(No Model.)

4 Sheets—Sheet 1.

R. CREUZBAUR.

COMPOUND SINGLE ACTING STEAM ENGINE.

No. 369,923.

Patented Sept. 13, 1887.

Fig. 1.

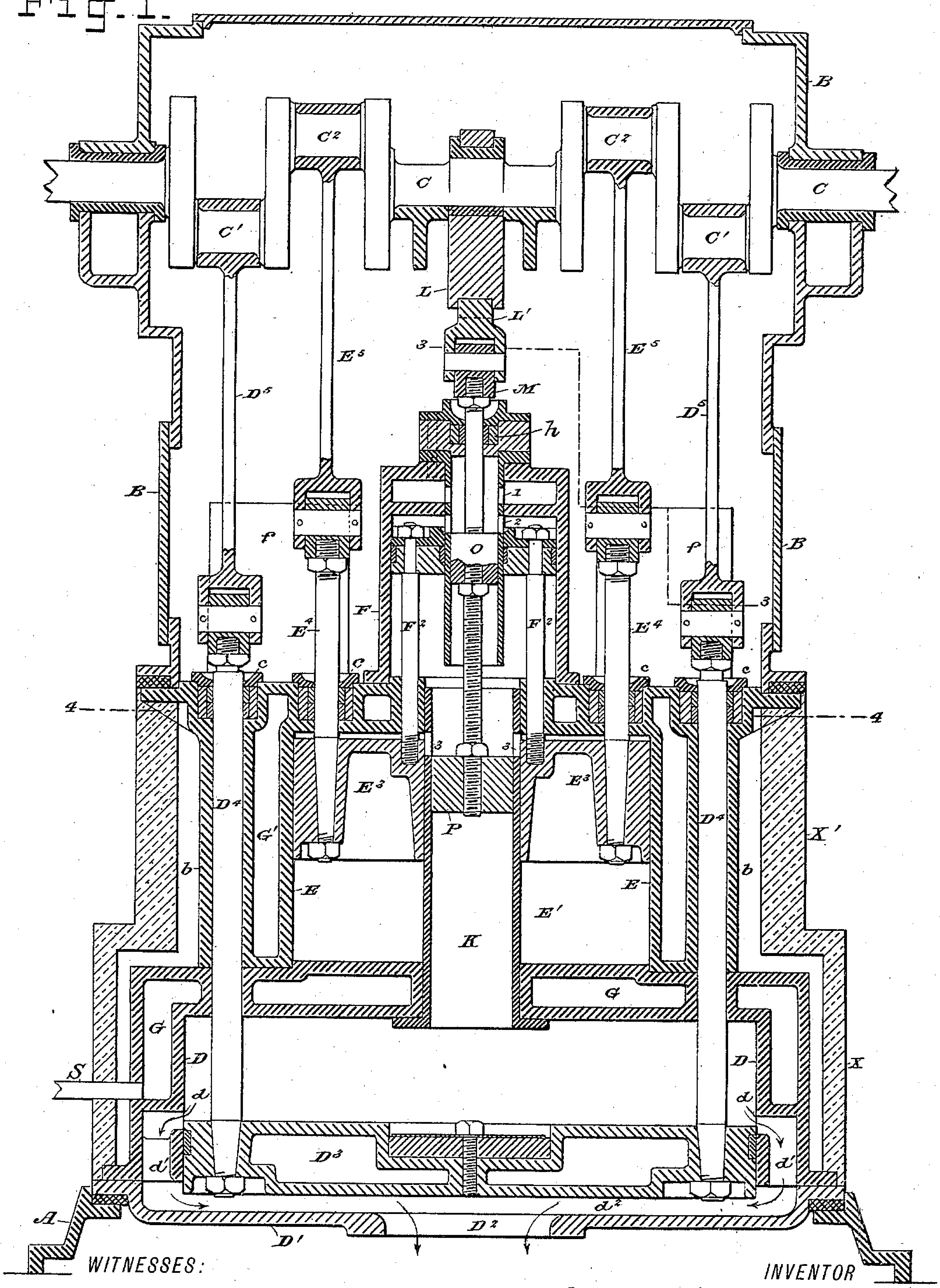

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Fig. 2. Fig. 3. Fig. 4.

