W. I. KOVALSKY.

STARTING VALVE FOR COMPOUND ENGINES.

APPLICATION FILED JULY 27, 1909.

963,375.

Patented July 5, 1910.

2 SHEETS—SHEET 1.

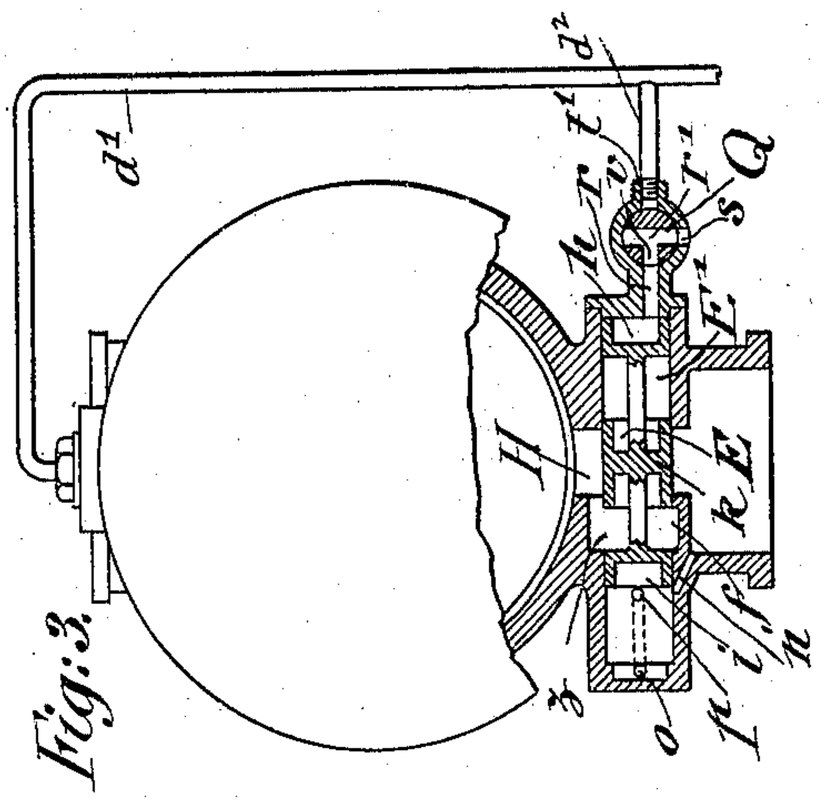

Fig: 3.

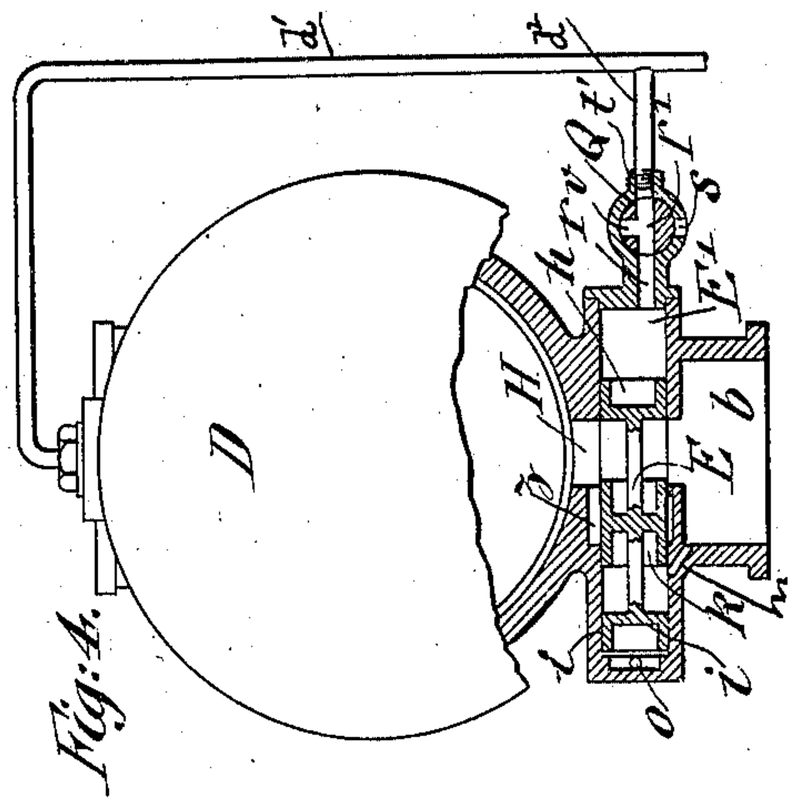

Fig: 4.

