

No. 719,530.

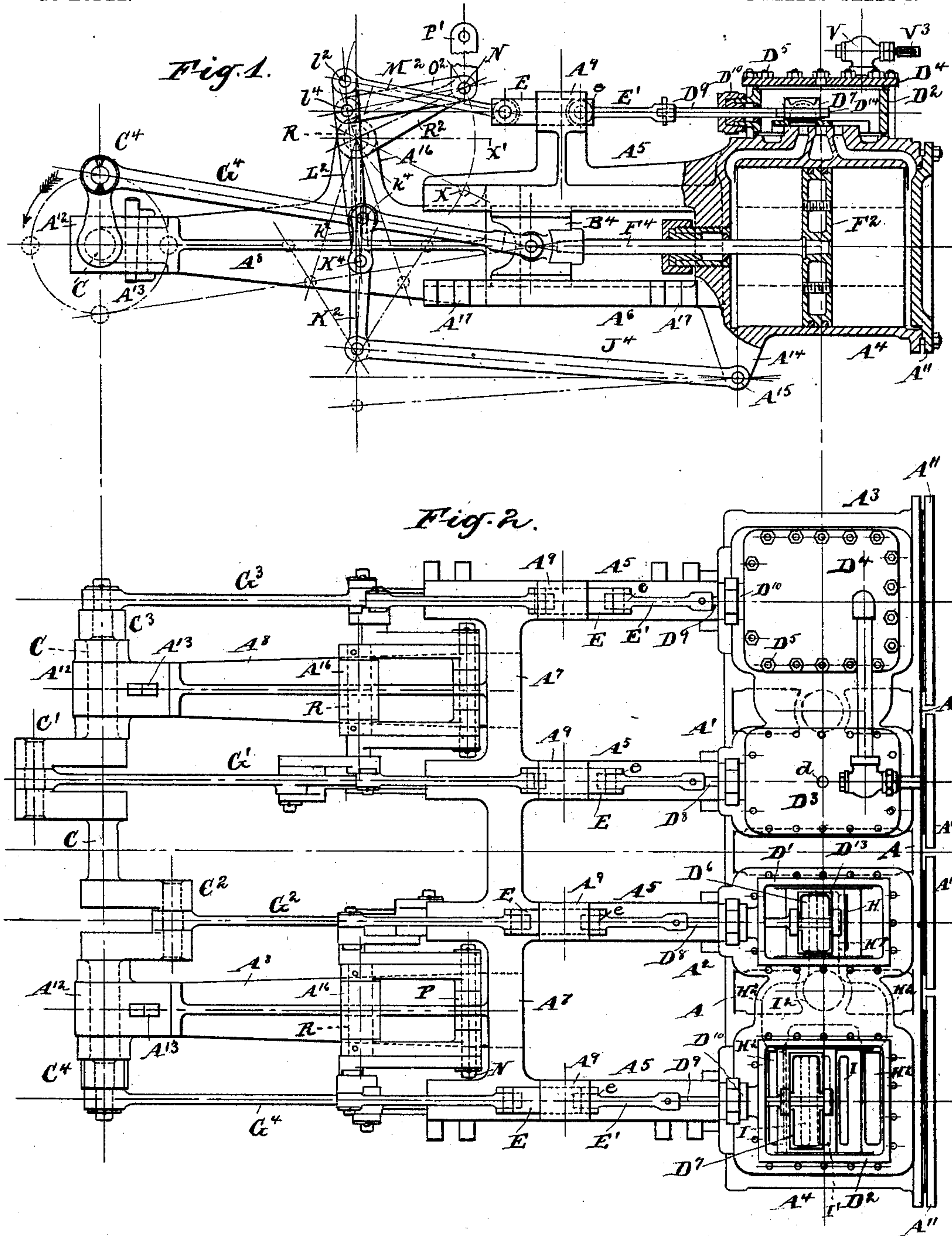
PATENTED FEB. 3, 1903.

W. SUTCLIFFE.  
STEAM ENGINE.

APPLICATION FILED JAN. 9, 1902.

NO MODEL.

