

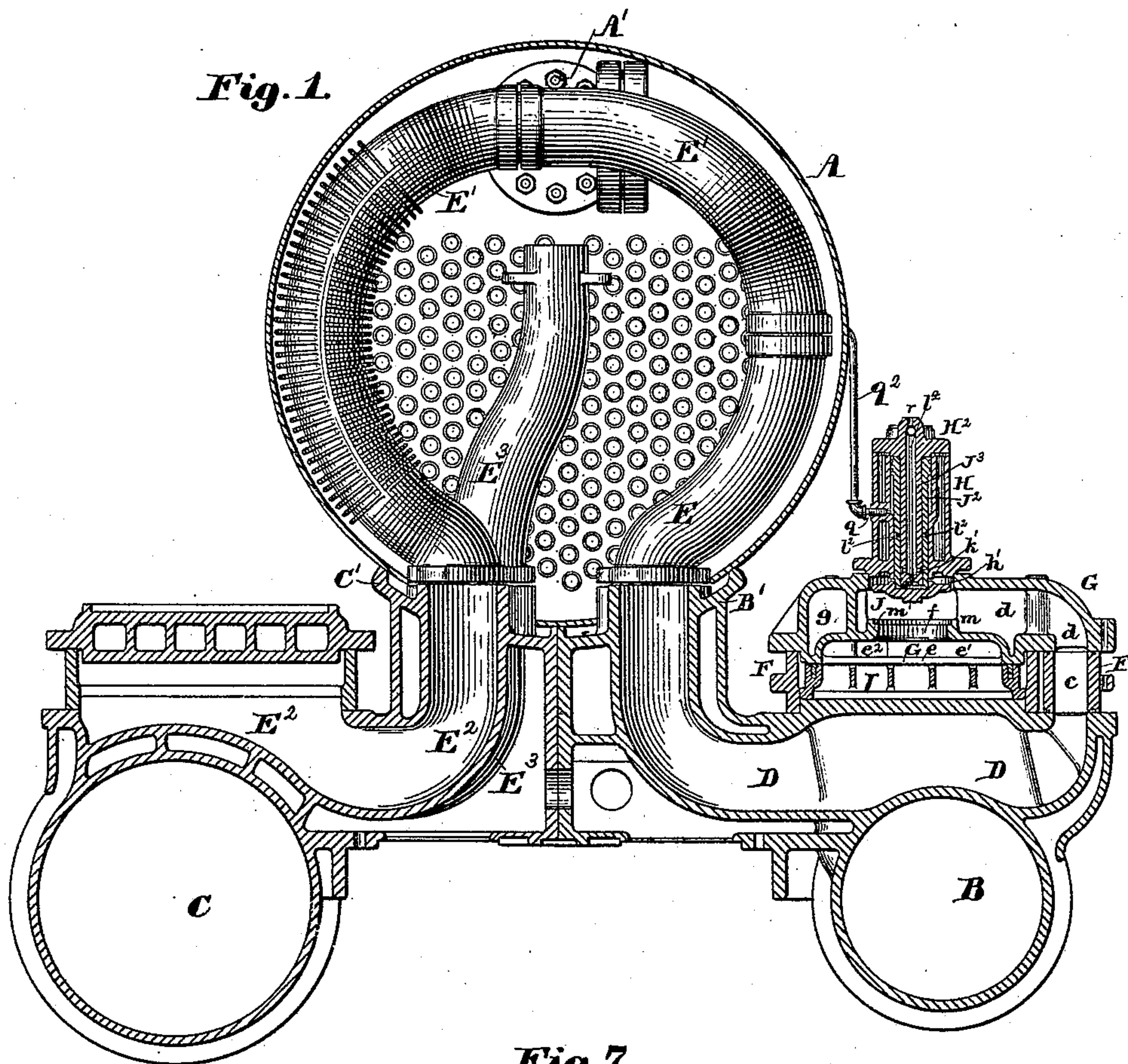
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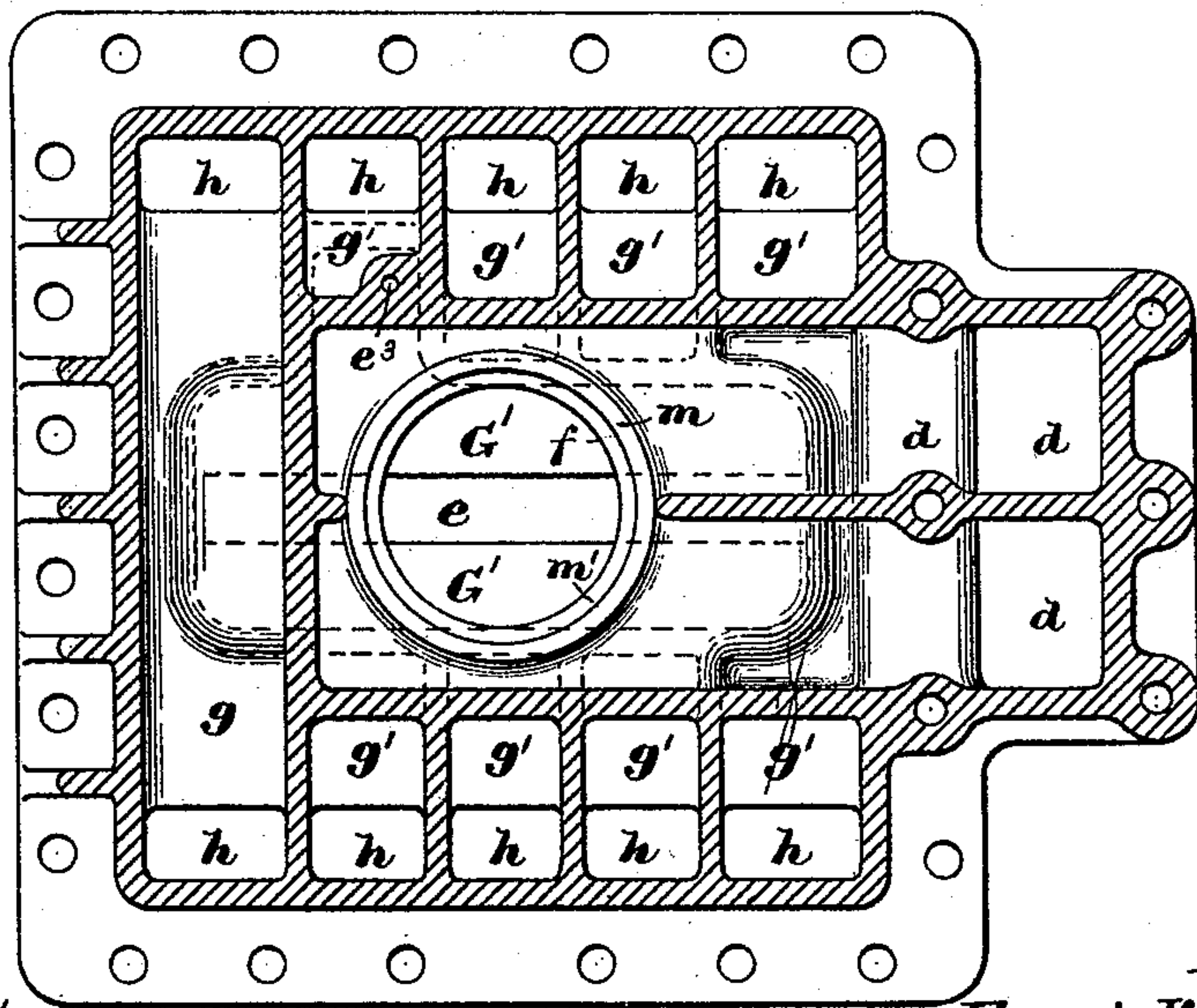
F. W. DEAN.  
COMPOUND LOCOMOTIVE ENGINE.

