No. 847,623. PATENTED MAR. 19, 1907.

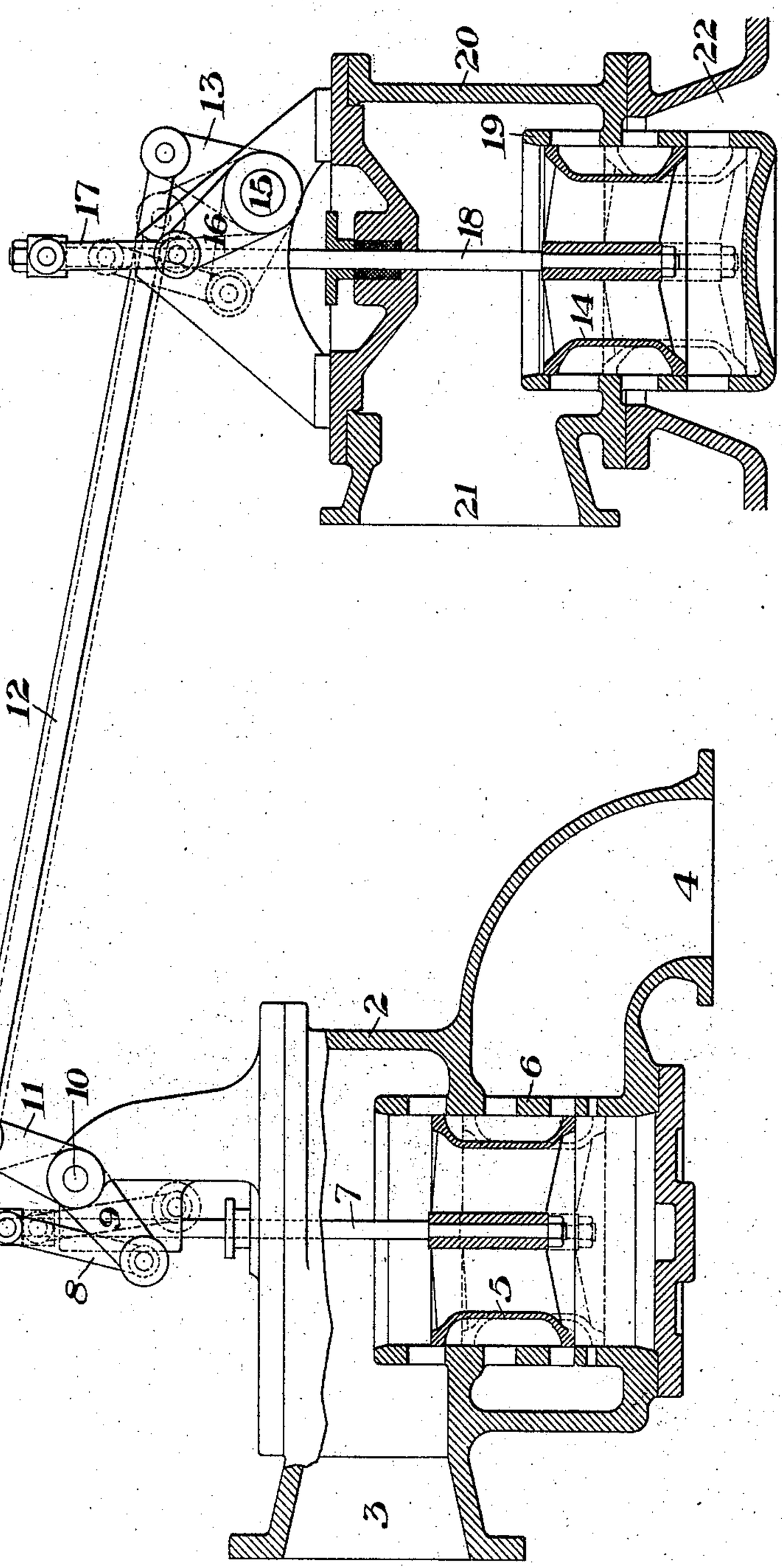
W. TRINKS.

THROTTLE VALVE SYSTEM.