2 SHEETS—SHEET 1.



WITNESSES:  
Edwin Gould,  
B. E. Abert

INVENTOR.  
BY William Sutcliffe  
Charles R. Searle,  
ATTORNEY.

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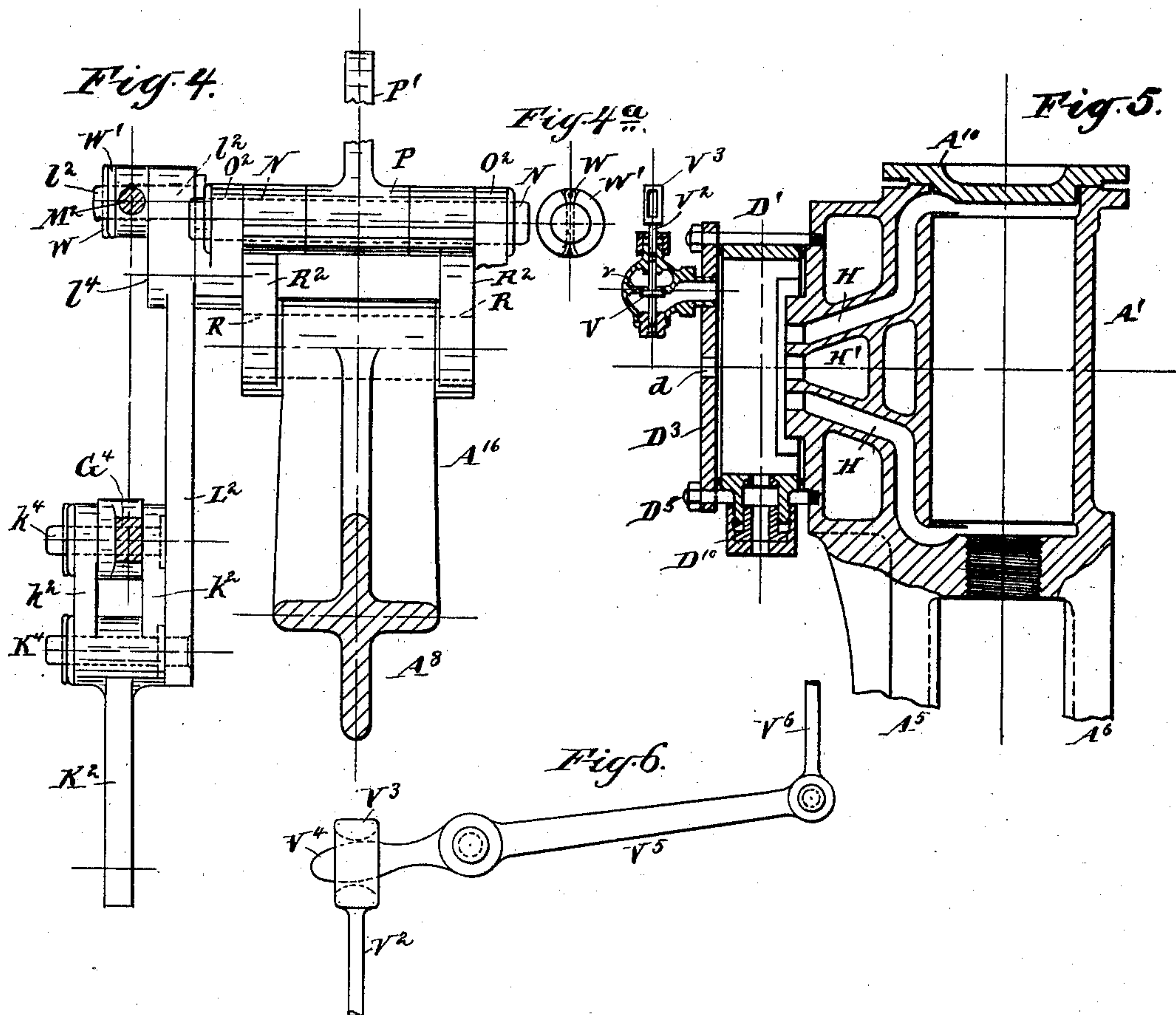
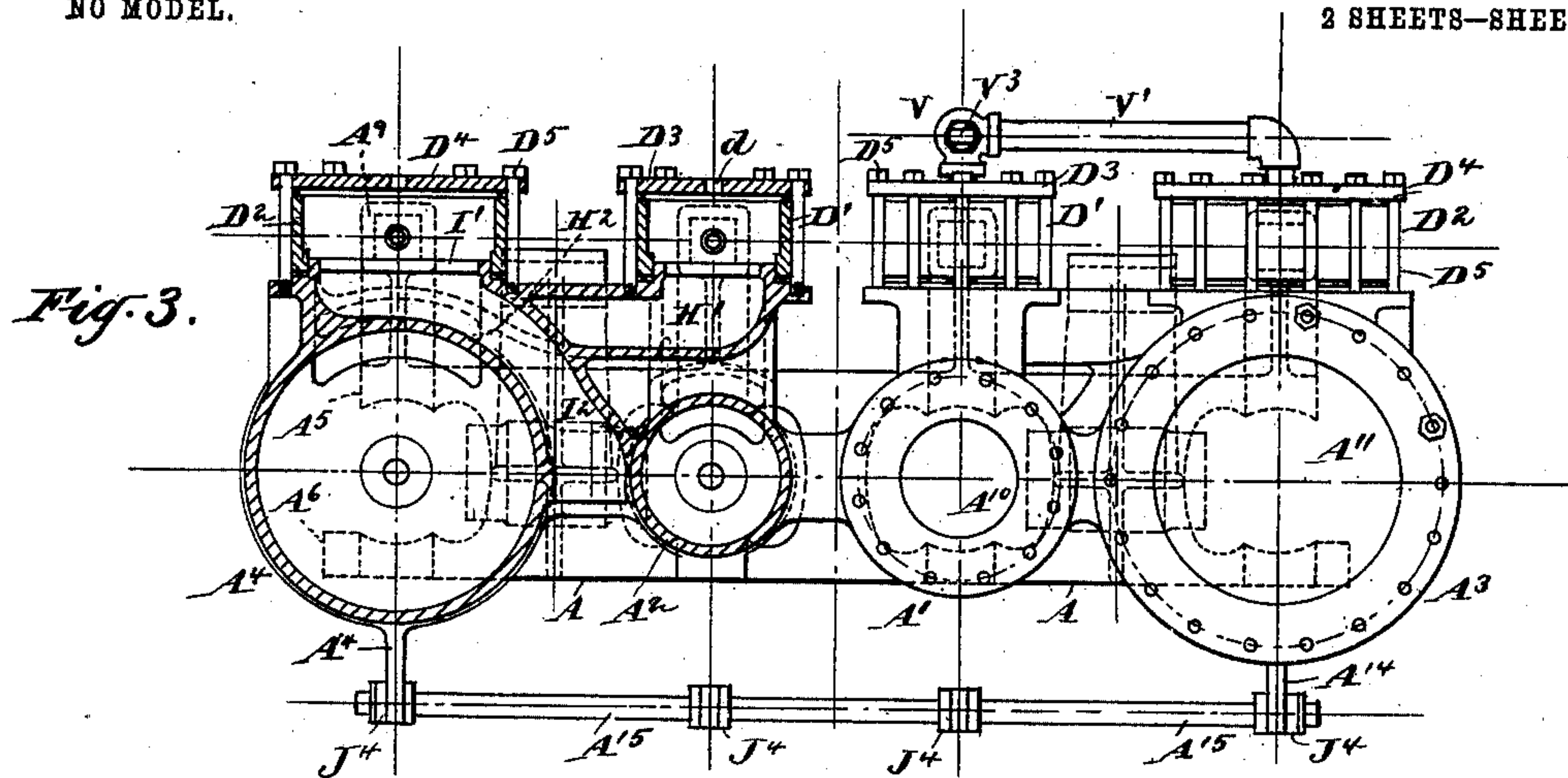
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# UNITED STATES PATENT OFFICE.

