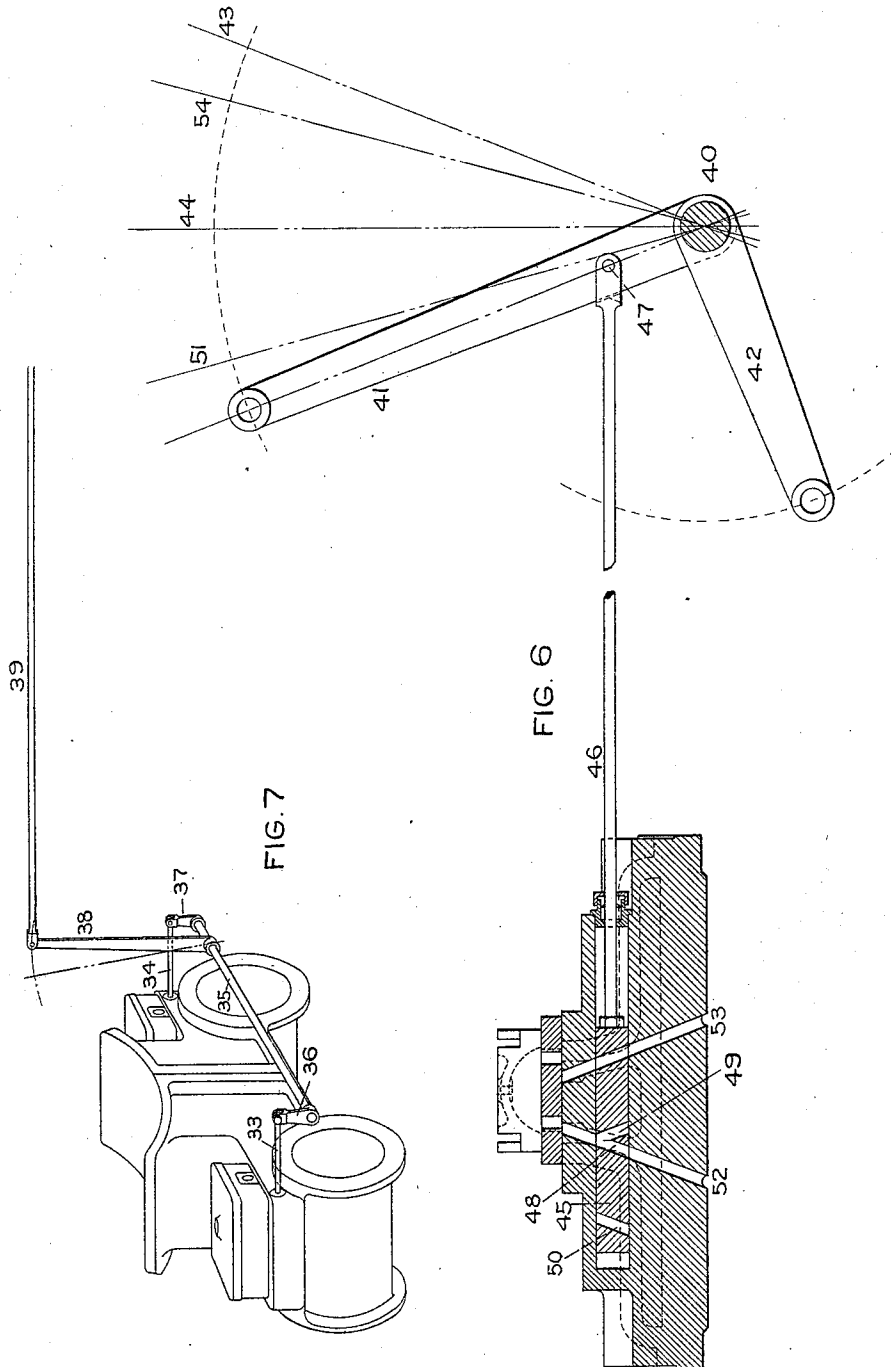
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3 Sheets—Sheet 2.

