

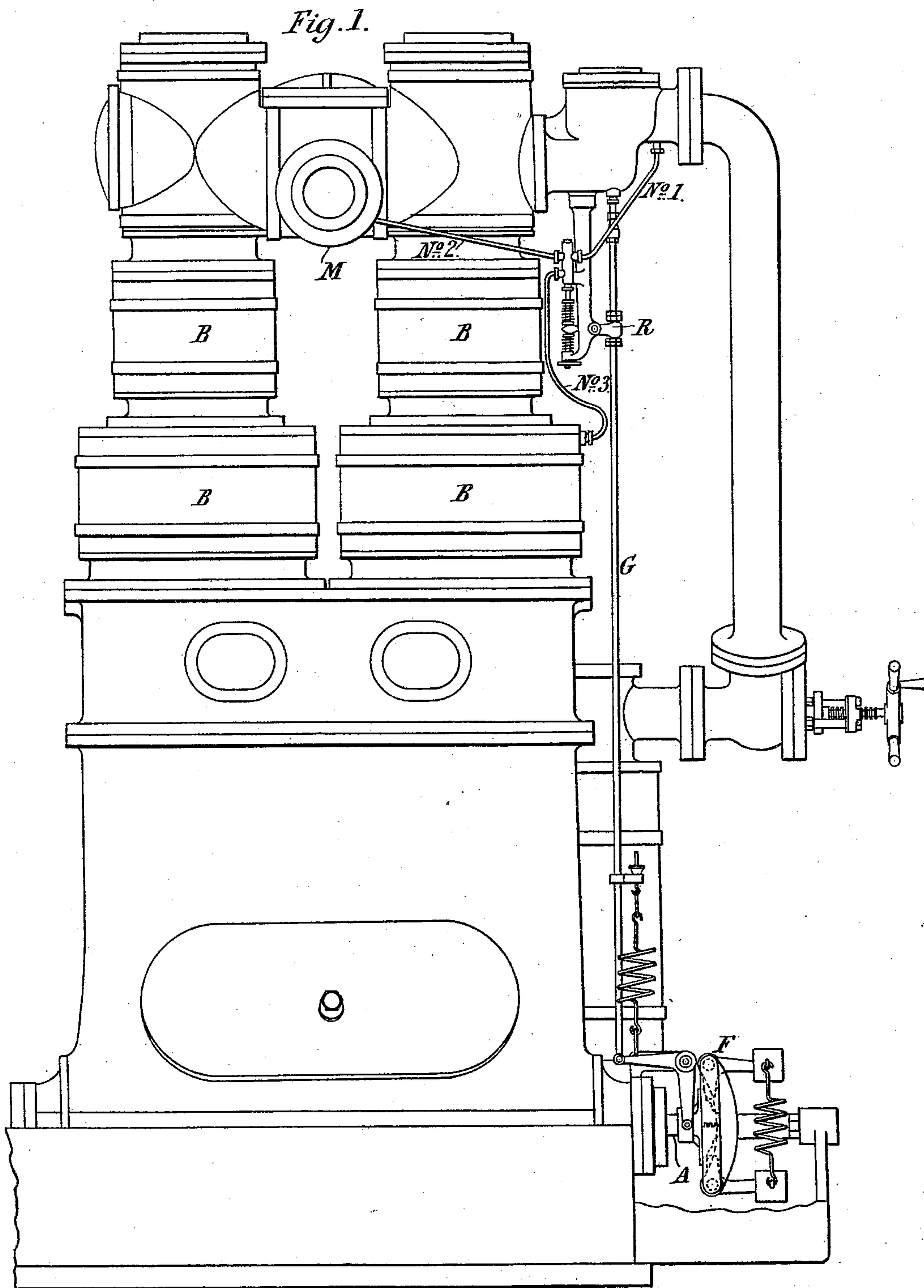
(No Model.)

3 Sheets—Sheet 1.

M. H. P. R. SANKEY.  
EXPANSION GEAR FOR ENGINES.

No. 521,574.