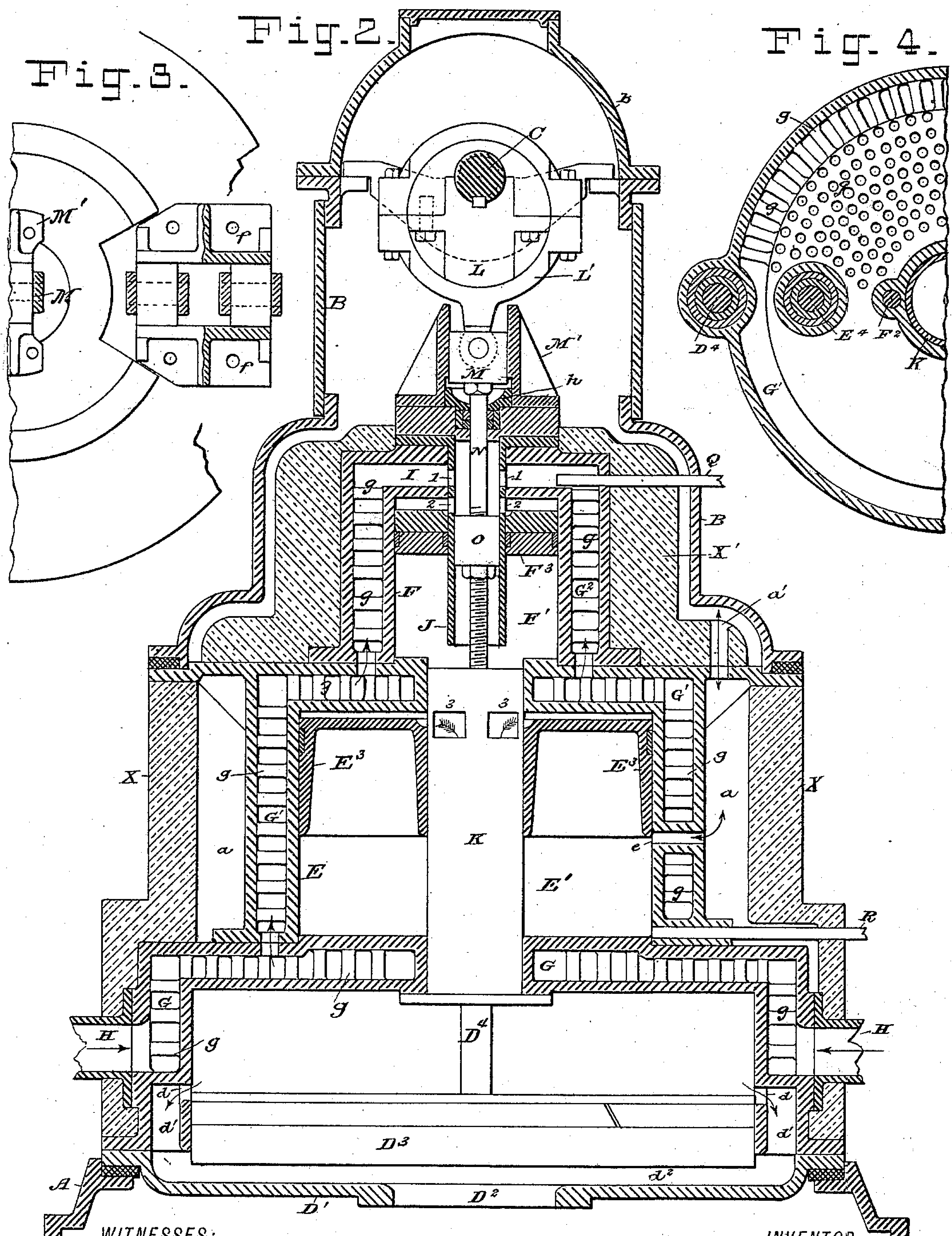

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Fig. 5.