No. 507,353.

Patented Oct. 24, 1893.



**Fig. 7.**



**Witnesses:**

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by N. E. Lombard Attorney.



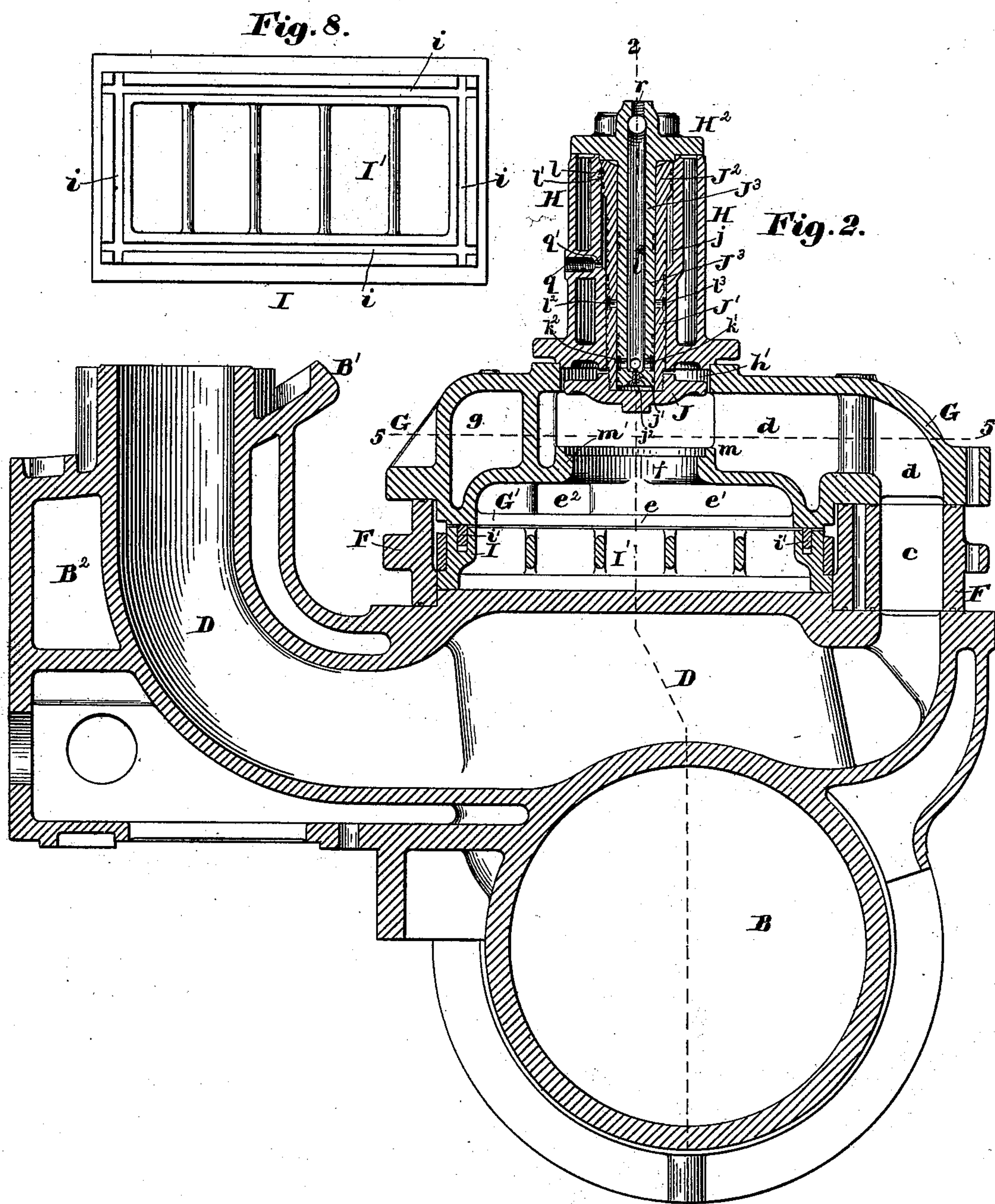
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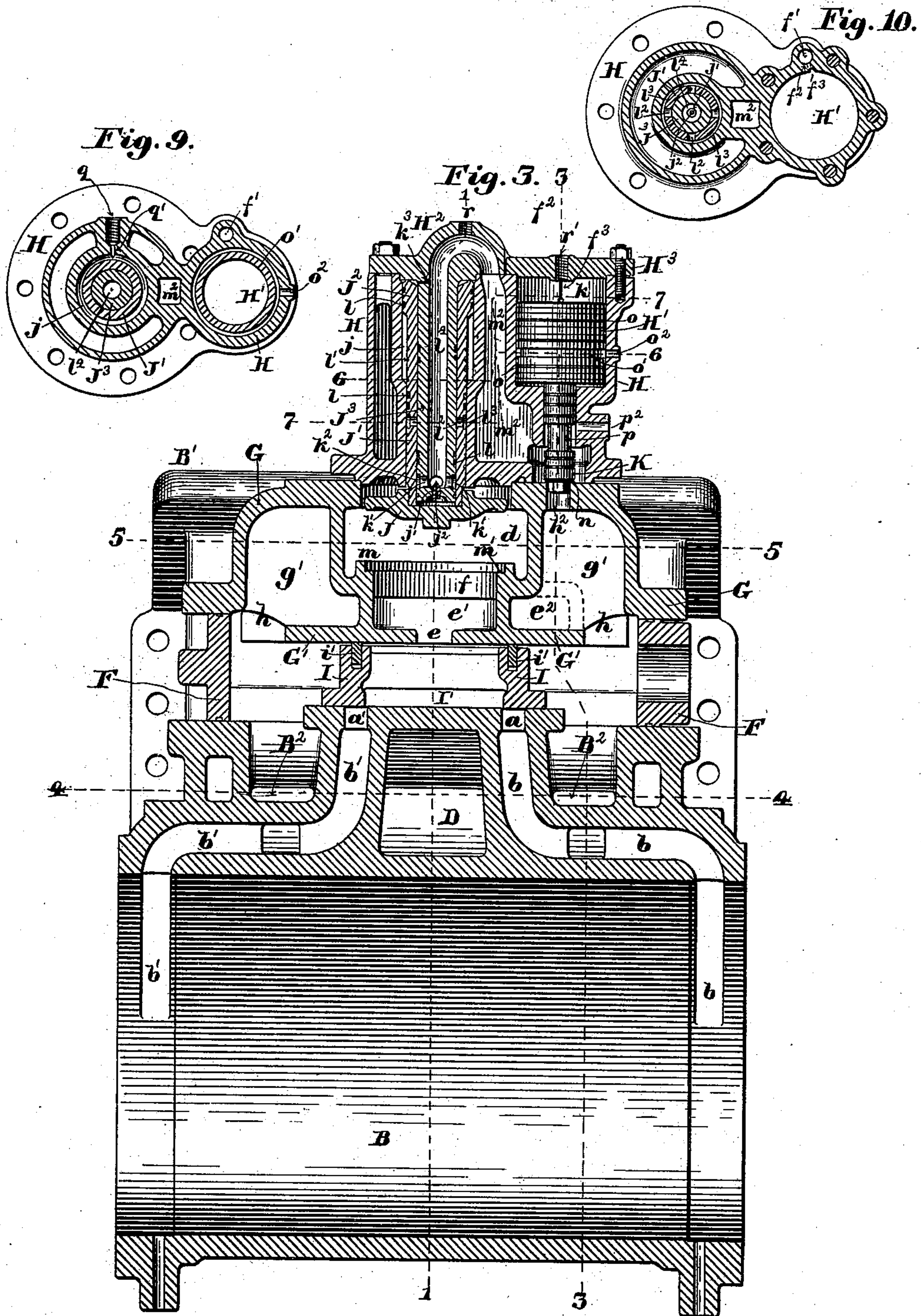