Patented June 19, 1894.



Witnesses

*R. W. Miller.*  
*Lucy E. Davis*

*M. H. P. R. Sankey* Inventor  
*By his Attorney*  
*Baldwin Dandson Wright*

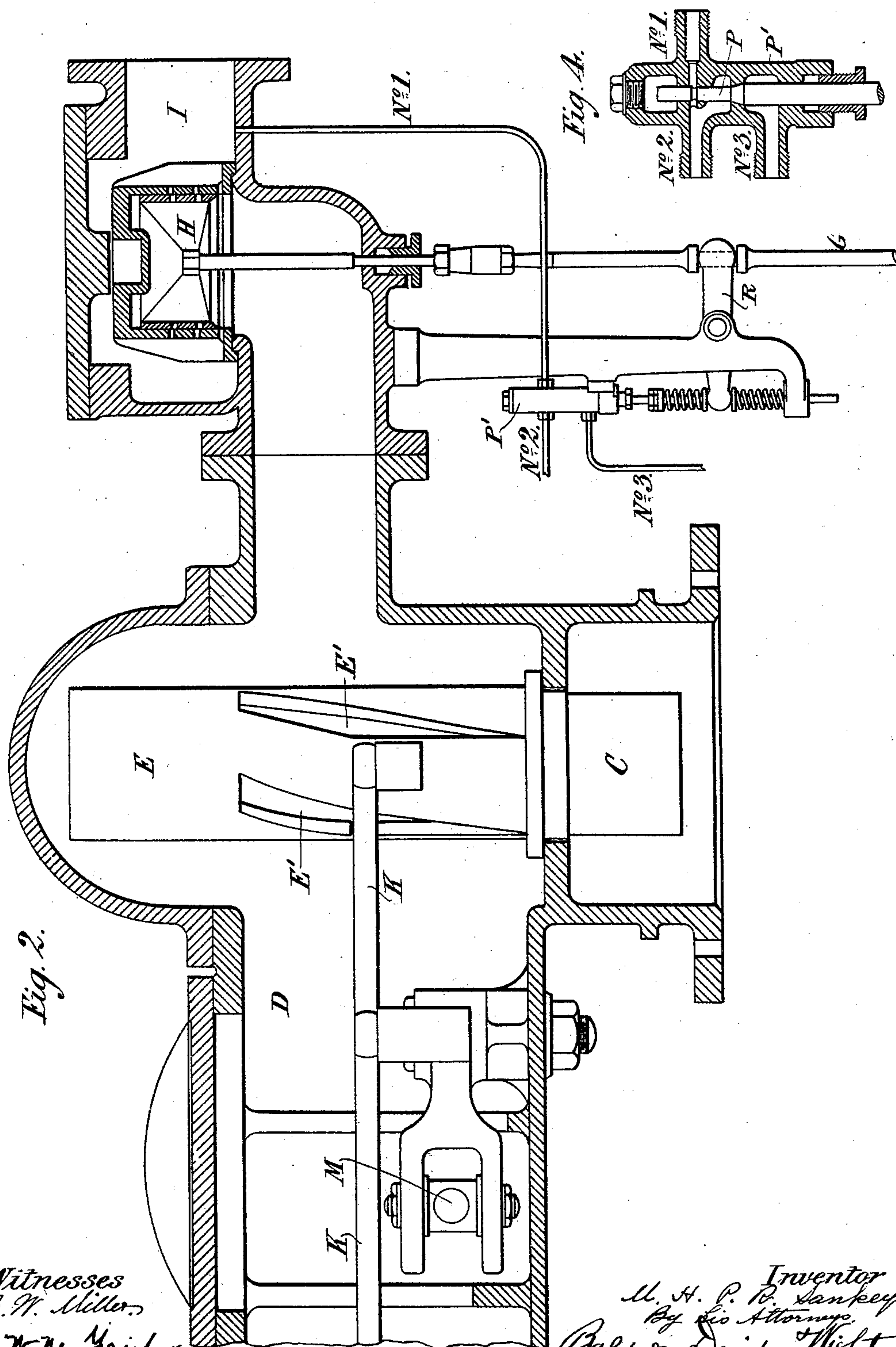
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M. H. P. R. SANKEY.  
EXPANSION GEAR FOR ENGINES.