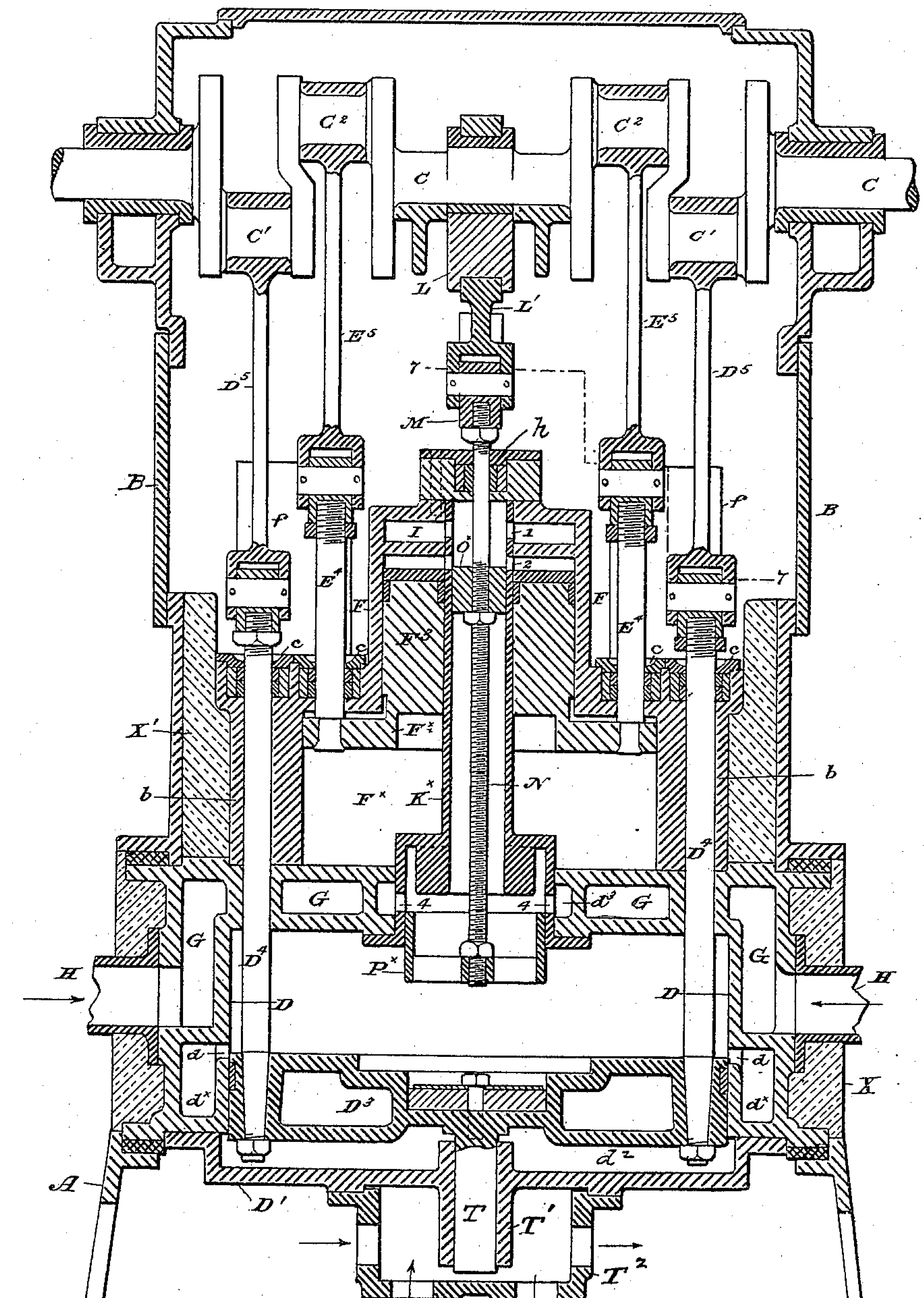

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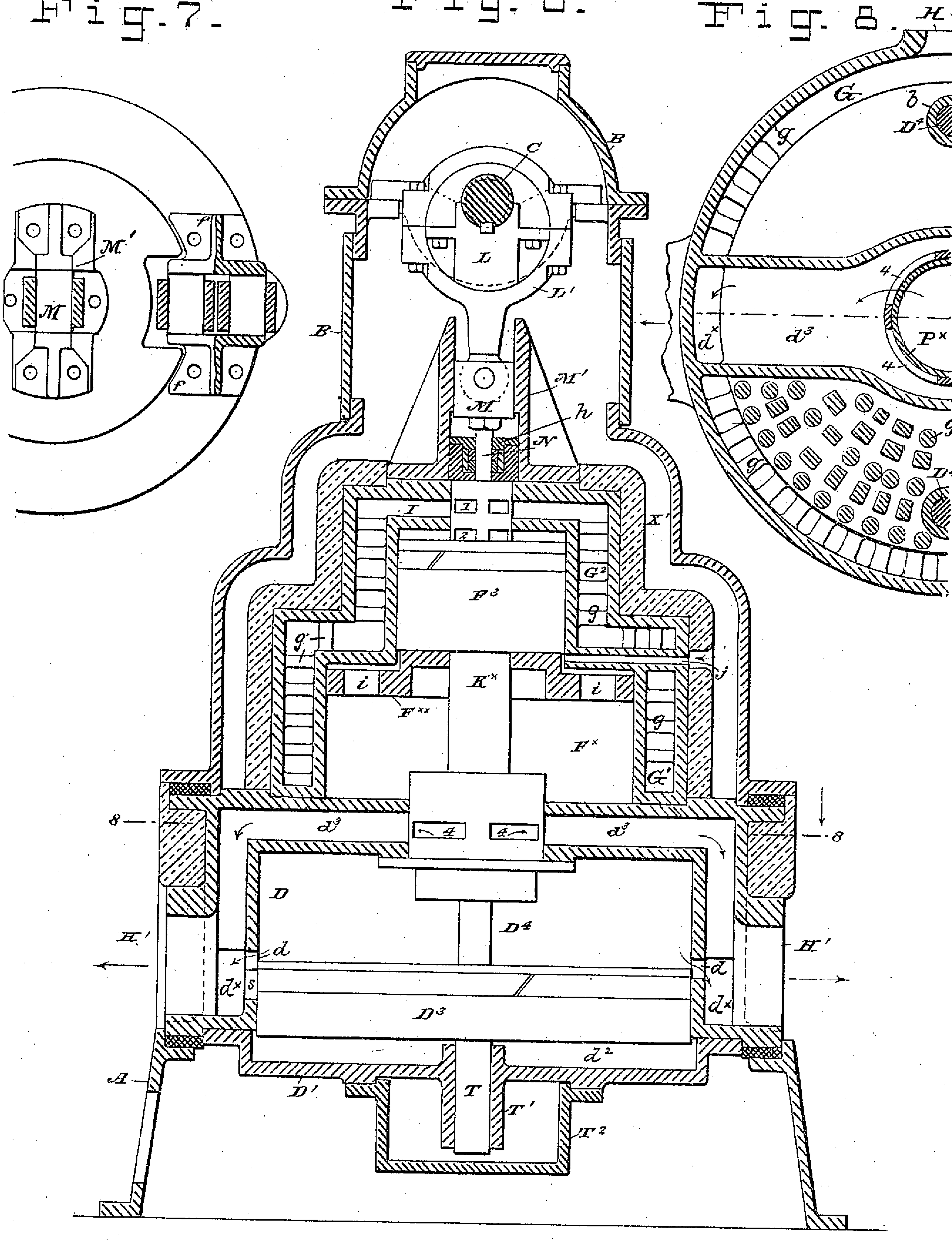
Fig. 7. Fig. 6. Fig. 8.



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UNITED STATES PATENT OFFICE.

ROBERT CREUZBAUR, OF BROOKLYN, NEW YORK.

COMPOUND SINGLE-ACTING STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 369,923, dated September 13, 1887.

Application filed November 18, 1886. Serial No. 219,242. (No model.)

To all whom it may concern:

Be it known that I, ROBERT CREUZBAUR, a citizen of the United States, and a resident of Brooklyn, Kings county, New York, have invented certain Improvements in Compound Single-Acting Steam-Engines Arranged Tandem, of which the following is a specification.

My present invention is a complement to a series of improvements in engines of this class embodied in my several pending applications for patent bearing the serial numbers 171,412, 171,413, 193,001, 193,721, and 207,309, to which reference is made for a detailed description of the construction and operation of this class of engines not set forth and claimed herein.

My present improvement consists in, first, connecting the high-pressure piston on its nonworking side with the working side of the intermediate piston by means of a pair of rods arranged on opposite sides of an axially-arranged valve-casing; second, in an engine having three pistons, the coupling of the intermediate piston with the high-pressure piston by rods extending downward from the non-working side of said high-pressure piston, whereby steam that may leak through the top of the intermediate cylinder around said rods will be utilized in acting on the intermediate piston and during the exhaust upon the low-pressure piston; third, a cushion-chamber under one of the working-pistons, in which a constant cycle of pressures is automatically maintained by connecting said chamber at proper times with a body of an elastic fluid of approximately constant and uniform tension; fourth, the inlet for the superheated boiler-steam into the steam-jacket, so arranged that the unequal expansion caused thereby will be approximately neutralized or balanced on opposite sides by employing two or more oppositely-arranged inlets for said steam, and, fifth, the arrangement whereby the low-pressure piston is cushioned, which is effected by entrapping more or less of its exhaust-steam. I attain these ends by the construction and arrangement of the engine as illustrated in the accompanying drawings, wherein—