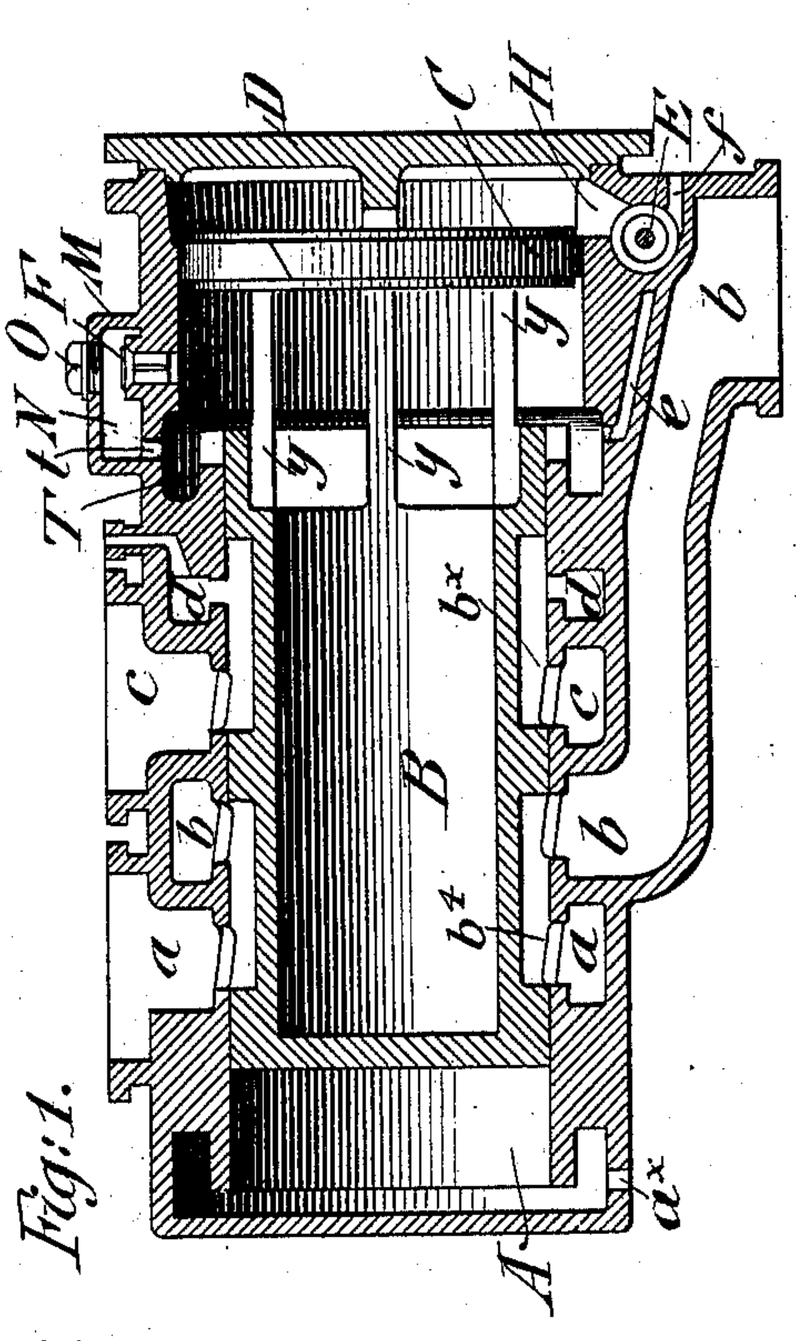

Fig: 1.