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H. Mac Carthy
M. G. Stewart
WITNESSES

Frank A. Haughton
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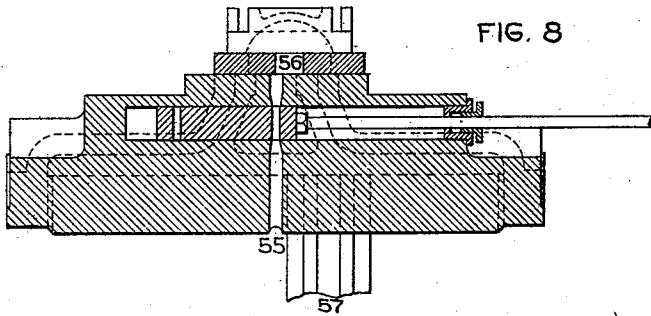


FIG. 8

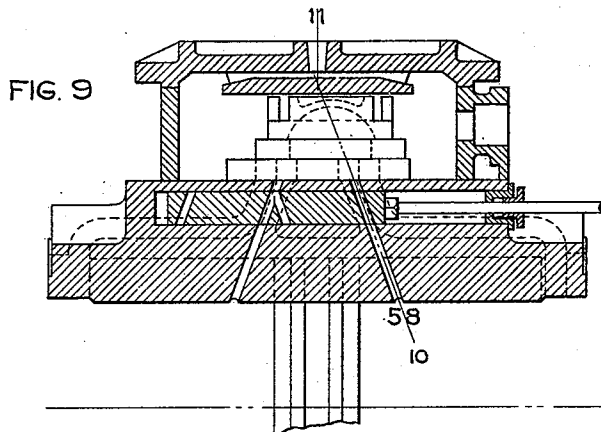


FIG. 9

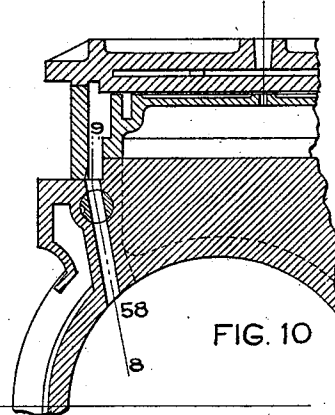


FIG. 10

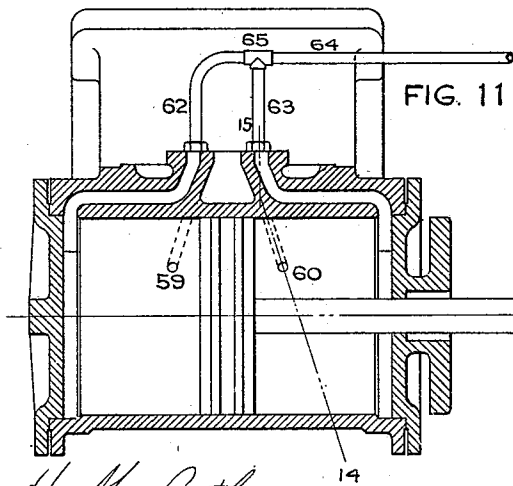


FIG. 11

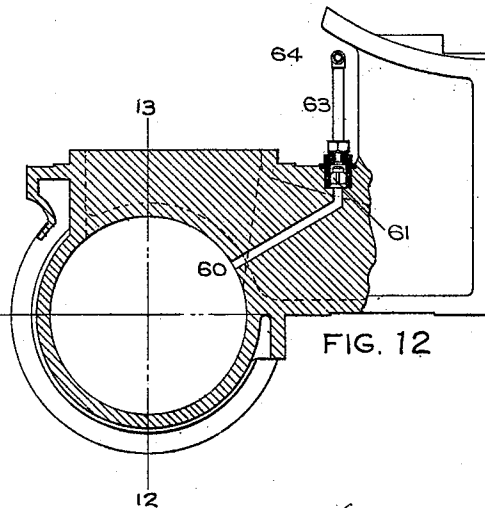


FIG. 12

H. MacCarthy
M. G. Stewart

WITNESSES

Frank A. Haughton
INVENTOR

UNITED STATES PATENT OFFICE.