APPLICATION FILED APR. 21, 1906.

2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES

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2 SHEETS—SHEET 2.

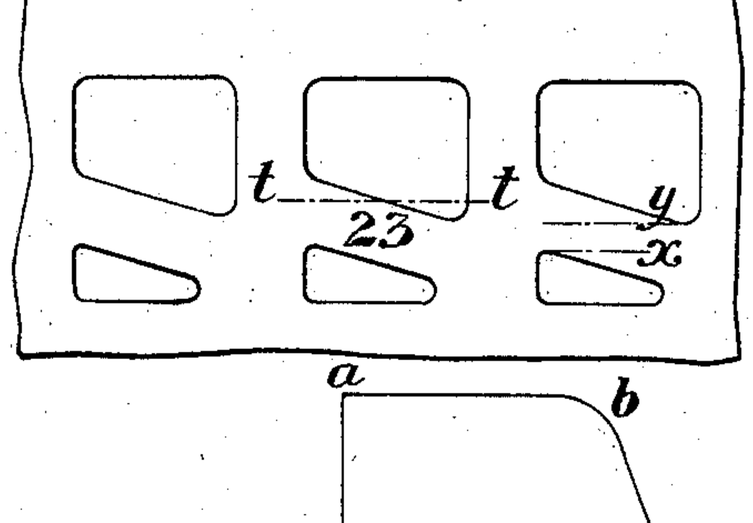
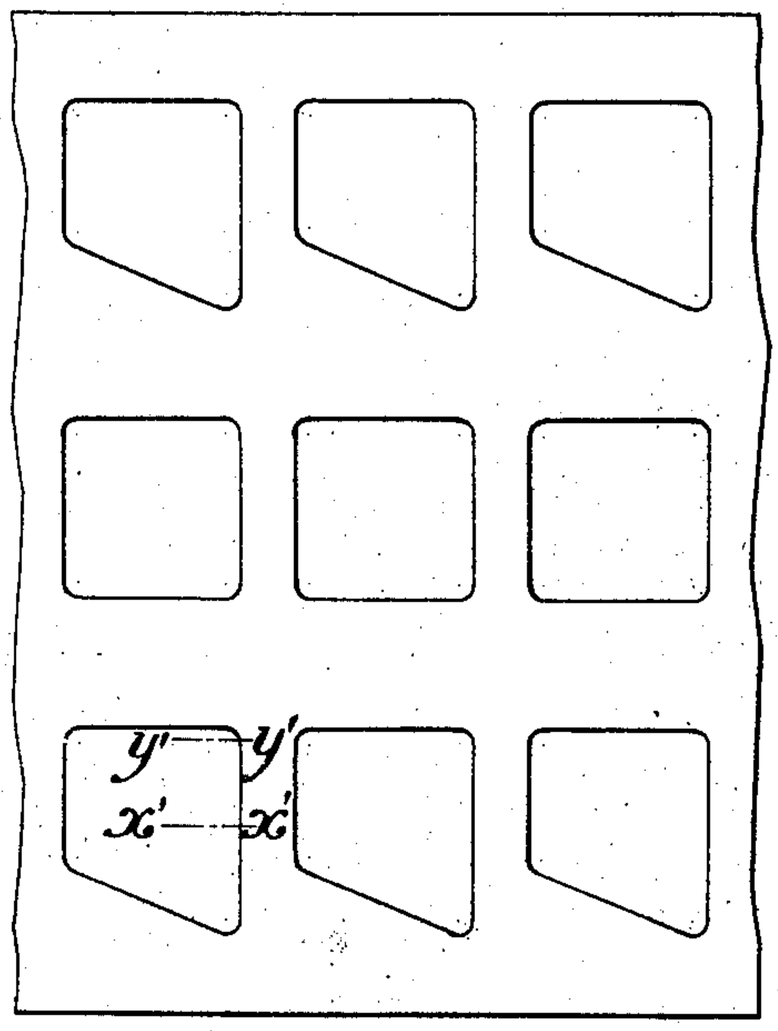


Fig. 2.

Fig. 3.