WILLIAM SUTCLIFFE, OF PATERSON, NEW JERSEY.

## STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 719,530, dated February 3, 1903.

Application filed January 9, 1902. Serial No. 88,966. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM SUTCLIFFE, a citizen of the United States, residing in Paterson, in the county of Passaic and State of New Jersey, have invented a certain new and useful Improvement in Steam-Engines, of which the following is a specification.

The invention relates more particularly to engines of the double-compound non-condensing type, and is designed more especially for service in driving motor-vehicles and analogous light duty.

The object of the invention is to provide an engine which shall be extremely simple in construction, of few parts not liable to derangement, highly efficient in service, and easily controlled and operated. I attain these desired objects by making the cylinders and frame in a single casting especially designed for easy and extremely accurate finishing operations by machinery and having peculiarly-arranged steam-passages in conjunction with a valve-motion specially adapted for controlling the admission and release of steam to and from the several cylinders.

The invention consists in the above novel features and in certain details of construction and arrangements of parts to be more fully described.

The accompanying drawings form a part of this specification and show the invention as I have carried it out.

Figure 1 is a side elevation of the engine, partly in vertical section. Fig. 2 is a corresponding plan view with certain parts removed; and Fig. 3 is a corresponding end view or rear elevation, partly in vertical section. Fig. 4 is a vertical section and elevation showing a portion of the valve-motion on a larger scale. Fig. 4<sup>a</sup> is a side view showing a detail of construction. Fig. 5 is a section, partly in elevation, showing a vertical arrangement of the engine and a valve serving to aid in starting the engine and as a relief-valve therefor under certain conditions. Fig. 6 is an elevation showing a detail of the preceding figure.

Similar letters of reference indicate the same parts in all the figures.

The four cylinders are arranged side by side with their axes parallel and in the same plane, the high-pressure cylinders A<sup>1</sup> and A<sup>2</sup> lying next each other and between the low-pressure

cylinders A<sup>3</sup> and A<sup>4</sup>. All are in one casting forming two pairs of cylinders, each pair consisting of one high and one low pressure cylinder. The pairs are connected by webs A at the ends of adjacent cylinders and by integral connections between the slide-frames. The latter are pairs of parallel extensions A<sup>5</sup> and A<sup>6</sup>, cast in one with the cylinders, the members of each pair arranged one above the other and finished by boring their inner faces to serve as curved-faced guides for the cross-heads B<sup>4</sup>. Each pair is joined to its neighbor by the strong webs or connections A<sup>7</sup> A<sup>7</sup>, extending transversely near their outer ends. From the webs A<sup>7</sup>, joining the guides or slide-frames for each pair of engines, extends a forwardly-projecting arm A<sup>8</sup>, supporting at their extreme outer ends the main shaft C. All the stationary parts described are in a single casting, preferably of malleable iron. The rear heads A<sup>10</sup> A<sup>11</sup> for the high and low pressure cylinders, respectively, are removable and are held in place by studs and bolts, as usual.

A steam-chest D<sup>1</sup> for each high-pressure cylinder and a steam-chest D<sup>2</sup> for each low-pressure cylinder are mounted upon the upper faces of such cylinders and are closed by the chest-covers D<sup>3</sup> D<sup>4</sup>, secured to the chests and cylinders by studs D<sup>5</sup>. The valve-seats are plane and provided with slide-valves D<sup>6</sup> D<sup>7</sup>, operated by valve-stems D<sup>8</sup> D<sup>9</sup>, extending through stuffing-boxes D<sup>10</sup> on the front of the steam-chests, as usual. All the valve-seats are in the same plane, and the D-valves are so constructed as to bring all the stems in the same plane with each other.

On the uppermost of each pair of guides A<sup>5</sup> A<sup>6</sup> is cast an upwardly-projecting lug or arm having a rectangular head A<sup>9</sup>, finished interiorly to receive and guide a rectangular block E parallel and in line with the valve-stem for its respective cylinder, and is joined to its stem by a bar E', keyed thereto and flexibly connected by a joint e to the sliding block E.