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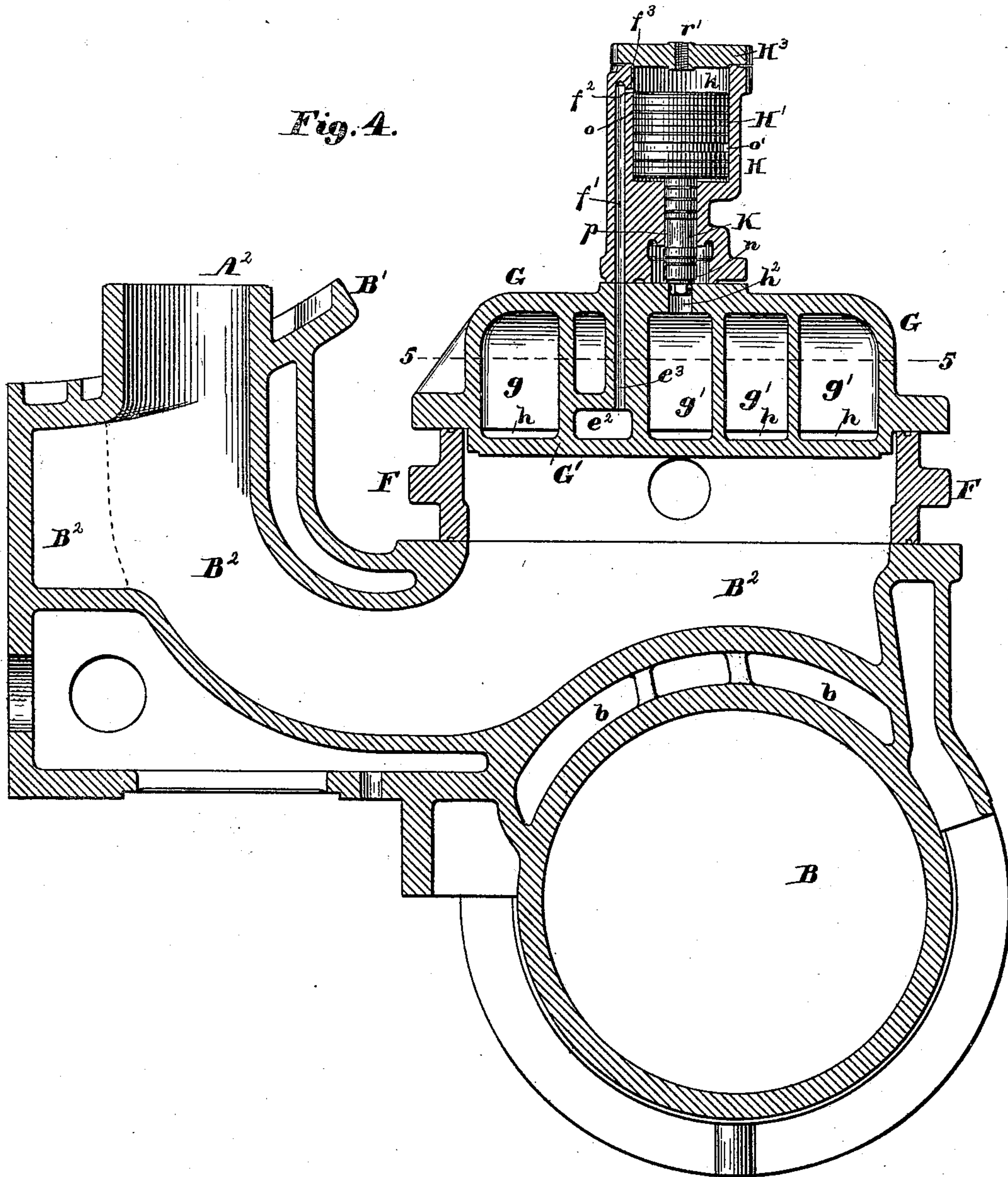
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