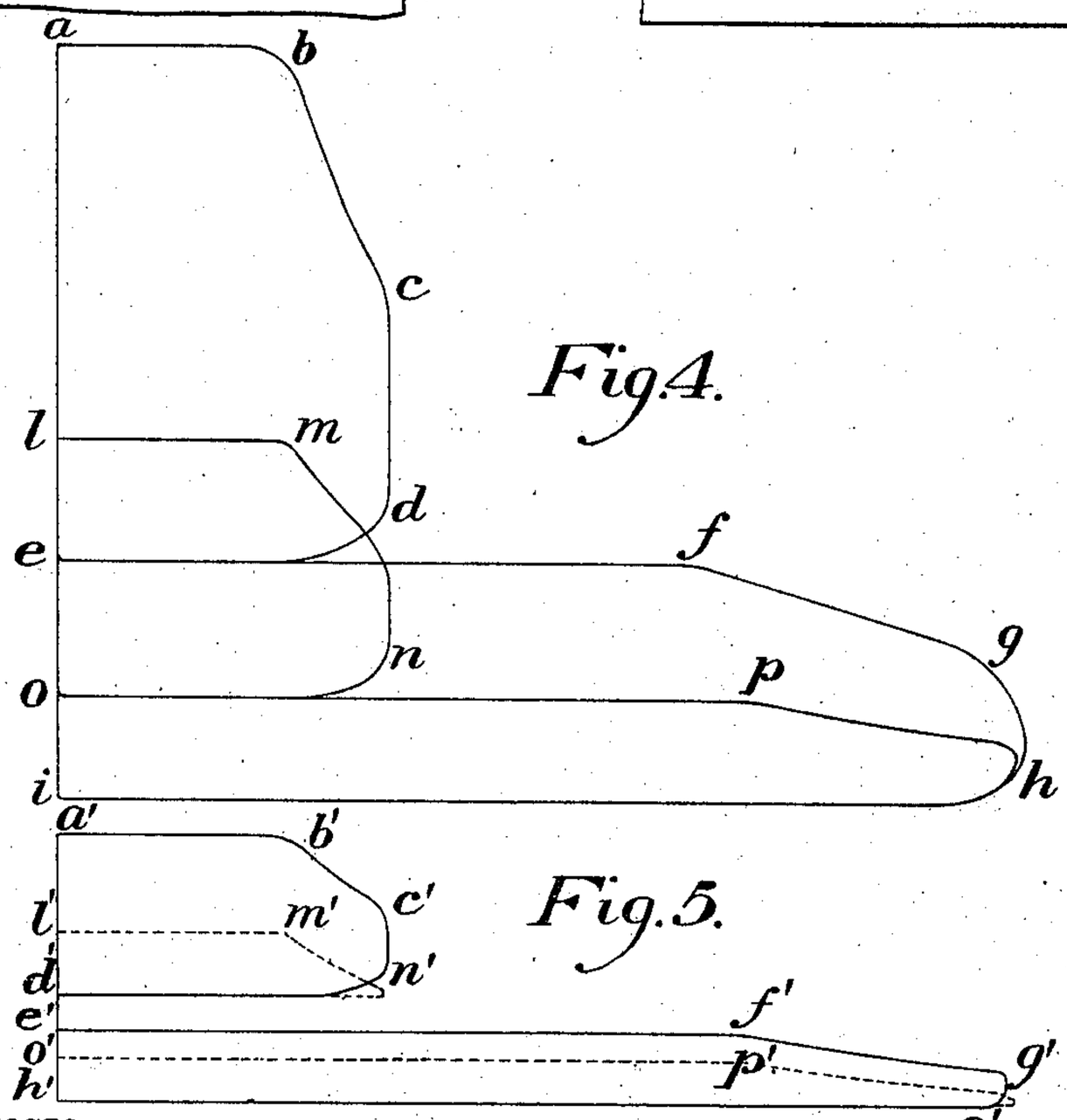


Fig. 4.

Fig. 5.

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THROTTLE-VALVE SYSTEM.

No. 847,623. Specification of Letters Patent. Patented March 19, 1907.