FRANK A. HAUGHTON, OF BALTIMORE, MARYLAND.

LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 536,622, dated April 2, 1895.

Application filed December 5, 1894. Serial No. 530,887. (No model.)

To all whom it may concern:

Be it known that I, FRANK A. HAUGHTON, a subject of the Queen of Great Britain, and a resident of the city of Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Locomotives, of which the following is a specification.

This invention relates to improvements in locomotives, its object being to utilize an increased tractive force or effort at the drawbar, in a locomotive having a given weight transmitted to the rails by its driving wheels, with a given rate of expansion of steam in its cylinders; or in other words, to employ a turning power to the driving wheels just within their limit of adhesion to the rails, when steam is being cut off in the cylinders near the most usual point in the piston stroke for so doing, instead of near the full stroke of the piston.

In existing locomotives which depend on the adhesion of their driving wheels to the rails for their power of traction, the current practice is to design the maximum turning power of the driving wheels, such as shall be just within the limit of their adhesion to the rails, for a cut-off in the cylinders at nearly the full stroke of the piston. Now, with this design where the adhesion of the drivers is fully utilized at a nearly full stroke cut-off, it is readily understood that when this engine is working with a shorter cut-off (that is, with an increased rate of expansion) the adhesion of the driving wheels to the rails is not fully utilized. Therefore, the hauling power is materially reduced at the shorter cut-off, below that at the nearly full stroke cut-off.

It is well known to be undesirable to operate a locomotive at a full stroke cut-off except at very slow speed, both on account of the excessive back pressure formed in the cylinder and on account of the injurious effect of the powerful pulsations of the draft on the fire, caused by the steam being exhausted at a high pressure. Suppose now, for example, we employ a maximum cut-off at half the piston's stroke in the above locomotive (whose maximum cut-off was at nearly a full stroke); that is, that we arrange the valve gear so that a cut-off at half the piston's stroke is the maximum cut-off obtainable. With this cut-off, the turning force on the driving wheels has been materially reduced below that at the

nearly full stroke cut-off, and the full adhesion of the driving wheels to the rails not utilized; but, suppose now, (the maximum cut-off remaining at half stroke) that we increase the turning power on the driving wheels by either increasing the boiler pressure or the size of the cylinders, or by increasing both, until the point be reached just within the limit of adhesion of the driving wheels to the rails. We shall now have a locomotive developing the same hauling power at a half stroke cut-off as before at a full stroke cut-off; but in making the maximum cut-off at half stroke we encounter a difficulty in starting, provided the cranks be in a certain position. In a two-crank engine with the cranks set at right angles with each other, if the cut-off for example, be at one-half stroke, when the piston of one crank has just passed the one-half stroke the other crank is near its dead center and has little effect on turning the wheels, so that should an engine stop with its pistons and cranks in this position little turning power would be exerted when required to start, as no steam will be admitted into the cylinder whose crank is in a favorable angular position, and the other crank being in an unfavorable position the steam admitted into its cylinder has little effect on turning the wheels. To obviate this difficulty in starting I employ the following means shown on the attached drawings.