Figures 1 to 4 show my invention as applied to a three-cylinder compound condensing engine, and Figs. 5 to 8 show certain features of my invention as applied to a two-cylinder compound non-condensing engine. Fig. 1 is a vertical axial section of a three-cylinder condensing-engine constructed according to my invention, the plane of the section being taken longitudinally through the crank-shaft. Fig. 2 is a similar section, taken at right angles to Fig. 1, and showing some of the central parts in elevation. Fig. 3 is a fragmentary horizontal section taken in the plane indicated by line 3 3 in Fig. 1. Fig. 4 is a fragmentary horizontal section taken in the plane indicated by line 4 4 in Fig. 1. Figs. 5 and 6 are sections, respectively, like Figs. 1 and 2, of a two-cylinder non-condensing engine constructed according to my invention. Fig. 7 is a fragmentary horizontal section on line 7 7 in Fig. 5, and Fig. 8 is a fragmentary horizontal section on line 8 8 in Fig. 6.

In the condensing-engine illustrated in Figs. 1 to 4 no exhaust-valve for the low-pressure cylinder is provided, the entrapped low-pressure steam being employed as a cushion for the piston in its upstroke. A chamber under the high-pressure cylinder serves as a "receiver" for the exhaust from said cylinder. A chamber under the intermediate piston serves as a cushion-chamber upon the elastic medium in which the two lesser pistons and their attachments are cushioned. This cushion-chamber is kept at an approximately-constant cycle of pressures by an opening into the crank-shaft chamber, which opening is uncovered during the time the piston stands at the end of its upstroke.

Referring to Figs. 1 to 4, I will now describe the construction of this engine.

Let A represent the base of the engine, B the shell or casing forming the crank-shaft chamber, and C the crank-shaft, which has bearings in said casing.

D is the low-pressure cylinder, and D′ its bottom plate, in which is an aperture, D^2, whereby the connection is made with the condenser.

D^3 is the low-pressure piston.

d d are exhaust-ports in the walls of the low-pressure cylinder, distributed around its entire circumference and opening into an annular passage, *d′*, which is traversed by ties at intervals for strength. The passage *d′* opens into the chamber d^2 below the piston. When the piston is at the end of down or out stroke, it uncovers ports *d d* momentarily, as seen in

Figs. 1 and 2. The low-pressure cylinder is mounted on the base A, as clearly shown.

E is the intermediate cylinder, which is mounted on the top of the low-pressure cylinder. The casing B is mounted on the top of this intermediate cylinder.

E^3 is the intermediate piston, and E′ is the cushion-chamber below said piston. In the wall of cylinder E is an aperture or port, *e*, connecting chamber E with the crank-shaft chamber through an air jacket or space, *a*, between the walls of cylinders D and E and the lagging or non-conducting material X, arranged around these cylinders.

In Fig. 2 is shown the air-passage *a′* through the lagging X′ around the high-pressure cylinder, whereby communication is effected between the air-space *a* and the crank-shaft chamber. The intermediate piston, E^3, uncovers port *e* momentarily at the end of its upstroke, as seen in Fig. 2, and thus reduces any undue tension in the cushion-chamber E′ that may have accumulated, or, rather, it preserves a uniform tension-cycle within said chamber. The crank-shaft chamber is open to the atmosphere through its unpacked joints, and the connection of chamber E′ therewith is equivalent to opening said chamber direct to the atmosphere, except that the air in the crank-shaft chamber will be maintained at a temperature somewhat above that of the surrounding air.

F is the high-pressure cylinder, which is mounted on the intermediate cylinder, E, and F^3 is the high-pressure piston. A peculiarity of the high-pressure cylinder lies in its having no lateral nor upward apertures through the live-steam chamber for connecting it to its connecting-rods.

F′ is a receiving-chamber under the high-pressure piston. The high-pressure piston F^3 is connected to the intermediate piston, E^3, by rods F^2 F^2, which pass through and play in apertures in the top of the cylinder E. The rods fit snugly in these apertures; but no packing is necessarily employed. They may, however, be bushed, if desired.