Application filed April 21, 1906. Serial No. 312,993.

To all whom it may concern:

Be it known that I, WILLIBALD TRINKS, of Pittsburg, Allegheny county, Pennsylvania, have invented a new and useful Throttle-Valve System for Compound Reversing-Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a vertical section showing the valves and connections in two positions thereof. Fig. 2 is a diagrammatic view showing a development of the ports in the high-pressure valve. Fig. 3 is a view similar to Fig. 2, showing development of the ports in the low-pressure valve; and Figs. 4 and 5 are diagrams of steam-cards, illustrating the influence of the invention on the steam distribution of the two cylinders.

My invention relates to compound reversing-engines having throttle-valves, and is designed to give a substantially free and unobstructed flow of the steam to the low-pressure cylinder between full load and an intermediate load, preferably half-load.

Where throttling has been used between the high and low pressure cylinders of such engines, economy has been reduced by the throttling action on the low-pressure cylinder between heavy and medium loads. By the use of my invention the engines may be run more economically, since throttling is substantially prevented between the cylinders until the load, and consequently the receiver-pressure, have become so small that a further decrease of receiver-pressure would interfere with the quick starting of the engine and would cool the walls of the high-pressure cylinder more than is desirable. From the intermediate load through smaller loads the low-pressure steam is effectively throttled, so that the receiver-pressure is not substantially reduced. I obtain these desirable results by a peculiar arrangement of the ports in the throttle-valves, preferably in combination with levers or similar devices for giving a differential movement to the throttle-valves.

In the drawings, referring to Figs. 1 and 2, 2 represents the throttle-valve casing, having the inlet 3 for live steam, and the port 4, leading to the steam-chest of the hgih-pressure cylinder. The throttle-valve 5 is arranged to reciprocate within the ported valve-cage 6, and its stem 7 extends up through a stuffing-box and is connected by pivotal links 8 to lever-arm 9. This lever-arm is secured to a rock-shaft 10, having a lever 11 pivotally connected by the rod 12 to the actuating-lever 13 for the low-pressure throttle-valve 14. The lever 13 is secured to a shaft 15, having a lever-arm 16 connected by pivotal links 17 to the valve-stem 18 of the valve 14. The valve 14 moves within the ported cage 19 in the valve-casing 20, having the inlet-port 21 from the high-pressure exhaust-chest. The steam for the low-pressure cylinder passes through the ports of cage 19 and through the annular port 22 to the steam-chest of the low-pressure cylinder. In this Fig. 1 I have shown in full lines a position of the valves where both are partially opened, and in dotted lines I have shown their closed position and also the position of the link connections for such closed position.

It will be noted that when the high-pressure valve is closed the links 8 and the lever 9 are near the dead-center or toggle position. Consequently for a uniform movement of the driving-lever 11, which is actuated through shaft 10, the valve will lift slowly through the first part of its movement, and its speed will then be increased, as the valve is open.

The link system for the low-pressure valve, on the contrary, is arranged so that when the valve is closed the links 17 have a large leverage and gradually approach the dead-center or toggle position as the valve is opened. The result is that for a uniform motion of the driving-lever 13 for the low-pressure valve this valve opens rapidly through the first part of its opening movement and then more slowly. This differential movement of the throttles will, therefore, open the low-pressure valve quickly, avoiding throttling for medium loads, which are obtained by a comparatively small opening of the high-pressure throttle-valve. In other words, the throttling of the low-pressure valve is avoided at the period when the throttling through the high-pressure valve is considerable.

As above stated, the object of my invention is to allow a free passage for the low-pressure or receiver steam between half-load and maximum load—that is, between the times when the high-pressure throttle is wide

open and the period when it is closed down to reduce the high-pressure steam to about one-half the absolute boiler-pressure. To illustrate this matter, I will now refer to Figs. 4 and 5. Fig. 4 shows the type of indicator-cards obtained with an unobstructed or free flow of steam between the high and low pressure cylinders. In this figure the inclosure marked *a b c d e* shows the maximum load high-pressure card, while the inclosure marked *e f g h i* is the corresponding low-pressure card. The inclosure *l m n o* is the half-load high-pressure card, while the inclosure marked *o p h i* is the corresponding half-load low-pressure card. These inclosures represent the two limits between which the receiver-steam should not be throttled.