Figure 1 is a sectional view of a locomotive cylinder formed by a vertical plane passing through its bore, valve seat, and end flange of slide valve, and auxiliary ports with a cut-out valve, on the line 4—5, Fig. 2. Fig. 2 is an oblique transverse section of the same cylinder formed by a plane passing through the bore, valve seat, slide valve, one auxiliary port, and the cut-out valve, on the line 2—3, Fig. 1. Fig. 3 is an enlarged sectional view of the slide valve, valve seat, cut-out valve, and auxiliary ports, formed by a vertical plane passing through them in the same position as in Fig. 1. Fig. 4 is a cross section of the cut-out valve 22 formed by a plane cutting it transversely on the line 6—7, Fig. 3. Fig. 5 is a plan of a portion of the slide valve and seat shown in Fig. 3. Fig. 6 is a sectional view of a portion of the cylinder, valve seat, slide valve, and cut-out valve, formed by a

vertical plane passing through them, in the same position as in Fig. 1, together with a connection from the cut-out valve to the reverse or lifting shaft. Fig. 7 is a perspective view of a pair of locomotive cylinders together with a mechanism for operating the cut-out valves. Fig. 8 is a sectional view of a portion of a similar cylinder, slide valve, and valve seat with a modified form of cut-out valve and auxiliary port, formed by a vertical plane passing through them in the same position as in Fig. 1. Fig. 9 is a sectional view of a portion of a similar cylinder and valve seat, together with the steam chest and another modification of the cut-out valve and auxiliary ports, formed by planes passing through them on the line 8—9, Fig. 10. Fig. 10 is a sectional view of a portion of the cylinder, valve seat, slide valve, cut-out valve, and steam chest formed by planes passing through them transversely on the line 10—11, Fig. 9. Fig. 11 is a section view of a similar cylinder formed by a vertical plane passing through the axis of the bore and valve seat on the line 12—13, Fig. 12, and showing an additional modification of the auxiliary ports. Fig. 12 is a sectional view of the cylinder shown in Fig. 11 formed by transverse planes passing through the bore, valve seat and one of the auxiliary ports, on the line 14—15, Fig. 11.

Referring to Figs. 1 and 5, 13 and 14 are the two main steam ports and 15 the exhaust port as they exist in the usual design of locomotive cylinders.

16 is the slide valve in such a position of its travel in Fig. 1 as to just cover the main steam port 13, while the main steam port 14 is a little more than one-half open to the exhaust port 15 through the exhaust cavity in the slide valve, which cavity is shown dotted in Fig. 1 but in section in Fig. 2 at 17.

18 and 19, Figs. 1 and 5, are two small ports or slots in the end flange of the slide valve, equal approximately in width to the outside lap of the slide valve.

20 and 21 are two small or auxiliary ports extending from the valve seat to the bore, 20 being shown in Fig. 2.

22 is a cylindrical valve fitting closely in the chamber 23, capable of being moved axially by the stem 24 passing through a stuffing box 25, by which the ports 20 and 21 may be intercepted. In Fig. 1 it is shown in the position in which the passage through the auxiliary ports is uninterrupted, and in Fig. 3 moved sufficiently to the right to intercept the passage through the auxiliary ports.

An enlarged view of the cut-out valve 22 is shown in Figs. 3 and 4, which also show a groove or passage 26 in the cut-out valve extending from end to end thereby connecting the chambers at the ends of the cut-out valve, equalizing any pressure which may occur therein and preventing any compression taking place therein when the cut-out valve is moved.

The slide valve 16 (Figs. 1 and 3) has for

example a three-fourths inch outside lap, no inside lap nor clearance but is line to line with the ports on the exhaust side when in the middle of its travel as shown in Fig. 3 by the dotted lines 28 and 29, and having such a travel as to cut off steam at one-half stroke of the piston, lead opening occurring at twenty-three inches of the stroke, compression at nineteen inches and exhaust at nineteen inches, the full stroke of the piston being twenty-four inches.