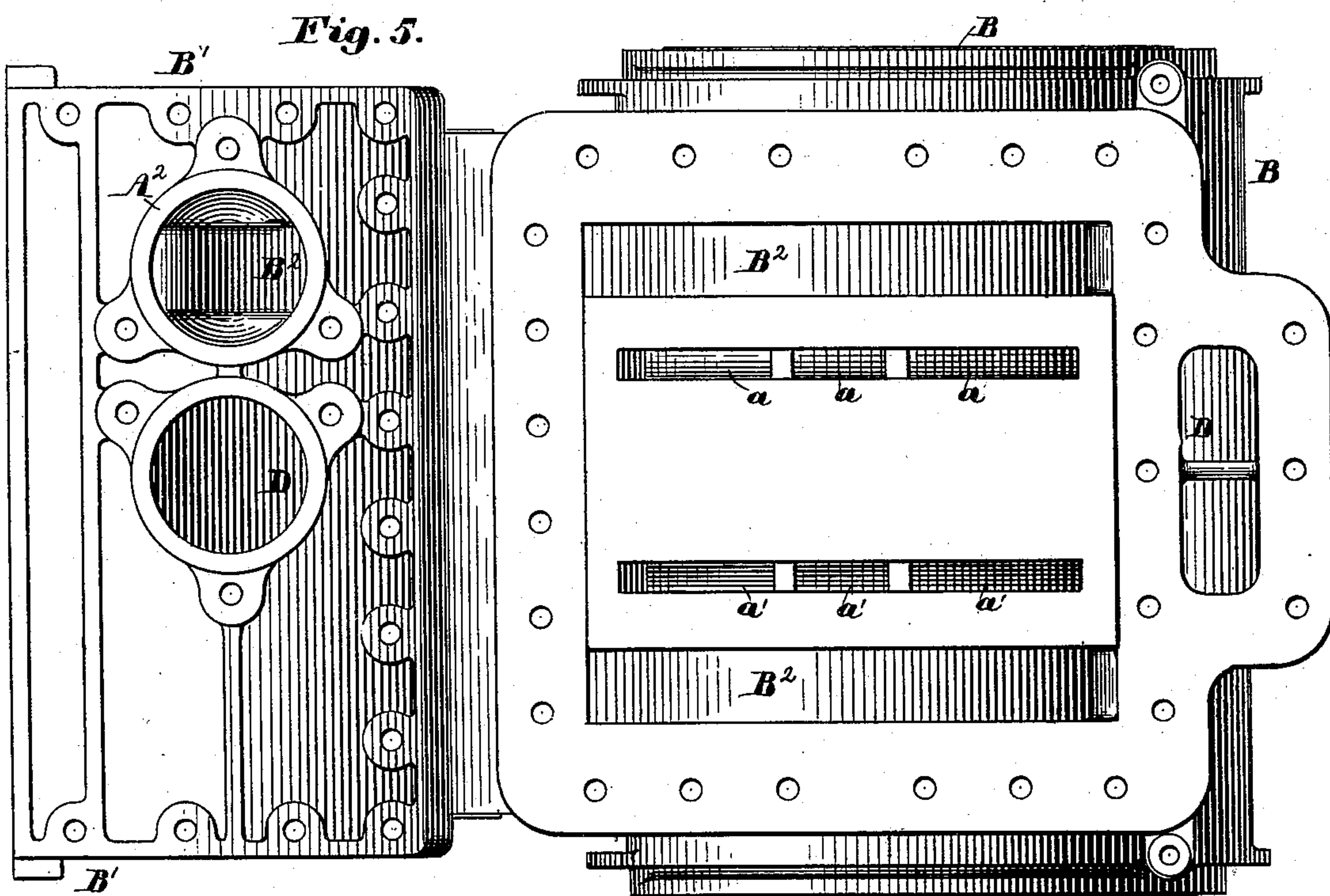
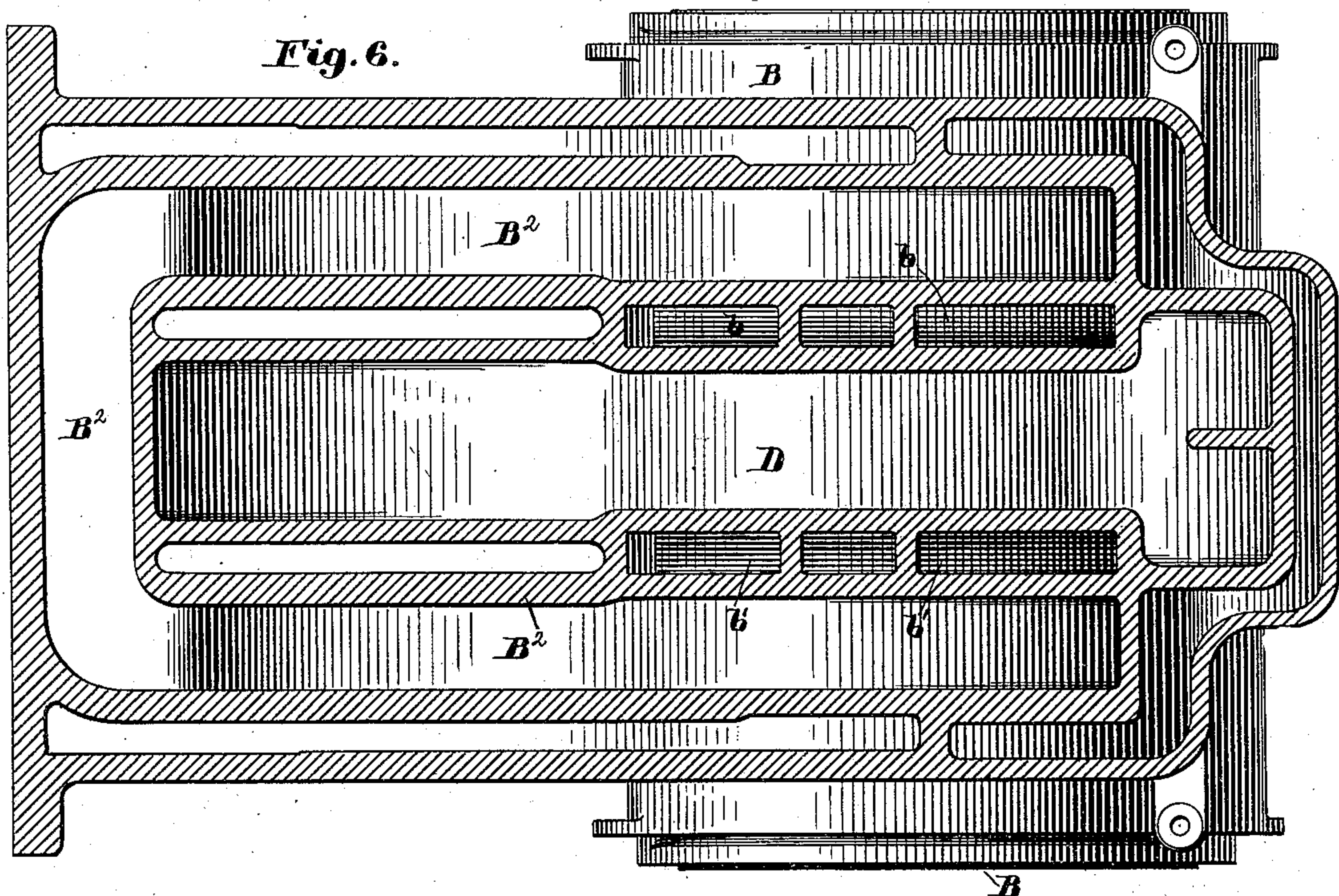
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# UNITED STATES PATENT OFFICE.