The pistons are of any ordinary or approved construction adapted to be reciprocated in the cylinders by the action of the steam or other elastic medium employed. Only one—the low-pressure piston F<sup>2</sup>—is shown, with one of the piston-rods F<sup>4</sup>. The piston-rods extend through stuffing-boxes and glands on the closed front heads of the several cylin-



ders and join the cross-heads  $B^4$ , only one being shown, by any suitable connections.

The shaft C, with the cranks  $C^1$ ,  $C^2$ ,  $C^3$ , and  $C^4$ , is preferably sectional, as shown. Each pair of cranks is opposite to another, and all are quartering, as shown. The shaft is rev-  
 5 olubly held to the arms  $A^8$  by straps  $A^{12}$ , partially encircling the shaft and secured to the arms by gibs and keys  $A^{13}$ . The straps and  
 10 arms may be equipped with brasses, if preferred.

$G^1$ ,  $G^2$ ,  $G^3$ , and  $G^4$  are connecting-rods from their respective cross-heads to the cranks and join the latter by solid ends, as shown.

15 I provide a valve-motion for each cylinder and connect them together to be operated by a single lever. (Not shown.) A transverse rod  $A^{15}$  extends across below the cylinders, supported at each end in lugs  $A^{14}$  on the un-  
 20 der side of each low-pressure cylinder. The rod carries four forwardly-extending links  $J^4$ , one beneath each cylinder, forming part of the motion. The latter is arranged in two sets joined together, one for each pair of cyl-  
 25 inders, and as each set is a counterpart of the other a description of one will suffice. The links  $J^4$  are knuckled to the lower ends of a pair of swinging levers  $K^2$ , the upper  
 30 ends of which are bifurcated at  $k^2$  and inclose each its corresponding connecting-rod at about the mid-length and are pivotally se-  
 35 cured thereto by pins  $k^4$ . Below each junction is set a pin  $K^4$ , on which are centered the links  $L^2$ , the upper ends of which are piv-  
 40 oted at  $l^2$  to the ends of a pair of rearwardly-extending rods  $M^2$ , the rear ends of which are knuckled to the outer ends of the slide-blocks  $E$ , free to reciprocate in the heads  $A^9$ , as be-  
 45 fore described.

40  $A^{16}$  is a lug on each arm  $A^8$ , carrying a short transverse shaft R, carrying on its overhung ends two rearwardly-extending arms  $R^2$ , to  
 45 which are pivotally connected the links  $O^2$  by means of a short transverse shaft N, also carrying a hub or collar P, lying between the  
 50 links  $R^2$  and having an arm or reach-rod  $P^1$ , adapted to be engaged by any suitable connection to the corresponding reach-rod of the  
 55 other set and both sets operated by a single lever located at any convenient point. The links  $O^2$  extend forwardly and are pivotally  
 60 connected to the links  $L^2$  at the points  $l^4$  below the pins  $l^2$ . The shaft N through its con-  
 65 nections to the reverse-lever (not shown) may be raised or lowered about the shaft R as a center and the valves correspondingly moved  
 into such relation to the other parts of the motion as to turn the main shaft C forward or  
 backward, as required.

60 The operation of the valve-motion is as follows: Referring for convenience of descrip-  
 65 tion to one side of one set, the reciprocations of the cross-head  $B^4$ , in combination with the rotary motion of the crank  $C^4$ , induces a gyra-  
 70 tory movement of the point  $l^4$  and causes it to move in an elliptical path. The pin  $K^4$  describes a somewhat similar but shorter el-

lipse and imparts its motion to the link  $L^2$ , which acts as a lever fulcrumed at  $l^4$ , the short arm of which from  $l^4$  to  $l^2$  produces, 70  
 through its connections, a short reciprocating movement of the valve and admits and cuts off steam at the proper intervals. In order to change the position of the point  $l^4$ , and thus  
 75 allow for changing the direction of the engine, the shaft N, connected to the reverse-lever (not shown) by the reach-rod  $P^1$ , may be raised and lowered, as indicated. When the parts are in the position shown in Fig. 1,  
 80 the engine will run to revolve the main shaft in the direction indicated by the arrow, and when depressed to the position indicated by the dotted line X the revolution will be re-  
 85 versed. In both positions the steam follows to the limit provided for by the motion. In ap-  
 90 proaching the center line X' from either direction the engine cuts off shorter, and when the center of the shaft N coincides with the line X' the cut-off will be at the shortest—  
 about one-tenth of the stroke, when propor-  
 95 tioned as shown in the drawings. A peculiar advantage of this form of motion is the uni-  
 100 formity of lead and lap inside and outside at all points of expansion.