In order to secure sufficient receiver-pressure for starting, the low-pressure valve should begin to throttle effectively through all loads lighter than the half-loads shown in Fig. 4. The diagrams for such conditions are ilustrated in Fig. 5. In this figure the inclosure *a' b' c' d'* is a light-load high-pressure card, while the inclosure *e' f' g' h'* is the corresponding low-pressure card. Pressure indicated by *d'* to *h'* is equal to pressure in Fig. 4 from *o* to *i*. The distance from *d'* to *e'* is the drop by throttling. The inclosure in Fig. 5 marked *l' m' n' d'* is the high-pressure card for a still lighter load, and the inclosure *o' p' q' h'* is the corresponding low-pressure card. The distance from *d'* to *o'* indicates the throttling.

In order to start the throttling through the low-pressure valve suddenly at a given point or load, the valve-motions must be altered in a discontinuous manner, which cannot be effected by the differential movement imparted to the throttles through the connections shown. In order to produce this effect of discontinuity between movements of the throttles, I preferably provide bridges 23 between the first and second set of ports of the high-pressure throttle-valve, as shown in Fig. 2, whereby the outlet area through this valve is not changed through the lift of the valve from the point *x* to *y*. During the time when the high-pressure valve is moving upwardly over the bridge with the constant port opening, the low-pressure valve lifts rapidly and increases the area for the flow of receiver-steam proportionately

Considering now the development of the high and low pressure ports shown, respectively, in Figs. 2 and 3, assume that the throttles are wide open. This position is used for starting and for heavy drafts in the first passes of a rolling-mill. For these passes the mean piston speed should never exceed nine hundred feet per minute, and the ports should be so large that the mean steam velocity through the throttles does not exceed one hundred and seventy-five feet per second. The ports and the throttles must therefore be at least eight and one-half per cent. of the respective cylider areas to give this result. For all loads smaller than maximum load the high-pressure steam must be throttled in order to keep the speed of the engine within proper limits. In giving this result the connecting-rod 12 of Fig. 1 is moved toward the left, thereby closing the high-pressure throttle part way, while the low-pressure valve is moved very little and leaves a substantially unrestricted opening. Under normal conditions of rolling—that is, with a reversing-engine of the proper size for the load and the rolls correctly designed—the bulk of the rolling is carried out with power varying between the maximum torque and one-half the maximum torque of the engine. A smaller torque is only required for the last few passes where the work is small. It is therefore desirable for economy in the compound reversing-engines that no throttling be effected between the high-pressure exhaust and the low-pressure cylinder until the initial pressure in the high-pressure cylinder has been throttled down to about one-half boiler-pressure. High-pressure steam is throttled down to one-half its absolute pressure by steam velocity of seventeen hundred feet per second. For half-loads or lighter loads a piston speed of seventeen feet per second is the rule. For average running conditions the initial pressure in the high-pressure cylinder will therefore be one-half the boiler-pressure when the port area through the high-pressure throttle is equal to one per cent. of the high-pressure-cylinder area. This ratio is obtained when the lower edge of the high-pressure valve reaches the point *y* of Fig. 2. Shortly before it reaches this point the area changes very little on account of the triangular shape of the ports. Fig. 1 shows in full lines the relative position of the two throttles when the lower edge of the high-pressure valve is on the line *t t* of Fig. 2. The area of the high-pressure throttle is then slightly in excess of one per cent. over the high-pressure-cylinder area. At this time the low-pressure valve is still wide open, so that at this position of the valves there is no throttling of the receiver-steam. While the high-pressure valve is moving from *y* to *x* of Fig. 2, its area remains constant and equal to one per cent. of the high-pressure-cylinder area, while through this period the low-pressure valve moves from the line *y' y'* to the line *x' x'* of Fig. 3, thus reducing the area through the low-pressure valve to about four and three-fourths per cent. of the low-pressure-cylinder area. If the connecting-rod 12 is moved still farther to the left, both valves will be moved farther to a closed position. During this action the closing of the high-pressure valve is gradual and slow, for two

reasons—first, because the link-motion is near the toggle-line, and, second, because only one side of the double-ported valve is open and that only on part of its circumference. Through this time the closing of the low-pressure valve is rapid, for two reasons—first, because the lever 16 is near intermediate positions, and, second, because both sides of the low-pressure double-operated throttle-valve remain open until the valve is closed. Owing to this difference in the speed of closing, both the throttles will close simultaneously.