FRANCIS W. DEAN, OF CAMBRIDGE, MASSACHUSETTS.

## COMPOUND LOCOMOTIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 507,353, dated October 24, 1893.

Application filed April 12, 1893. Serial No. 470,084. (No model.)

*To all whom it may concern:*

Be it known that I, FRANCIS WINTHROP DEAN, of Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Compound Locomotive-Engines, of which the following, taken in connection with the accompanying drawings, is a specification.

My invention relates to compound locomotive engines, and is an improvement upon the inventions described in the Letters Patent Nos. 459,779 and 474,000, granted to me September 22, 1891, and May 3, 1892, respectively; and it consists in certain novel features of construction, arrangement and combination of parts, which will be readily understood by reference to the description of the accompanying drawings, and to the claims at the end of this specification, in which my invention is clearly pointed out.

Figure 1 of the drawings is a vertical transverse section through the smoke box and high and low pressure cylinders of a compound locomotive, illustrating my invention, the cutting plane being through the exhaust passage of the high pressure cylinder and the steam passage leading to the low pressure cylinder. Fig. 2 is a similar section through the high pressure cylinder, its steam chest, valve, steam chest cover, and the intercepting valve, drawn to an enlarged scale, the cutting plane being on line 1, 1, on Fig. 3. Fig. 3 is a vertical longitudinal section through the same parts on line 2, 2, on Fig. 2, the cylinder heads and the valve stem being removed. Fig. 4 is a vertical transverse section of the high pressure cylinder and the converting valve, on line 3, 3, on Fig. 3. Fig. 5 is a plan of the high pressure cylinder, with the steam chest and valve removed. Fig. 6 is a horizontal section through the steam and exhaust passages of said cylinder on line 4, 4, on Fig. 3. Fig. 7 is a horizontal section through the steam chest cover on line 5, 5, on Figs. 2 and 4. Fig. 8 is a plan of the steam valve for the high pressure cylinder. Fig. 9 is a horizontal section through the intercepting and converting valve casings on line 6, 6, on Fig. 3. Fig. 10 is a horizontal section through the intercepting and converting valve casing on line 7, 7, on Fig. 3.

In the drawings A is the boiler shell cut in section transversely through the smoke box, see Fig. 1. B is the high pressure cylinder cast in one piece with the steam and exhaust passages and the saddle B' for securing it to the boiler, and C is the low pressure cylinder cast in one piece with the steam and exhaust passages and the saddle or bracket C' for securing it to the boiler. The high pressure cylinder B is provided with the two steam ports *a* and *a'* and steam passages *b* and *b'* of usual construction, and in lieu of the ordinary exhaust port and passage is provided with the exhaust passage D communicating at one end with the pipe E in the smoke box of the boiler, and at the other end through a passage *c* in the steam chest casting F entirely outside of the steam chamber, with the passage *d* in the steam chest cover G, as shown in Figs. 1 and 2. The cover G is a hollow casting provided with the bottom plate G' which has formed therein the port *e*, communicating with the shallow oblong chamber *e'*, which in turn communicates through the circular opening *f* with the passage *d*, as shown in Figs. 1, 2, and 3. The chamber *e'* has a lateral extension *e<sup>2</sup>* which communicates through the small hole *e<sup>3</sup>* with a corresponding passage *f'* in the converting valve casing, which communicates, at its upper end, through the horizontal hole *f<sup>2</sup>* and vertical groove *f<sup>3</sup>* with the interior of the converting valve casing H, above the piston H' as and for the purposes hereinafter described. The cover G also has formed therein the chambers *g*, *g'*, which communicate through the openings *h* *h* with the interior of the steam chest outside of the valve I as shown in Figs. 3 and 7. The top plate of the steam chest cover G has formed therein the large circular opening *h'*, in axial line with the circular opening *f*, and with the smaller opening *h<sup>2</sup>* communicating with one of the chambers *g'* as shown in Fig. 3. The steam valve I is rectangular in outline and has a rectangular opening I' entirely through the same the two longer bars of said valve being connected together by a series of tie ribs of less height than the depth of said valve as shown in Figs. 1, 2, 3, and 8. The upper side of the valve I has formed therein grooves *i* *i* to receive



the packing  $i' i'$  which act against the ground under side of the plate  $G'$  of the cover  $G$  as shown.

$H$  is the casing of the intercepting and converting valves, cast in one piece, and bolted to the top of the steam-chest cover so as to cover the openings  $h'$  and  $h^2$  and the hole  $e^3$  as shown in Figs. 1, 2, 3, and 4. The casing  $H$  has formed therein the intercepting valve cylinder  $j$  and the converting valve cylinder  $k$  having their axes parallel to each other, and each bored out to two different diameters and having their upper ends closed by the caps  $H^2$  and  $H^3$  respectively.