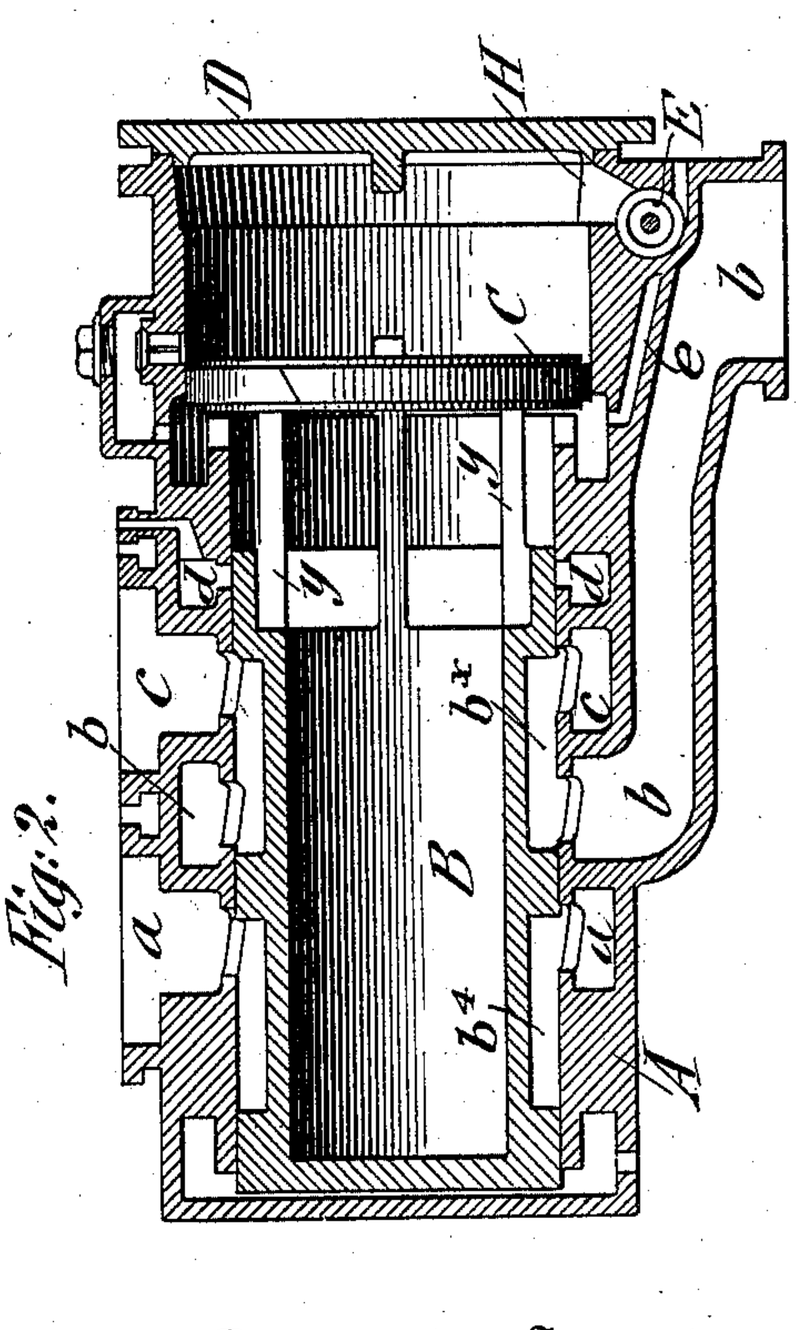

Fig: 2.