The arrangement of steam-passages for one 95  
 pair of cylinders is the counterpart of the other pair. Steam is admitted to the high-pressure steam-chest  $D^1$  through the opening  
 100  $d$  in the cover  $D^3$  from a connected steam-pipe (not shown) and passes to the cylinder  
 105 through the end ports H H and is exhausted through the throat of the valve  $D^6$  after exerting its force upon the piston as usual and is led through the passage  $H^1$  and its branches  
 110  $H^2$   $H^2$  to the low-pressure steam-chest  $D^2$  and is alternately admitted through the ports I I  
 115 by the valve  $D^7$  and exhausted through the port I' and is finally led away through the passage  $I^2$ , lying between the branches  $H^2$   $H^2$ , and escapes either directly, as shown, or  
 120 through a suitable exhaust-pipe leading to any convenient point of discharge. It will be observed that the several ports and pas-  
 125 sages are formed by coring the single casting and that pipe connections between the high  
 and low pressure cylinders are avoided. Another important feature is the contiguity per-  
 mitted by the alternating arrangement of the steam-passages and the resulting economy  
 130 attained by reducing the casting and in less-  
 ening the condensation due to difference in temperature between the high and low pres-  
 sure cylinders and their passages, the latter serving as partial steam-jackets and aiding  
 to induce uniformity of temperature in both  
 cylinders, further aided by the arrangement of the high-pressure cylinders between the  
 cooler low-pressure cylinders.

V is a valve set in the cover of the high-pressure steam-chest  $D^1$  to serve the double 130  
 function of relieving the engine when steam is shut off and the engine continues to run—  
 as on a downgrade, for example—and as an aid in starting the engine when the high-pres-



sure pistons are on the forward and back quarters. The valve is held normally to its seat *v* by steam-pressure in the chest and falls by gravity when the pressure is removed, and thus serves as a relief-valve. The pipe *V'*, extending from the valve-casing, communicates with the steam-chest *D*<sup>2</sup> of the low-pressure cylinder, and when the valve is forcibly depressed against the steam-pressure in the chest *D'* allows live steam from the latter to flow directly to the low-pressure chest and exert its full pressure upon the low-pressure piston. The valve is depressed by a rod *V*<sup>2</sup>, extending through the stuffing-box in the valve-casing and terminating in a yoke *V*<sup>3</sup>, as indicated in Fig. 6, which receives one arm *V*<sup>4</sup> of a lever *V*<sup>5</sup>, connected by a link *V*<sup>6</sup> to any convenient point. A pull on the lever *V*<sup>5</sup> forces the valve *V* from its seat, as will be readily understood.

The motion described for operating the slide-valves is of simple construction, being composed of simple lever-and-link connections, preferably joined by pins to avoid the use of bolts and nuts liable to work loose by vibration, and avoids the complication of the usual link-motions. Bolts and nuts are dispensed with throughout the engine as far as practicable, the studs and nuts for the rear cylinder-heads and the steam-chests and covers being the only exceptions.

The removal of the valve-motion is effected by taking out the pins connecting the several links *J*<sup>4</sup> to the levers *K*<sup>2</sup>, removing the cross-head pins, the shafts *N*, and the pins at the junctions of the links *M*<sup>2</sup> with their slides *E*, and the gibs and keys *A*<sup>13</sup>, holding the straps *A*<sup>12</sup> to the arms *A*<sup>8</sup>. The main shaft, with its cranks and connecting-rods, and the systems of links and levers constituting the valve-motion, with the exception of the short shafts *R* and arms *R*<sup>2</sup>, may be then all taken out together for inspection or repairs and again replaced. The several pins and short shafts are held against accidental displacement by split keys *W*, inserted therein and partially received in corresponding retaining-washers *W'*, as shown in Fig. 4<sup>a</sup>.