$J$  is the intercepting valve secured to the lower end of the tubular stem  $J'$ , the upper end of which is enlarged to fit the diameter of the enlarged upper portion of the cylinder  $j$  and form a piston  $J^2$  of small area, said piston and its stem being provided with packing rings  $l$  and grooves  $l'$  substantially as in my prior patent, No. 474,000, before cited. The cap  $H^2$  has formed in one piece therewith the pendent tube  $J^3$ , the lower end of which has screwed therein the plug  $j'$ , through which is made a small vent hole  $j^2$ , and said tube has formed therein near its lower end a plurality of lateral openings  $k' k'$  opening into the circumferential groove  $k^2$  surrounding said tube, and, at its junction with the cap  $H^2$ , with the small lateral orifice  $k^3$ , which communicates with the cylinder  $j$  above the upper end of the piston  $J^2$ . The valve stem  $J'$  also has formed therein a plurality of lateral openings  $l^2 l^2$  which communicate with the circumferential groove  $l^3$  surrounding said stem, and which when the valve  $J$  has descended till its outer edge is within the annular rib or lip  $m$  surrounding the valve seat  $m'$  will be in such position relative to the under side of the casing  $H$  and the groove  $k'$  that the steam in the tube  $J^3$  can pass freely through the holes  $k' k'$  and  $l^2 l^2$  into the exhaust passage  $d$ . The bore  $l^4$  of the tube  $J^3$  extends in a semi-circular form through the cap  $H^2$  and registers with the upper end of the passage  $m^2$  formed in the casing  $H$  between the cylinders  $j$  and  $k$  and connected at its lower end with the chamber surrounding the converting valve  $n$  as shown in Fig. 3. The converting valve  $n$  is secured to the lower end of the stem  $K$ , to the upper end of which is secured the piston  $H'$  fitted to the enlarged upper portion of the cylinder  $k$ . The piston  $H'$  has formed in its periphery a series of small packing grooves  $o$  and the larger groove  $o'$ , designed to receive any steam which may leak past the packing above it, and from which said steam may escape into the air through the hole  $o^2$  when the piston  $H'$  is in its lowest position as shown in Fig. 3. The stem  $K$  has its central portion reduced in diameter as shown at  $p$  and has formed in its larger portions a series of small packing grooves to prevent, or minimize, the leakage of steam past the same. The casing  $H$  has formed therein, opposite the stem  $K$ , a hole  $p^2$  through

which any steam in the passage  $m^2$  may escape into the atmosphere when the valve  $n$  is on its seat, as shown in Fig. 3. The casing  $H$  is also provided with a socket  $q$ , from which a small orifice  $q'$  opens into the interior of the cylinder  $j$ , at the lower end of the larger portion thereof, as shown in Fig. 2, and a pipe  $q^2$  has one end screwed into said socket, the other end of which communicates with the interior of the steam space of the boiler, so that live steam is always in direct communication with the interior of the cylinder  $j$ , beneath the piston  $J^2$ .

The pipe  $E$  communicates with the forked receiver pipes  $E'$ , constructed substantially the same as in my before cited Patent No. 459,779, and leading to and discharging into the steam passage  $E^2$  of the low pressure cylinder  $C$ , the exhaust steam from which is discharged into the smoke stack through the pipe  $E^3$ , as in my said prior patent. The main steam pipe leading from the steam space of the boiler at  $A'$  is connected at its other end to the pipe  $A^2$  of the saddle  $B'$  of the high pressure cylinder and communicates with the steam passage  $B^2$ , which, in the cylinder casting has two branches extending transversely of said cylinder and connected together at the saddle end of said casting by a section parallel to the axis of said cylinder, as shown in Fig. 6. The caps  $H^2$  and  $H^3$  are provided with the holes  $r$  and  $r'$  respectively, to receive oil cups, not shown.

The operation of my invention is as follows: The several parts being in the positions shown in the drawings, and in a state of rest, if it is desired to start the engine, the throttle valve is opened, when steam from the boiler flows through the main steam pipe into the passage  $B^2$ , the interior of the steam chest at the front and rear of the valve  $I$ , and into the chambers  $g$  and  $g'$  in the steam chest cover  $G$ , and, acting upon the converting valve  $n$  moves it upward away from its seat, fills the passage  $m^2$ ,  $l^4$ , flows through the orifice  $j^2$  in the plug  $j'$  into the space between the end of the tube  $J^3$  and the intercepting valve  $J$ , and at the same time the live steam passes through the orifice  $k^3$  into the space above the piston  $J^2$ , the combined pressure of the steam on the upper end of said piston and the valve  $J$  beneath the tube  $J^2$  causing said valve  $J$  to be moved downward, slowly, against the pressure of the steam in the cylinder  $j$  beneath the piston  $J^2$ , until the outer edge of the valve  $J$  is partially within the annular lip  $m$ , when the lower edge of the circumferential groove  $l^3$  in the periphery of the stem  $J'$  will have passed below the lower end of the casing  $H$  and the openings  $l^2 l^2$  through said stem will be opposite, or nearly so, to the circumferential groove  $k^2$  and openings  $k'$  in the lower end of the tube  $J^3$ , when the live steam will flow freely into the passage  $d$ , forcing said valve  $J$  firmly upon its seat  $m'$ , and thence flowing through the passages  $c$  and  $D$ , the pipe  $E$ , receivers  $E'$ , and the passage  $E^2$  to the in-