The low-pressure piston D^3 is connected to its crank-pins C′ by two piston-rods, D^4 D^4, which play in guides *b b*, formed integrally with cylinder E, and by two connecting-rods, D^5 D^5, coupled at their upper ends to said crank-pins and at their lower ends to said piston-rods.

The intermediate piston, E^3, is connected to its crank-pins C^2 by two piston-rods, E^4 E^4, and two connecting-rods, E^5 E^5, coupled at their upper ends to said crank-pins and at their lower ends to said piston-rods.

The piston-rods D^4 and E^4 are provided with suitable stuffing-boxes, *c c*, and their heads, where they are coupled to their respective connecting-rods, are provided with suitable guides, *f f*, Figs. 1 and 3, one pair of guides serving for both sets of rods in this case, although two sets may be employed.

The several cylinders D E F are surrounded, wholly or partially, by connected steam-jackets G G′ G^2, respectively, which form, also, a passage for the steam to the steam-inlet port of the high-pressure cylinder. In Figs. 2 and 4 I have shown these jackets or passages provided with "heat-pegs" *g g*, extending across from the exterior face of the cylinder-walls to the interior face of the outer shell of the jackets, the three parts being integral. The steam—usually superheated steam—enters the jacket around the low-pressure cylinder and flows upward around the several cylinders to the steam-chamber at the upper part of the high-pressure cylinder. This feature is fully shown in my pending applications, and is not herein claimed. I have not shown the heat-pegs *g* in Fig. 1, as they form no essential or novel part of my present invention. In my present engine, however, I provide oppositely-arranged inlets H H for the superheated boiler-steam, in order to equalize the expansion of the parts caused by the heating of the same adjacent to said inlets; and I may employ more than two oppositely-arranged inlets for the steam in order to more effectually or perfectly accomplish this result. The jacket G^2 does not entirely surround the high-pressure cylinder F, but is divided into two parts, forming broad steam-passages, as seen in Fig. 2, and these passages connect at their upper ends with or open into a steam-chamber, I, on the top of the high-pressure cylinder F on opposite sides of said chamber. The steam-distribution is effected by the following-described mechanism:

J is a tubular valve-casing mounted in the top of the high-pressure cylinder F and depending in the axis of the same to a point near the lower edge of piston F^3 when in its extreme lower position. Said piston embraces and plays over said tubular casing.

K is a similar but larger tubular valve casing mounted in the top of the intermediate cylinder, E, and in the top of the low-pressure cylinder D, and extending through the axis of cylinder E. This casing opens at its upper end into the receiving-chamber F′ under the high-pressure piston F^3, and opens at its lower end into the low-pressure cylinder D above its piston D^3.

L is a valve-operating eccentric on shaft C, and L′ is the eccentric-strap. This strap is coupled to a cross-head, M, which plays in cross-head guides M′, mounted on the high-pressure cylinder. To cross-head M is rigidly attached a valve-stem, N, which passes through a stuffing-box, *h*, and down into the tubular valve-casings J and K.

On the valve-stem N are adjustably mounted two piston-valves, O and P, which control the distribution of the steam. The valve O controls ports 1, which admit steam from chamber I to valve-casing J, and ports 2, which allow the passage of the live steam from casing J to the working end of the high-pressure cylinder F, and the passage of the exhaust-steam from said cylinder through said casing to the receiving-chamber F′. The valve P controls ports 3 in casing K, which allow the passage of steam from receiving-chamber F′ to the working end of cylinder E, and the passage of the exhaust-steam from this cylinder through said casing K to the low-pressure cylinder D.

Q is a tube or pipe for supplying a lubricant to the boiler-steam in chamber I. R is a drainage-pipe for draining the cushion-chamber E′, and S is a pipe for draining the connected steam-jackets G G′ G^2. The cranks to which the pistons E^3 and F^3 are connected in common are set oppositely to the cranks to which the piston D^3 is connected. Consequently the low-pressure piston D^3 makes its working-stroke while the pistons E^3 and F^3 are making their non-working stroke, and vice versa. Figs. 1 and 2 show the pistons at the ends of their respective strokes, piston D^3 being at the end of its down or working stroke. Piston D^3 has uncovered ports *d* and opened cylinder D to the condenser. Valve O has opened ports 1 and 2 to admit live steam to the working side of high-pressure piston F^3, and valve P has opened ports 3 to admit steam from the receiving-chamber F′ to the working side of piston E^3. This latter piston, being at the end of its upstroke, has uncovered port *e*, and thus opened communication between cushion-chamber E′ and the crank-shaft chamber. When the cranks have passed the center, pistons E^3 and F^3 descend and piston D^3 rises. The first movements of pistons D^3 and E^3 close, respectively, the ports *d* and *e*. Piston D^3 is cushioned on the elastic fluid thus entrapped above it in cylinder D, and piston E^3, together with piston F^3 connected therewith, is cushioned on the elastic fluid in chamber E′. When the several pistons shall have reached the ends of their respective strokes, the valves O and P will have moved upward. Valve O will have closed ports 1 and opened ports 2 to receiving-chamber F′, and valve P will have closed ports 3 to receiving-chamber F′ and opened them to cylinder D above piston D^3.