No. 521,574.

Patented June 19, 1894.



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(No Model.)

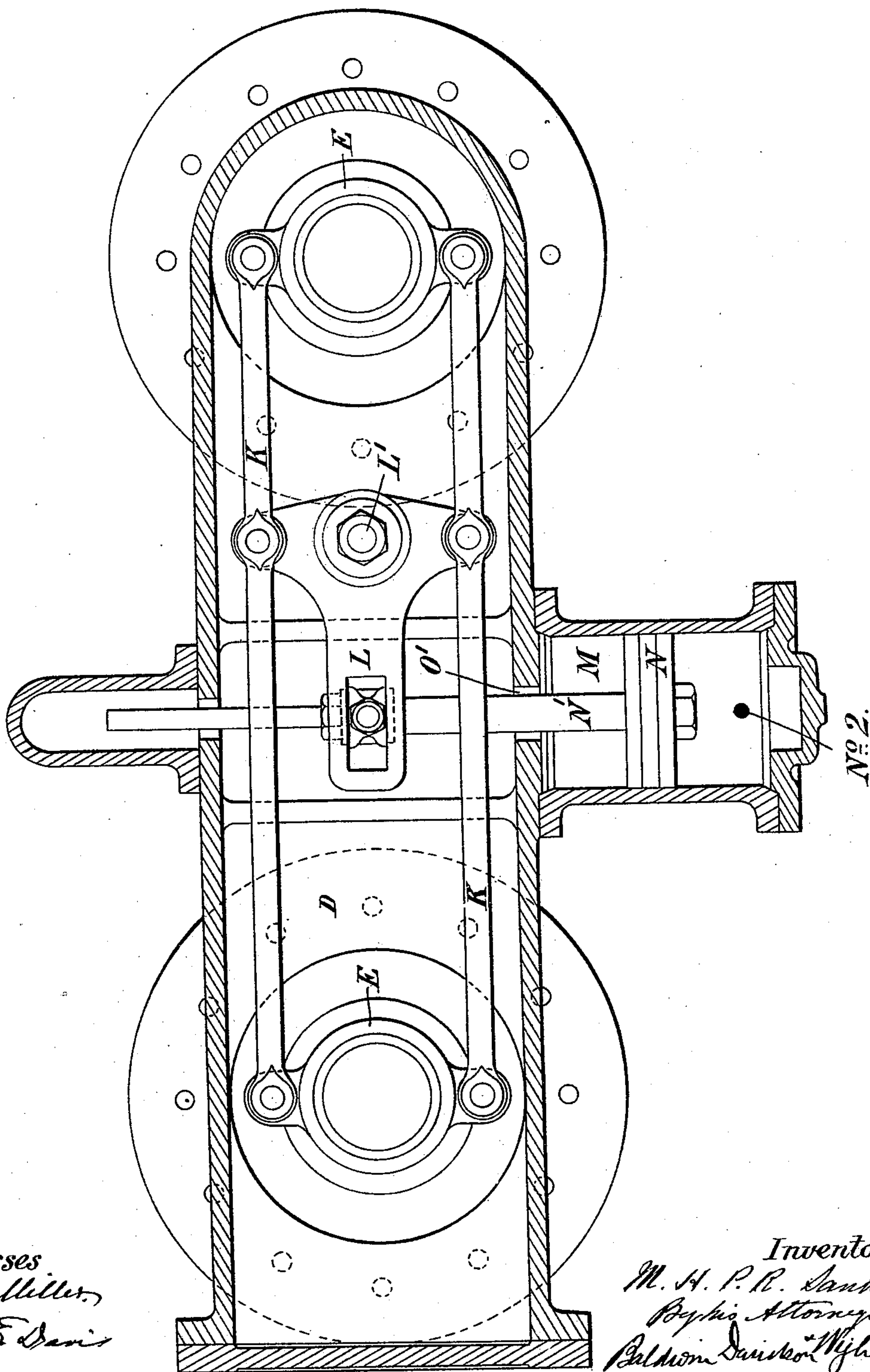
3 Sheets—Sheet 3.