terior of the steam chest of the low pressure engine, whence it flows into the low pressure cylinder C, if the valve of said cylinder is in the proper position to admit of such passage, and starts or assists in starting the engine, substantially as in my before cited prior patents. If the crank of the high pressure engine should happen to be upon one or the other of its dead centers, the engine will be started by the action of the live steam upon the piston of the low pressure engine, automatically directed thereto as above set forth, but if the said high pressure crank should be in a favorable position, the boiler steam after being admitted to the steam chest of the high pressure cylinder will flow through one of the ports *a* or *a'* and passages *b* or *b'* to one or the other end of the interior of the cylinder B, according to the position of the valve I and act upon the piston of said high pressure cylinder to start the engine at the same time that a portion of said steam flows into the low pressure cylinder as above described to assist in said starting. As soon as the engine is started and the high pressure piston has completed a stroke in one direction and commences to exhaust, the steam escaping from said cylinder flows upward through the central opening in the valve I, through the port *e* into the chamber *e'*, *e*<sup>2</sup> and a portion of it flows through the passages *e*<sup>3</sup> and *f'*, the hole *f*<sup>2</sup> and groove or channel *f*<sup>3</sup> to the upper side of the piston H', and, acting upon the large area thereof overcomes the pressure of the live steam on the under surface of the converting valve *n*, and forces said piston and valve downward till the valve *n* finds its seat and closes the passage *h*<sup>2</sup> when the live steam in the passages *m*<sup>2</sup> and *l*<sup>4</sup> will escape into the atmosphere, through the opening *p*<sup>2</sup>, and the pressure of the boiler steam in the cylinder *j* beneath the piston J<sup>2</sup> will move the intercepting valve J upward into the position shown in the drawings where it will be maintained by the constant pressure of said boiler steam, and no more live steam will find its way to the low pressure cylinder until it becomes necessary to again start the engine from a state of rest. The intercepting valve is prevented from slamming in its downward movement by the fact that the steam that moves it is wire-drawn through the small holes *k*<sup>3</sup> and *j*<sup>2</sup>, and the cushioning effect of forcing steam from the cylinder *j* into the boiler, and is also prevented from slamming in its upward movement by forcing steam backward through these same holes *k*<sup>3</sup> and *j*<sup>2</sup> into the passage *l*<sup>4</sup>. The intercepting and converting valves operate substantially as described in my before cited prior Patent No. 474,000, and only such changes are made in their construction as are made necessary by the change in location and combining them in one casing, except the change in the details of the lower end of the tube J<sup>3</sup> as shown.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a compound engine, the combination of a high pressure cylinder having two steam ports opening into the valve chamber; a slide valve having an exhaust passage entirely through it; a steam chest inclosing said valve; a hollow steam chest cover provided with a bottom plate having an exhaust port above the exhaust passage of said valve, and a chamber above said plate; an opening from said chamber provided with a valve seat, and communicating with a passage leading to the steam chest of the low pressure cylinder and with a corresponding opening through the top of said cover; a valve casing mounted on said cover and covering said opening through the top of same; and an intercepting valve carried by said casing and arranged to co-operate with said seat to close the passage from said chamber.

2. In a compound engine the combination of a high pressure cylinder having two steam ports, opening into the valve chamber of the steam chest, and a port or passage leading from the surface upon which the steam chest rests outside of the valve chamber of the steam chest and extending to and communicating with the receivers in the smoke box; a steam chest having a valve chamber inclosing said steam ports and provided with a separate passage to coincide and communicate with the exhaust port in said cylinder; a slide valve having an exhaust passage entirely through the same; a hollow steam chest cover having a port in its bottom above the exhaust passage of said valve, a chamber above said port; a passage leading from said chamber to the independent passage through said steam chest casting and provided with a circular valve seat above said port, and a large and small opening in its top plate; and an intercepting valve and a converting valve mounted in independent cylinders, formed in a single casing, with their axes parallel, said casing being mounted upon the steam chest cover substantially as described.

3. In a compound locomotive engine the combination with the steam supply pipe and the receivers located in the smoke box, of the high pressure cylinder B provided with the steam ports *a* *a'* and steam passages *b* *b'* and B<sup>2</sup>, and the exhaust passage D; the steam chest F having a valve chamber and the passage *c*; the valve I having an exhaust opening through the same; the hollow steam chest cover G provided with the bottom plate G', the port *e* cut through said plate, the chamber *e'* with the extension *e*<sup>2</sup>, the passage *f* provided with the valve seat *m'*, the passage *d* the chambers *g* and *g'*, and the larger and smaller discharge openings *h'* and *h*<sup>2</sup>; the casing H having formed therein two cylindrical chambers *j* and *k* with their axes parallel; the intercepting valve J, mounted upon a stem fitted to one of said cylinders, and arranged to cooperate with the seat *m'* to close the passage *f*; the converting valve *n* mounted upon a stem fitted to the other of said cylinders,



and having the piston H' secured to its upper end; and a passage leading from the chamber  $e' e^2$  to the upper end of the cylinder  $k$ .

4. In a compound engine the combination  
5 with the high pressure cylinder, its steam chest, and a slide valve having an exhaust opening extending entirely through the same, of the hollow steam chest cover G provided with the bottom plate G', the exhaust port  $e$ ,  
10 chambers  $e'$ ,  $e^2$ , and  $g$ ,  $g'$ , an exhaust passage connected in any suitable manner to the receivers and thence with the low pressure cylinder, the passages  $f$ ,  $h'$  and  $h^2$ , the valve seat  $m'$ , the intercepting valve J constructed and  
15 arranged to cooperate with the seat  $m'$  to close the passage  $f$ , and the converting valve  $n$  constructed and arranged to close the passage  $h^2$ , said valves being mounted upon stems provided with pistons fitted to independent  
20 cylindrical chambers mounted upon said steam chest cover.

5. In a compound engine the combination

of a high pressure cylinder having two steam ports  $a a'$ ; the exhaust passage D; the steam chest F having a valve chamber and the pas- 25 sage  $c$  outside of said valve chamber; a slide valve having an exhaust passage entirely through it; a steam chest cover provided with the bottom plate G', the port  $e$  cut through said plate, the chamber  $e'$ ; the passage  $f$  lead- 30 ing from said chamber; the valve seat  $m'$  surrounding said passage  $f$ ; a valve for closing said passage  $f$ ; and the passage  $d$  leading to, and communicating with the passage  $c$  through the steam chest casting. 35

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, on this 10th day of April, A. D. 1893.

FRANCIS W. DEAN.

Witnesses:

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W. E. MATHEWS.