The results obtained by the differential motion of the throttle-valves might be obtained by changing the shape of the ports in the valves, as by making the bottom portion of the high-pressure valve longer or making the first port and the bridge wider and extending the top part of the low-pressure ports up higher. This, however, I do not consider as desirable as my differential motion, as a long lift for the valves would be necessary, which would result in a costly and less desirable construction.

The advantages of my invention will be apparent to those skilled in the art. The small ports are first opened in the high-pressure throttle-valve, and the bridges hold the port-opening constant through a portion of the farther travel before the large ports are reached. The high-pressure throttle-valve is moved slowly near its closing-point and more quickly when opened wider, while the low-pressure throttle-valve moves quickly near its closing-point and more slowly when it is opened. A good economy is thus afforded by avoiding throttling to the low-pressure cylinder between full load and half-load. The valves are closed simultaneously, and the receiver-pressure drops freely down to half-load and then is maintained practically constant for smaller loads.

The port arrangement may be applied to different types of valves, such as a double-ported piston-valve or a double-beat puppet-valve, and the ports may be located either in the valve or cage. Other connections may be employed for giving the differential motion to the valves, and many other changes may be made in the form and arrangement of the parts without departing from my invention.

I claim—

1. A compound engine having throttle-valves for the high and low pressure cylinders and actuating connections for said valve arranged to close the low-pressure valve more rapidly than the high-pressure valve during the latter part of its closing movement; substantially as described.

2. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, and actuating connections arranged to move the low-pressure throttle-valve slowly when it is in open position and increase the rapidity of motion as the low-pressure valve is closed; substantially as described.

3. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, and actuating connections arranged to close the valves simultaneously and move the high-pressure valve more slowly than the low-pressure valve in closing; substantially as described.

4. A compound reversing-engine having throttle-valves for high and low pressure cylinders, having a link driving mechanism for the valves arranged to bring the high-pressure throttle-link near a dead-center position when the high-pressure valve is closed, and the low-pressure throttle-link near the dead-center position when the low-pressure throttle-valve is wide open; substantially as described.

5. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, actuating link connections arranged to move the high-pressure throttle more rapidly in its more open positions, and the low-pressure throttle more rapidly in its closing positions; substantially as described.

6. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, and admission-ports for the high-pressure throttle-valve arranged to give a constant inlet area for a predetermined movement of the valve; substantially as described.

7. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, the high-pressure throttle-valve having a bridge arranged to maintain the port area constant through an opening portion of the valve movement; substantially as described.

8. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, the high-pressure throttle-valve having small ports which are first opened, a bridge arranged to then maintain the area constant, and larger ports beyond the bridge to increase the opening area; substantially as described.

9. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, the high-pressure throttle-valve having small ports which are first opened having an area equal approximately to one per cent. of the high-pressure-cylinder area, larger successive ports, and a bridge between the small and large ports arranged to maintain the port-opening substantially constant through a predetermined lift of the valve; substantially as described.

10. A compound reversing-engine having throttle-valves for the high and low pressure cylinders, actuating connections arranged to

move the high-pressure throttle more slowly near its closing-point, connections arranged to move the low-pressure throttle-valve more quickly near its closing-point, the high-pressure throttle-valve having small ports at the first part of its travel, larger ports at the latter part of its travel, and means for maintaining the high-pressure opening substantially constant before the larger ports are reached; substantially as described.

In testimony whereof I have hereunto set my hand.

WILLIBALD TRINKS.

Witnesses:
H. M. CORWIN,
C. P. BYRNES.