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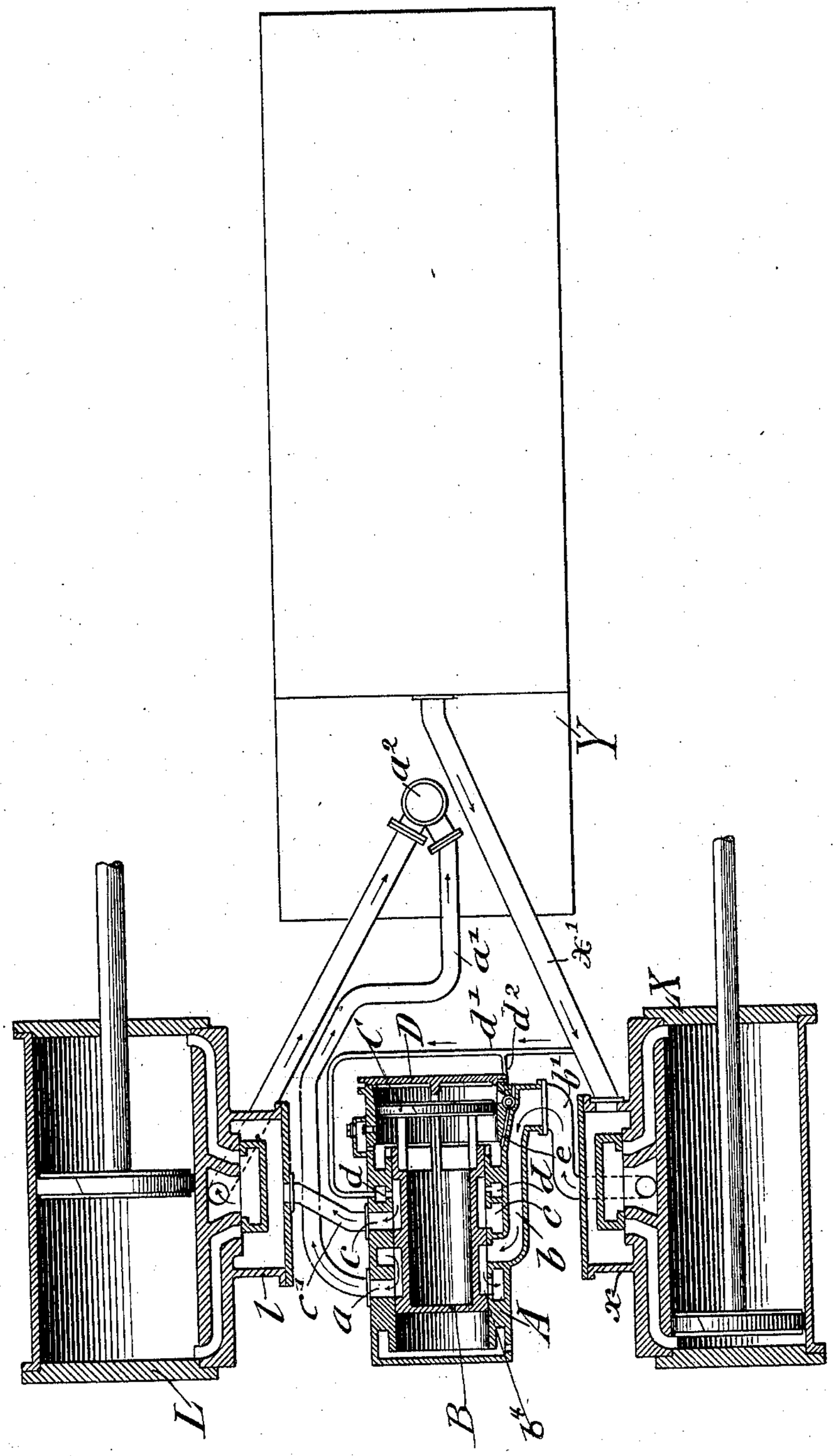
2 SHEETS—SHEET 2.

Fig. 5.



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UNITED STATES PATENT OFFICE.

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STARTING-VALVE FOR COMPOUND ENGINES.

963,375. Specification of Letters Patent. **Patented July 5, 1910.**

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To all whom it may concern:

Be it known that I, WLADIMIR I. KOVALSKY, a subject of the Czar of Russia, residing at Stanzia Zdolbunoff R. R. Colony of the Southwestern R. R. Co., in the Empire of Russia, have invented certain new and useful Improvements in Starting-Valves for Compound Engines, of which the following is a specification.

This invention relates to an improved apparatus for converting a compound engine into a single engine and vice versa. Said apparatus is operated by a manually-controlled three-way valve, and performs its function automatically after the three-way valve is set. This apparatus is intended to be used as a starting valve for locomotives and may be adapted to be operated from the engine cab, by the engineer.