The slots 18 and 19 in the end flange of the slide valve 16 (Figs. 1, 3 and 5), are of a width, in the direction of its travel, equal or nearly so to the outside lap of the slide valve, and in such a position in the direction of its travel that when the valve is in the middle of its travel as in Fig. 3, both auxiliary ports 20 and 21 will be partly uncovered, and when the valve is in the cut-off position (as in Fig. 1, with the piston shown dotted at 27) the auxiliary port 20 (Fig. 1) for the end of the cylinder where cut-off is taking place will be partially uncovered. These dimensions, however, may be varied somewhat to suit varying conditions. The auxiliary ports 20 and 21 (Figs. 1 and 3) extending from the valve seat to the bore enter the latter at such a distance from its ends that neither of the ports 20 and 21 will be in communication with that portion of the cylinder where compression is taking place, but sufficiently near its ends, that when the piston reaches the point of maximum cut-off, the small port 20 or 21 for the respective end of the cylinder where cut-off is taking place shall have been passed by the piston, and be in communication with the space included between the piston and the end where cut off is taking place. The auxiliary ports enter the valve seat so close together, that when the valve is in the extreme position of its maximum travel neither of them shall be uncovered by the outer edges 28^a, 29^a of the valve, but so far apart that when the valve is in one extreme position of its maximum travel the slot 18 shall not be in communication with the auxiliary port 21. Likewise in the opposite extreme position the slot 19 shall not be in communication with the auxiliary port 20.

Now in Fig. 1, suppose the piston 30 to be moving toward the front end of the cylinder and has remaining one inch to complete the forward stroke. During the forward stroke just being completed, compression on the front side of the piston and release on the back side took place when the back side of the piston reached the point 32, and therefore no steam was admitted on the front side of the piston through either auxiliary port after this point was reached thereby avoiding the undue retarding to the forward motion of the piston which would occur should steam be admitted in front of the piston after compression begins, that is, after exhaust closes on the front end. Now, suppose the piston to have completed the forward stroke and reached the middle of the backward

stroke as shown dotted at 27. The slide valve would be in the position as shown in Fig. 1 at the point of cutting off, moving toward the front end of the cylinder. It will be seen that the auxiliary port 20 is partially uncovered at the edge of the slot 18 in the valve and forming a communication for steam in the steam chest into the front end of the cylinder from which end steam has just been cut off from entering through the main steam port 13, while the auxiliary port 21 is covered by the slide valve. Now when the piston reaches the position shown dotted at 31 the slide valve will have reached the middle point of its travel (the position shown in Fig. 3) and release will begin on the front side and compression on the back side of the piston, that is, exhaust will begin to open on the front side and close on the back side, and both auxiliary ports 20 and 21 will be partially uncovered by the valve and form a communication into the front end of the cylinder. Now it will be seen that if the locomotive be in a state of rest with one of its cylinders having its piston in the central position 27 (Fig. 1) about to move toward the back end, with steam cut off, the crank will be in about the most favorable angular position for exerting a turning force, and the crank of the other cylinder will be near the dead point (the cranks being made at right angles to each other) and comparatively useless to exert a turning force on the driving wheels. Therefore, it will be seen that with the pistons, cranks and valves in these relative positions that little or no tractive force can be exerted unless some provision be made to admit steam into the cylinder in which the piston is at half stroke. By the arrangement of auxiliary ports, &c., herein described, steam will be admitted through the auxiliary ports into the cylinder whose slide valve has cut off the admission through the main port, and exert a turning force on the driving wheels, during the stroke of the piston between cut-off and release, and when the release position is reached the piston and crank of the other cylinder will be in a favorable relative position to exert a useful turning force on the driving wheels. As soon as a revolution of the wheels is made the main steam ports 13 and 14 supply the necessary amount of steam to the cylinders at the proper intervals and the auxiliary ports may be thrown out of action by moving the cut-out valve sufficiently to intercept them, and thus prevent any waste of steam through them when in communication with the portion of the cylinder exhausting. Yet, if the auxiliary ports are not made too large, the cut-out valve might be dispensed with and allow the slide valve with the slots 18 and 19 to control their action alone.