The valves O and P are provided with female screws and the rod N with a male screw. The valves are adjusted by screwing them up or down on the rod, and they are held in position by jam-nuts.

I will now describe the construction shown in Figs. 5 to 8, wherein some of my improvements are shown as applied to a two-cylinder compound non-condensing engine.

As in the engine just described, A represents the base of the engine; B, the casing forming the crank-shaft chamber; C, the crank-shaft; C′ C^2, the crank-pins to which the pistons are coupled, arranged oppositely; X, the lagging of non-conducting material around the low-pressure cylinder; X′, the lagging around or partly around the high-pressure cylinder; D, the low-pressure cylinder; D′, its bottom plate; D^3, the low-pressure piston; D^4, its piston-rods; D^5, its connecting-rods, which couple rods D^4 to the crank-pins C′; *c c*, the stuffing-boxes; *f f*, the guides; *b b*, guide-bearings for piston-rods D^4; *d d*, exhaust-ports in cylinder D; F, the high-pressure cylinder; F^3, its piston; I, the steam-chamber over said cylinder F; G G′ G^2, the connected steam jackets or passages; H H, the inlets for the steam; *g*, the heat-pegs in the jackets; L, the valve-operating eccentric; L′, its strap; M, the cross-head; M′, its guides, and N the valve stem.

$F^{\times}$ is a cushion-cylinder below the high-pressure piston F^3. This cylinder chambers the enlargement $F^{\times\times}$, connected to the lower end of said piston F^3, and forming a guide for the same in its movements. This disk-like enlargement fits snugly in the chamber $F^{\times}$, and is provided with one or more apertures, *i*, for the passage of air. The piston F^3 is a cylinder of considerable length, and when at the end of its upstroke, as in Figs. 5 and 6, its lower end uncovers a port, *j*, which connects the cushion-chamber $F^{\times}$ with the crank-shaft chamber, as seen in Fig. 6. Thus a constant tension-cyle is maintained in chamber $F^{\times}$.

The enlargement $F^{\times\times}$ transmits the motion of piston F^3 to the piston-rods E^4 E^4, which are firmly attached thereto, as shown, these rods E^4 being connected with crank-pins C^2 C^2 through the connecting-rods E^5 E^5, which are coupled at their one ends to said crank-pins, and at their other ends to said piston-rods.

The steam-distribution is effected by the following-described mechanism. $K^{\times}$ is a tubular valve-casing secured at its upper end in the top of cylinder F, and at its lower end in the top of cylinder D. It is arranged axially in the cylinders and in chamber $F^{\times}$. At its upper end are formed ports 1 and 2, arranged precisely like ports 1 and 2 in Fig. 1, and these ports are controlled in the same manner as the latter by a valve, $O^{\times}$, on valve-stem N. At its lower end the casing $K^{\times}$ is enlarged, and in said enlargement are formed exhaust-ports 4, which open into an exhaust-passage, d^3. (Clearly shown in the horizontal section, Fig. 8.) These ports 4 are controlled by a valve, $P^{\times}$, which is tubular or open, so as not to impede the passage of steam from the high-pressure to the low-pressure cylinder.

The low-pressure cylinder D is entirely closed at its bottom by the plate D′. Before the piston D^3 in making its outstroke has closed the ports *d* the space between said piston and the bottom plate, D′, will be in communication with the exhaust-channel $d^{\times}$, through which channel and ports *d* the said space will be filled with exhaust-steam; and when the piston descends far enough to close ports *d* such steam will be entrapped below the piston and serve to cushion the momentum of the said piston and its attachments downwardly, and also to give them an upward impetus at the beginning of the upstroke of piston D^3. The extent or amount of this cushioning is regulated by enlargements, one or more, of such ports *d* downwardly, as shown at *s* in Fig. 6. The lower this enlargement extends the less exhaust-steam will be entrapped.