In the accompanying drawings, Figures 1 and 2 represent substantially vertical longitudinal sections, showing the main slide-valve of the apparatus respectively in its initial or starting position for running the engine as a compound engine, and in the position for running the same as a simple engine, Figs. 3 and 4 are end-elevations, partly in section through the piston slide-valve by which the main slide-valve is controlled, showing the parts in the position shown by Figs. 1 and 2 respectively, and Fig. 5 is a view showing the attachment of my apparatus to the high and low pressure cylinders and the boiler, the cylinders and the slide-valves being shown in section and the boiler diagrammatically.

Similar letters of reference indicate corresponding parts throughout the several views.

Referring to the drawings, A represents a cylindrical steam-chest, which is closed at one end and provided at the opposite end with a detachable head D. In the steam-chest is guided a main cylindrical slide-valve B, which is closed at the end adjacent to the closed end of the steam-chest A, and provided at the opposite end with a piston C of larger diameter than the diameter of the slide-valve B, said piston moving in the end of the steam-chest adjacent to the head D, which is made of larger diameter than the steam-chest for the remaining portion of the cylinder A. The cylinder A and the slide-valve B together form a four-way valve, as will appear. The piston C is connected by means of ribs *y* with the cylindrical slide-valve B. In the lower part of the steam-chest A, adjacent to the head D, is arranged a cylindrical valve-box E^1, which is located transversely to the longitudinal axis of the steam-chest A, and which is connected by a central channel H with the space between the piston C and head D. In the valve-box E^1 is arranged a slide-valve E, which is provided with three small pistons *i*, *k* and *h* on the same stem.

The steam-chest A has four contiguous channels *a*, *b*, *c* and *d*, of which the channel *a* is permanently connected with the atmosphere by means of the exhaust-pipe a^1 connecting with the vertical exhaust pipe or nozzle a^2 on the boiler Y. The port *b* is connected by means of the pipe b^1 with the steam-exhaust channel of the high-pressure cylinder X. The port *c* is connected by means of the pipe c^1 with the slide-valve chest *l* of the low-pressure cylinder L. The port *d* is connected by means of the small pipe d^1 with the main steam-pipe x^1 leading to the slide-valve chest *x* of the high-pressure cylinder X. The space between the piston C and head D is connected when the piston is in the position, shown in Figs. 1 and 3, with the atmosphere by means of the central channel H, the connecting channel *z* at the inside face of the valve-box E^1 (see Fig. 3), and the outlet-channel *f*.

At the upper part of the cylindrical steam-chest A, in the larger end-portion of the same, is arranged a valve-box M which incloses an upwardly-opening valve F, the valve-box being closed by a plug O, which serves for the inspection of the valve F, the interior space N of the valve-box M being connected by means of the duct *t* with the annular channel T which communicates with the space between the main slide-valve B and the piston C. The annular channel T is constantly connected by means of channel *e*, which has two openings *p*, *o*, (see Fig. 3) with the end of the space in which the piston *i* of the slide-valve E moves, which space, by means of the channel *n*, is connected with the channel *b* of the cylindrical steam-chest A, as shown clearly in Fig. 3. The channel *n* is made very small in cross-section relative to the channel H.

At the end of the chest of the valve-box E^1 is arranged a three-way cock Q adjacent to the end-piston *h* and adapted to be manu-

ally operated by any suitable means. The small pipe d^1, which, as stated, communicates with the main steam-pipe x^1, is provided with a branch d^2 leading to a channel t^1 (see Fig. 5) leading to the spigot of the three-way cock Q. When the spigot of the three-way cock is placed in the position shown in Fig. 4, it establishes, by means of the channels t^1, r^1 and r, the communication between the slide-valve chest of the main steam-pipe x^1 and the space between the piston h and the adjacent end of the valve-box E^1. The space between the closed end of the main-cylinder A and the end of the main slide-valve B is connected by means of the hole a^x with the atmosphere.