Fig. 7 shows a mechanism for operating the cut-out valves when it is desired to throw the auxiliary ports in or out of action. 33 and 34 are the cut-out valve stems. 35 is a rock-shaft with the two crank arms 36 and 37 at

ached rigidly to the shaft 35 and pivoted to the valve stems 33 and 34, so that with an angular movement of the crank arms 36 and 37 on the shaft 35 as an axis the cut-out valves are moved by their attached stems 33 and 34. 38 is an additional arm attached rigidly to the shaft 35 and pivoted to the rod 39 which leads back to a convenient position in the cab where the engineer can operate the cut-out valves at will by imparting a movement to the rod 39 in the direction of its length.

Fig. 6 shows the form of cut-out valve which may be employed when operated by the reversing gear and is a modification of the one shown in Figs. 1, 2, 3 and 4. 40 is the reverse or lifting shaft, 41 being the arm to which the reach rod is attached that leads to the reverse lever in the cab. 42 is one of the arms from which the links are hung. They are shown in the full travel forward position. The broken line 43 is the full travel backward position. The broken line 44 is the midway, or out-of-gear position. The cut-out valve 45 is attached by the stem 46 to the arm 41 of the reverse shaft by a pivot 47 so that an angular movement of the arm 41 produces a corresponding movement of the cut-out valve 45. The cut-out valve 45 differs only from the one shown in Figs. 1, 2, 3 and 4, by its greater length and by having the additional ports 48 and 49. Now, when it is desired to start the locomotive ahead the reverse shaft arm 41 is placed in the angular position shown in Fig. 6 leaving the passage through the auxiliary ports uninterrupted. As soon as a start has been accomplished the cut-out valve may be made to intercept the auxiliary ports by moving the reverse shaft to the angular position represented by the broken line 51, which of course at the same time raises the links and reduces the cut-off slightly. When it is desired to start backward the reverse shaft arm 41 is moved to an angular position represented by the broken line 43. This causes a movement of the cut-out valve and brings the port 50 in the same line with the auxiliary port 52, and the port 49 in line with the port 53, thus giving free passage through the auxiliary ports 52 and 53 as before when starting forward. Then after a start has been accomplished the arm 41 is moved to the position represented by the broken line 54 which causes the cut-out valve to intercept the auxiliary ports 52 and 53, which also lowers the links and reduces the point of cut-off slightly. For all intermediate positions of the arm 41 between the positions represented by the broken lines 51 and 54, the cut-out valve intercepts the auxiliary ports and prevents the flow of steam through them. This arrangement avoids the use of additional mechanism in the cab, for moving the cut-out valve 22.

If the maximum cut-off employed be greater than half stroke, by an amount equal or greater than one-half the thickness of the piston a single auxiliary port may be used as in Fig. 8 controlled by a single slot in the end

flange of the valve and a cut-out valve, provided either with the two ports as shown if operated by the reverse gear as in Fig. 6 or with a single port only if worked by the mechanism shown in Fig. 7.

In Fig. 8, 57 is a portion of the piston. The single auxiliary port 55 enters the bore of the cylinder midway between its ends, and the valve seat midway between its ends. The slot 56 in the end flange of the valve is of a width about equal to twice the outside lap of the valve, and in such a position that when the valve is in the cut-off position the auxiliary port 56 will be partially uncovered by the valve. These conditions are fulfilled when the slot is made equal in width to twice the outside lap of the valve and placed in the end flange midway from its ends. With this arrangement steam may be admitted through the auxiliary port 55 into the cylinder during the period in the piston's stroke between cut-off and release, and as the auxiliary port 55 enters the cylinder midway from its ends it must be passed by the piston before compression begins and therefore admits no steam into the space where compression is occurring, thereby fulfilling the requisite conditions for starting.

Fig. 9 shows another modification of auxiliary ports. It differs only from that shown in Figs. 1, 2, 3, 4 and 6, in that the auxiliary ports instead of entering the valve seat and being controlled by the movement of the slide valve, are always in free communication with the steam chest, and the cylinder except when intercepted by the cut-out valve, the form of which shown is the same as that shown in Fig. 6, but may be of the form shown in Figs. 1, 2, 3 and 4, if the operating gear shown in Fig. 7 be employed. Fig. 10 shows a cross section of this arrangement through the auxiliary port 58.