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Fig. 3.



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# UNITED STATES PATENT OFFICE.

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## EXPANSION-GEAR FOR ENGINES.

SPECIFICATION forming part of Letters Patent No. 521,574, dated June 19, 1894.

Application filed March 6, 1894. Serial No. 502,493. (No model.)

*To all whom it may concern:*

Be it known that I, MATTHEW HENRY PHINEAS RIAL SANKEY, late captain R. E., a subject of the Queen of Great Britain, residing at Ferry Works, Thames Ditton, in the county of Surrey, England, have invented certain new and useful Improvements in Automatic Variable-Expansion Gear for Steam and other Fluid-Pressure Engines, of which the following is a specification.

In automatic variable expansion gear constructed according to this invention the governor acts by any ordinary mechanism upon a throttle valve, and the point of cut off is varied by the change in the steam chest pressure following upon the closing or opening of the throttle valve. The rod which controls the cut off gear is attached to a piston working in a cylinder, one end of the cylinder is open to the steam chest, the other is normally exposed to the boiler pressure; in fact the two ends of the cylinder are normally in communication with the two sides of the throttle valve. The effective area of the piston may be approximately the same upon its two sides. The cut off gear is so arranged that cut off is made earlier by the piston moving toward the steam chest; later when it moves in the contrary direction. In making the cut off earlier the action is as follows: Suppose the engine to be loaded to normal full load, the passage through the throttle valve being fully open, and the cut off gear in the desired position for normal full load. On a reduction of load taking place, the increase of speed and consequent opening of the governor balls, closes the throttle valve and thereby controls the engine; the pressure in the steam chest falls at the same time, and the piston above referred to, being exposed to boiler pressure on one side, and to the now reduced steam chest pressure on the other, is moved toward the steam chest and by suitable mechanism makes the cut off earlier; this motion by well understood means, which need not be here described, may, if desired, be caused to take place slowly. As the cut off becomes earlier, the speed tends to diminish, and the governor then opens the throttle valve wider, thus increasing the steam pressure, and when the

alteration in the cut off ceases owing to comparative equalization on the two sides of the piston, the throttle valve and the governor balls will be nearly in their original positions; the only change being that the throttle valve has to be a little more closed than before, on account of the smaller quantity of steam required by the engine per unit of time. In making the cut off later the spindle which moves the throttle valve, also actuates two small valves; one for cutting off the supply of steam from the boiler to the space behind the piston already referred to, i. e. the end of the cylinder farthest from the steam chest; the other for opening the same space to the exhaust or other place of lower pressure, such as the receiver in a compound engine. The connection is such that no movement of the valves takes place when the throttle valve moves in the direction of closing, but they are moved when the throttle valve passes, as it is free to do beyond the position in which the steam way through it is fully open.

Suppose an increase of load to take place while the engine is lightly loaded, the throttle valve being approximately fully open and the cut off of course early. The action of the governor first moves the throttle valve, not only to, but beyond the full open position; simultaneously the throttle valve spindle also moves the valves described in the last paragraph, and the space behind the piston is both cut off from communication with the boiler and is opened to the exhaust or other place of lower pressure. The pressure on the other side of the piston, which is in permanent communication with the steam chest, now preponderates largely, and drives the piston rapidly away from the steam chest, making the cut off later,—probably too late, but this is not a source of trouble because the engine is controlled by the throttle valve, which, by reducing the pressure in the steam chest, gradually brings the cut off to a point as early as is consistent with the throttle valve returning to an approximately full open position. With this arrangement a slow inward movement of the piston may be obtained by making the opening between the inner end of the cylinder and the steam chest small so that the steam in the inner end of the cylinder may



form a cushion to prevent too quick a movement of the piston toward the steam chest. When the piston moves in the opposite direction the smallness of the opening through which a further supply of steam can enter the cylinder from the steam chest does not prevent rapid movement of the piston as the steam already in the inner end of the cylinder will act expansively.