The operation of my improved apparatus for converting the compound locomotive-engine into a simple one, and vice versa, is as follows: When the slide-valve B and piston C are in the position, shown in Fig. 1, and the spigot of the three-way cock Q is in the position shown in Fig. 3, high-pressure steam is admitted to the low-pressure cylinder by way of the small pipe d^1, the port d, the channel c and the pipe c^1, but the admission of exhaust steam to the low-pressure engine from the high-pressure engine is shut off, the exhaust from the high-pressure cylinder passing through pipe b^1, channel b, passage b^4, channel a and pipe a^1 to the vertical exhaust pipe a^2. When, however, the three-way cock is placed in the position shown in Fig. 4, then live steam from the main steam-pipe x^1 is conducted through the small pipe d^1, branch pipe d^2 and channels t^1, r^1 and r to the space in which the piston h is located, so that the pistons h, k and i assume the position farthest from the cock Q, so that the space between the piston C and head D is shut off from the atmosphere by the covering of the channels f and z (see Fig. 4) by the piston k, and the space referred to is connected by the channel H, the space between the pistons h and k and the channel b with the steam-exhaust pipe of the high-pressure cylinder.

While the exhaust steam from the cylinder of high pressure flows into the channel b, it enters from the channel H and the space between the pistons h and k into the space between the piston C and head D so as to push the piston C and the main slide-valve B connected with it toward the opposite end of the steam-chest A, so that the channel b will, by means of the passage b^x, the channel c and the pipe c^1, be connected with the slide-valve chest of the low-pressure cylinder; while the channels a and d will be covered by the main slide-valve B, so that the engines will work according to the compound system. At the same time, the exhaust steam from the channel b not only flows into the space between the piston C and the head D through the very wide channel H, but the exhaust steam also flows to a slight extent though the channels n and e into the space between the valve B and the piston C, the opening p being uncovered by the piston i. The pressure of the exhaust steam in the channel b is intermittently variable, being very low just before the exhaust port of the high pressure cylinder is opened and being very high immediately after this exhaust port is opened. Now since, as stated, the channel H is very wide, it does not at all throttle or impede the flow of steam from the channel b, and the great changes of pressure of the exhaust steam are instantly communicated to all parts of the space between the piston C and the head D, and, therefore, to the lower face of the valve F. On the other hand, the channel n is, as stated, of very small cross-section and the passage comprising the channels e, p, o and n is both narrow and tortuous and acts to very greatly impede and throttle the flow of the steam from the high pressure exhaust, particularly acting to absorb the shock of the very high pressure immediately after the high pressure cylinder exhaust port is opened. Because of this throttling effect of the channels e and n, the intermittent very high pressure of the exhaust steam is not communicated to the space between the piston C and the valve B, the pressure in said space, and therefore the pressure on the upper face the valve F being nearer the means between the highest and lowest pressure in the channel b. It is seen, then, that while the pressure in the space between the valve B and the piston C, and on the upper face is fairly constant and considerably below the maximum in the channel b; the pressure on the lower face of the valve F is very variable, and is, just after the opening of the exhaust port of the high pressure, very high. Now, at this time, when the pressure below the valve F is the highest and the pressure above the valve F is only about the average of the pressure in the channel b, the steam pressing below the valve F forces the valve open and enters the space between the valve B and the piston C, thus raising the pressure in said space a little above its average pressure. When the pressure in the channel b drops to its lowest, it is less than the pressure in the space between the valve B and the piston C which is, as stated near the mean of the pressure in the channel b. When this condition is reached, the pressure at the upper end of the passage comprising the channels e and is, therefore, greater than the pressure at the lower end of said passage, and when the relative pressures are thus, there is a tendency to force out into the channel b any water of condensation which may collect at the upper end of the channel e. This tendency is repeated after each

discharge of the exhaust of the high pressure cylinder, and the space between the piston C and the valve B is thus kept free from water of condensation. The condensation may be removed from the channel *b* in any convenient or usual manner.