If again the maximum cut-off exceed half stroke as explained in connection with Fig. 8, a single auxiliary port with a cut-out valve may be used communicating with the steam chest uncontrolled by the movement of the slide valve.

During starting, the arrangement in Fig. 9, whether with the two auxiliary ports as shown or with a single one, in either case uncontrolled by the slide valve movement, the loss through the auxiliary ports into the end of the cylinder exhausting is slightly greater than when controlled by the slide valve movement, but as they may be cut out of action as soon as a revolution of the wheels is made this loss becomes of little consequence.

Figs. 11 and 12 show another modification of the auxiliary ports. The two auxiliary ports 59 and 60 enter the bore of the cylinder in the same manner as explained for the auxiliary ports 20 and 21, Fig. 1. They are connected to the pipes 62 and 63 respectively, which in turn unite at the point 65 into the single pipe 64, which extends backward into the cab to a cock or valve under the control

of the engineer by which he may admit steam into the pipes when desirable and thus the cylinder through the auxiliary ports 59 and 60. A check valve 61, Fig. 12, is placed in each auxiliary port 59 and 60, which prevents steam from the cylinder blowing around from one port into the other, and from blowing back into the piping. It is obvious that in this case if the maximum cut-off be greater than half stroke by an amount equal to or greater than one-half the thickness of the piston, a single auxiliary port may be used in place of 59 and 60.

The above methods of starting are most useful in locomotives with their cranks set at right angles to each other. If the number of cranks is more than two and set at other than right angles to one another the possibility of starting without the use of auxiliary ports, &c., becomes greater as the number of cranks increases and their angles to each other vary, but on account of simplicity the prevailing practice is to employ two cranks only, set at right angles to each other, in which case my system of auxiliary ports is particularly applicable and useful in starting.

The tractive force of compound as well as simple expansion locomotives may be increased for given cut-offs, and the above arrangement of auxiliary ports provides for ready starting.

The auxiliary ports may be applied to a locomotive without increasing its cylinder power for a given cut-off as a means of starting at a shorter than nearly a full stroke cut-off thereby avoiding the injurious effect of the strong pulsation of the long cut-off exhaust on the fire, and thereby effecting a saving in the consumption of fuel which on accommodation runs would be appreciable, owing to the frequent number of starts to be made.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a steam engine the combination of a cylinder having piston and usual steam chest, slide valve and ports with an auxiliary steam port connecting the cylinder with a source of steam supply and entering the cylinder at its center.

2. In a steam engine the combination of a cylinder having piston and usual steam chest, slide valve and ports, with two auxiliary steam ports connecting the cylinder with a source of steam supply and entering the cylinder at such a distance from its ends that neither of the ports will be in communication with that portion of the cylinder where compression is taking place but sufficiently near the ends of the cylinder that when the piston reaches the point of maximum cut-off the auxiliary port for the respective end of the cylinder where cut-off is taking place shall have been passed by the piston, and said port be open to admit steam to the space included between the piston and the end where cut-off has taken place.

3. In a steam engine the combination of a cylinder having piston and usual steam chest and slide valve and ports with an auxiliary steam port connecting the cylinder with a source of steam supply and entering the cylinder sufficiently near the end of the cylinder where cut-off is about to take place that when the piston reaches the point of maximum cut-off the auxiliary port shall have been passed by the piston and said port be open to admit steam to the space included between the piston and the end where cut-off has taken place.

4. In a steam engine the combination of a cylinder having piston and usual steam chest and slide valve and ports with an auxiliary steam port connecting the cylinder with a source of steam supply and entering the cylinder at such a distance from its ends that it will never be in communication with that portion of the cylinder where compression is taking place but sufficiently near the end of the cylinder where cut-off is about to take place that when the piston reaches the point of maximum cut-off the auxiliary port shall have been passed by the piston and said port be open to admit steam to the space included between the piston and the end where cut-off has taken place.