*A*<sup>17</sup> represents feet cast on the frame and serving with suitable bolts to hold the casting in place during the finishing process and also in securing the engine to its bed in the horizontal position, as shown in Figs. 1, 2, and 3, or vertically, as indicated in Fig. 5. In finishing the casting the under faces of the guides *A*<sup>6</sup> are first planed true, and with these surfaces as a base the operations of boring the cylinders and cross-head guides, planing the valve-seats, and drilling for the valve-motion bearings may be easily and accurately performed with great economy and certainty.

In order to resist side strains in the valve-motion, the upper end of each lever *K*<sup>2</sup> is forked, as shown in Fig. 4, to give the pins *k*<sup>4</sup> substantial bearings on each side of the main connecting-rods.

Each valve-stem *D*<sup>8</sup> *D*<sup>9</sup> is provided with arms

*D*<sup>13</sup> *D*<sup>14</sup>, preferably each in one piece with its stem, receiving its valve between them and communicating the required motion to the latter without danger of derangement or loosening.

The double-compound engine thus constructed is peculiarly adapted to serve successfully for long periods without derangement, even in the hands of unskilled operators, by reason of the few parts and the simplicity and permanency of the connections, which when once adjusted cannot change their relation to each other, and by reason of the four cylinders and their pistons connected to the four cranks set quartering to each other on the main shaft the engine may be very exactly balanced and the vibrations tending to loosen the various connections reduced to a minimum.

Modifications may be made in the forms and proportions of the parts within wide limits without departing from the invention.

Although I have described the invention as adapted to serve in motor-vehicles and like duty, it will be understood that it will serve successfully in locomotive-work or as a marine or stationary engine under any conditions to which it may be adapted.

I prefer on account of its strength and other desirable qualities to use malleable iron for the single casting; but other materials may be employed for this and other parts.

The main shaft *C* and its cranks may be in a single piece or may be built up, as preferred.

All the parts and equipments not specifically described may be of any ordinary or approved construction.

I claim—

1. In a double-compound engine, two pairs of high and low pressure cylinders all in a single casting with their axes in the same plane and the high-pressure cylinders between the low-pressure cylinders, the valve-seats for all the cylinders being in a single plane in combination with the exhaust-steam passages *H'* and branches *H*<sup>2</sup> *H*<sup>2</sup> for said high-pressure cylinders, and exhaust-passages *I*<sup>2</sup> between said branches, for said low-pressure cylinders, the said passages formed by coring said single casting and arranged to serve as a partial steam-jacket for said high and low pressure cylinders, all substantially as herein specified.

2. In a double-compound engine, two pairs of high and low pressure cylinders all in a single casting with their axes in the same plane and their valve-seats in a single plane parallel with the plane of the axes, in combination with the exhaust-steam passages *H'* and branches *H*<sup>2</sup> *H*<sup>2</sup> for said high-pressure cylinders, and exhaust-steam passages *I*<sup>2</sup> between said branches, for said low-pressure cylinders, the said passages formed by coring said single casting and arranged to serve as a partial steam-jacket for said high and low pressure cylinders, the slide-frames *A*<sup>5</sup> *A*<sup>6</sup> and



connecting-webs A<sup>7</sup> and the arms A<sup>8</sup> on the  
latter supporting the bearings for the main  
shaft, the lugs A<sup>9</sup> on said slide-frames, the  
lugs A<sup>14</sup> on said low-pressure cylinders, and  
5 the lugs A<sup>16</sup> on said arms, the said lugs serv-  
ing to support a valve-gear, said slide-frames,  
webs, arms and lugs all in the same casting  
with said cylinders.

In testimony that I claim the invention  
above set forth I affix my signature in pres- 10  
ence of two witnesses.

WILLIAM SUTCLIFFE.

Witnesses:

EDWIN GOULD,  
C. E. ABERT.