Figs. 5 and 6 show piston D^3 at the end of its working-stroke, and piston F^3 at the end of its non-working stroke. Valve $P^\times$ has uncovered port 4 to the exhaust-steam from cylinder D, and this exhaust-steam flows out through exhaust-passages d^3 d^3, partitioned off in the steam-jacket G, to two exhaust outlets, H′ H′, as seen in Fig. 6. At the same time the piston D^3 has uncovered ports d, and a portion of the steam will pass out in this way, first, into the annular chamber $d^\times$, and then to the outlets H′. Valve $O^\times$ has uncovered ports 1 and 2 and admitted live or boiler steam from chamber I to cylinder F above piston F^3. When the cranks have passed the centers, piston F^3 begins its working-stroke and piston D^3 its non-working stroke, and when these pistons shall have reached the ends of their respective strokes the valves also will have shifted. Valve $O^\times$ will now have closed port 1 and opened port 2 to cylinder D in casing $K^\times$, so that the steam in cylinder F may exhaust into the low-pressure cylinder, and valve $P^\times$ will have closed ports 4. It may be added that the first movement of piston D^3 upward closed ports d, and the first downward movement of piston F^3 closed port j.

The piston D^3 has (in Figs. 5 and 6) an axial elongation on its lower or non-working face, which forms a pump-plunger, T. This plunger plays in a barrel, T′, formed integrally with the plate D′. T^2 represents the valve-chamber, which is also secured to plate D′. This device is more fully illustrated in one of my pending applications, and forms no part of my present invention, except in so far as the plunger and barrel serve also as a guide to steady the low-pressure piston in its movements.

In Fig. 8, where some of the heat-pegs g are shown in transverse section, I have illustrated various forms of such pegs, some cylindrical, some square, some oblong in cross-section. These pegs may have any form.

Having thus described my invention, I claim—

1. A compound engine composed of single-acting cylinders arranged tandem, having the high pressure piston connected on its non-working side with the working side of the intermediate piston by means of a pair of rods passing through the top of the intermediate cylinder, and having its ported valve-casing and valve arranged in the cylinder-axis between said rods.

2. A compound engine composed of three single-acting cylinders arranged tandem, and with their common axes vertical, having its crank-shaft above said cylinders, the low-pressure piston coupled to one set of crank-pins, and the intermediate piston coupled to another set of crank-pins set at right angles to the first-named set, the steam-distribution valves and their casings arranged in the cylinder-axes, and the high-pressure cylinder coupled on its non-working side to the working side of the intermediate piston by means of two rods which pass through the top of the intermediate cylinder.

3. A compound engine composed of single-acting cylinders, having a cushion-chamber arranged under one of its working-pistons, in which a constant cycle of pressures is automatically maintained by connecting said chamber momentarily at the end of the up-stroke with a body of an elastic fluid having an approximately constant tension.

4. A compound engine composed of single-acting cylinders, having a cushion-chamber under one of its working-pistons, which chamber has a port opening to the atmosphere and controlled by the said working-piston, substantially as set forth.

5. A compound engine composed of single-acting cylinders, having connected steam-jackets on said cylinders forming a passage for steam to the high-pressure cylinder, having oppositely-arranged inlets for the steam to said jacket, and having centrally-arranged exhaust-passages from one cylinder to the other, as set forth.

6. A compound engine composed of single-acting cylinders, having connected steam-jackets on said cylinders forming a passage for superheated steam to the high-pressure cylinder, and having oppositely-arranged inlets for the steam to said jackets, whereby the expansion caused by the heat from said steam is approximately balanced.

7. A compound engine composed of single-acting cylinders, having its low pressure cylinder closed at both ends and provided with exhaust-ports in its walls, which form the only communication from said cylinder to the exterior exhaust-channels of said cylinder, the low-pressure piston controlling said exhaust ports, and said exhaust-ports arranged at a point where they will be closed by the low-pressure piston before it reaches the end of its outstroke, whereby exhaust-steam will be entrapped under said piston for cushioning, as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ROBERT CREUZBAUR.

Witnesses:
HENRY CONNETT,
J. D. CAPLINGER.