When for some reason it should be necessary for the engineer to increase the force of the motive power of the engine and convert the engine from the compound to the simple system, then the three-way cock Q is turned in the position shown in Fig. 3, so as to connect the space around the piston *h* by means of the channels *r*, *v* and *s* with the atmosphere, while the steam contained in the channel *b* acts on the piston *h* and pushes instantly the slide-valve E to the position shown in Fig. 3, the pressure on both sides of pistons *i* and *k* being balanced. This connects the space between the piston C and the head D with the atmosphere by means of the channels H, *z* and *f*. In view of the fact that the atmospheric pressure is established in this space, the steam contained in the space between the valve B and piston C will hold the valve F to its seat, and owing to the difference of the cross-section of the slide-valve B and piston C will press more upon the piston C and return the piston C, together with the slide-valve B, to the initial position shown in Fig. 1, thus introducing live steam to the slide-valve box *l* by way of the pipes *x* and d^1, the port *d*, passage b^x, the port *c* and the pipe c^1, after which both cylinders run as a simple engine. Whenever it is desired to convert the simple action of the engine back to the compound action of the engine, the spigot of the three-way cock Q is turned back to the position shown in Fig. 4 as hereinbefore explained.

In view of the fact that when the regulator is in closed position the engine works as a simple one, the injurious suction and compression of the air in the cylinder, which would take place and injuriously affect the cylinder itself as well as the slide-valve chests, if the low-pressure cylinder were simply cut out and the piston allowed to reciprocate without steam, are dispensed with, so that a considerable saving in fuel and expense and an increase in speed, when moving without steam on the downward inclines of the road, is obtained.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. In a compound engine, the combination of a high-pressure cylinder, a low-pressure cylinder, a main slide-valve cylinder having a larger end and having a smaller end permanently communicating with the atmosphere, a hollow slide-valve in said main slide-valve cylinder having a closed end toward the large end of the main slide-valve cylinder, the opposite end being open, said slide-valve cylinder and said slide-valve forming a four-way valve adapted when in one position to establish communication between the exhaust of the high-pressure cylinder and the slide-valve chest of the low-pressure cylinder, and when in another position to establish communication between the slide-valve chests of the high-pressure and the low-pressure cylinders and between the exhaust of the high-pressure cylinder and the atmosphere, a piston in said larger end spaced from said open end, channels communicating with the space between said piston and the head of the large end of the main slide-valve cylinder with the space between said piston and said main slide-valve, with the exhaust of the high-pressure cylinder and with the atmosphere, a second slide-valve cylinder, and a second slide-valve in said second slide-valve cylinder and adapted when in one position to establish communication between the exhaust of the high-pressure cylinder and the space between said piston and the main slide-valve, and between the space between said piston and said head and the atmosphere, and when in another position to establish communication between the space between said piston and said head and the exhaust-channel of the high-pressure cylinder, and means to operate said second slide-valve.

2. In a compound engine, the combination of a high-pressure cylinder, a low-pressure cylinder, a main slide-valve cylinder having a large end and having a small end permanently communicating with the atmosphere, a hollow slide-valve in said main slide-valve cylinder having a closed end toward the large end of the main slide-valve cylinder, the opposite end being open, said slide-valve cylinder and said slide-valve forming a four-way valve adapted when in one position to establish communication between the exhaust of the high-pressure cylinder and the slide-valve chest of the low-pressure cylinder, and when in another position to establish communication between the slide-valve chests of the high-pressure and the low-pressure cylinders and between the exhaust of the high-pressure cylinder and the atmosphere, a piston in said large end and spaced from said open end, channels communicating with the space between said piston and the head of the large end of the main slide-valve cylinder with the space between said piston and said main slide-valve, with the exhaust of the high-pressure cylinder and with the atmosphere, a second slide-valve cylinder, and a second slide-valve in said second slide-valve cylinder and adapted when in one position to establish communication between the exhaust of the high-pressure cylinder and the space between said piston and the main slide-valve, and between

the space between said piston and said head and the atmosphere, and when in another position to establish communication between the exhaust-channel of the high-pressure cylinder and the spaces on both sides of said piston, means to operate said second slide-valve, an additional channel establishing communication between the spaces on both sides of said piston when said piston is in its extreme position toward the main slide-valve, and a check-valve in said last-named channel.

In testimony, that I claim the foregoing as my invention, I have signed my name in presence of the subscribing witnesses.

WLADIMIR IVANOVICH KOVALSKY.

Witnesses:

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FLEMPE MUXANNOBURR,

P. CHIKIN.