5. In a steam engine, the combination of a cylinder having piston and usual steam chest and slide valve and ports with an auxiliary steam port connecting the cylinder with a source of steam supply and entering the cylinder sufficiently near the end of the cylinder where cut-off is about to take place that when the piston reaches the point of maximum cut-off the auxiliary port shall have been passed by the piston and said port be open to admit steam to the space included between the piston and the end where cut-off has taken place, and an independent valve other than the slide valve interposed in said auxiliary port and adapted by operation to close said port at will.

6. In a steam engine the combination of a cylinder having piston and usual steam chest and slide valve and ports with an auxiliary steam port connecting the cylinder with a source of steam supply and entering the cylinder sufficiently near the end of the cylinder where cut-off is about to take place that when the piston reaches the point of maximum cut-off the auxiliary port shall have been passed by the piston and said port be open to admit steam to the space included between the piston and the end where cut-off has taken place, and a valve interposed in the path of said auxiliary port and provided with four ports through it, any one or more of which may be brought to register with the auxiliary port or ports, substantially as described.

7. In a steam engine, the combination of a cylinder having piston and usual steam chest and slide valve and ports with an auxiliary steam port connecting the cylinder with a source of steam supply and entering the cylinder sufficiently near the end of the cylinder where cut-off is about to take place that when

the piston reaches the point of maximum cut-off the auxiliary port shall have been passed by the piston and said port be open to admit steam to the space included between the piston and the end where cut-off has taken place, a valve adapted to close the auxiliary ports, provided with a stem which is connected to the reversing gear of the steam engine, said valve being provided with one or more ports which register with the port or ports and are so arranged that the auxiliary port or ports will be open to the cylinder when the reversing lever of the locomotive is at its extreme forward or backward position, but the auxiliary ports will be closed when the reversing lever is at any other position.

8. In a steam engine, the combination of a cylinder having piston and usual steam chest and slide valve and ports with an auxiliary steam port connecting the cylinder with a source of steam supply and entering the cylinder sufficiently near the end of the cylinder where cut-off is about to take place that when the piston reaches the point of maximum cut-off the auxiliary port shall have been passed by the piston and said port be open to admit steam to the space included between the piston and the end where cut-off has taken place, the valve of the cylinder being provided with one or more slots in its edge which in certain positions register with the auxiliary port or ports and admit steam to them.

9. In a locomotive cylinder, the combination of two small or auxiliary ports 20—21 extending from the valve seat to the bore, with the main valve provided with two slots or ports, the said ports 20—21 entering the bore of the cylinder at such a distance from its ends that neither of the ports 20—21 will be in communication with that portion of the cylinder where compression is taking place and at the same time entering the bore of the cylinder sufficiently near the beginning of the piston's stroke that when the said piston reaches the point of maximum cut-off, the small port 20 or 21, for the respective end of the cylinder where cut-off is taking place, shall have been passed by the said piston and be in communication with that end uncovered by the piston.

10. In a steam engine employing the expansion of steam, the combination of a cylinder having piston and usual steam chest and slide valve and ports with an auxiliary steam port or ports connecting the cylinder with a source of steam supply and entering the cylinder sufficiently near the end of the cylinder where cut-off is about to take place that when the piston reaches the point of maximum cut-off the auxiliary port shall have been passed by the piston and said port shall be open to admit steam to the space between the piston and the end where cut-off has taken place, the slide valve of the piston being provided with one or more slots or ports in its face which register with the auxiliary port or ports and admit steam to them and which are of a width

in the direction of the travel of the valve
which added to the width of the mouth of the
auxiliary port will be at least equal to the out-
side lap of the valve and admit steam to the
5 cylinder during the period between cut-off and
release.

Signed at Baltimore city, in the State of

Maryland, this 26th day of November, A. D.
1894.

FRANK A. HAUGHTON,

Witnesses:

JOHN L. HEBB,
H. MACCARTHY.