The automatic variable expansion gear above described may be used for giving a turning movement to a cut off sleeve in single acting engines of the central valve type such as are described in the specification of a prior Patent No. 339,242, issued on the 6th of April, 1886, in which the valves work within a hollow piston rod which itself moves up and down within the sleeve. If ports inclined on one side edge be cut in the sleeve and corresponding ports in the hollow piston rod of the engine the admission of steam from the steam chest to the hollow piston rod can be cut off earlier or later by turning the sleeve.

The drawings annexed show the invention applied to a single acting engine of the central valve type such as is described in the above mentioned patent.

Figure 1 is a front elevation of the engine. Fig. 2 is an elevation partly in section and on a larger scale of the steam chest. Fig. 3 is a horizontal section of the same, and Fig. 4 is a vertical section on a still larger scale of the valve used for controlling the admission of steam to the outer end of the cylinder used for controlling the cut off.

A is the crank shaft of the engine.

B B are two sets of cylinders, the cylinders in each set being one above the other.

C (see Fig. 2) is the upper end of the hollow piston rod of one set which as described in the above mentioned patent rises up into the steam chest D.

E is a sleeve surrounding the upper end of the piston rod, it is free to turn but not to move up or down. In it are oblique ports E'—corresponding oblique ports are also cut in the hollow piston rod.

F is a governor which may be of any ordinary construction acting on a rod G which at its upper end carries the throttle valve H.

I is the steam supply pipe.

K K (see Fig. 3) are links connecting arms on the sleeves E to a crank lever L which can be rocked on its fulcrum L'.

M is a cylinder extending outward from the steam chest. N is a piston working therein—the piston rod N' of this piston has projections standing out from it which enter radial slots in one of the arms of the lever L.

O' is a small passage which allows steam to pass slowly from the steam chest to the inner end of the cylinder M or from the inner end of this cylinder to the steam chest.

P' is the shell of a double valve P. It has three pipes leading from it—No. 1 going to some portion of the steam pipe between the throttle valve and the boiler—No. 2 going to

the outer end of the cylinder M and No. 3 to the exhaust or to some place of low pressure.

R is a lever one arm of which is acted on by the rod G the other acts on the stem of the valve P to draw it downward when the rod G moves upward to open the throttle valve H.

In the ordinary running of the engine when the throttle valve is in the full open or nearly full open position and the valves are in the position shown in Figs. 2 and 4 pipes Nos. 1 and 2 are in communication with one another and No. 3 is closed so that there is free communication between the boiler and the outer end of the cylinder M; but when under the influence of an increased load the speed of the engine has commenced to diminish and a later cut off is required the governor spindle rises and carries the throttle valve beyond the full open position and in so doing depresses the valve P and thereby opens the outer end of the cylinder M to the exhaust or other place of low pressure and at the same time closes the communication between the outer end of the cylinder M and the boiler. The pressure in the outer end of the cylinder M being in this way relieved the piston N moves away from the steam chest and the cut off is made later. When the oblique ports in sleeve E and hollow piston rod C are opposite to one another steam is admitted to the interior of the piston rod and thence by other ports in the rod to the cylinders B of the engine as described in the before mentioned patent but when through the descent of the piston rod the ports in it have passed below the ports E' in the sleeve steam is cut off. It is obvious that the point of cut off may be varied by rotating the sleeve upon its axis thus causing the ports in the hollow piston rod to pass below the oblique lower edges of the ports E' either earlier or later in the stroke according as the sleeve is rotated one way or the other. When the piston N moves toward the steam chest the sleeve is thereby rotated in a direction to make the cut off become earlier and as it moves away, to become later. When the piston moves toward the steam chest the movement is slow as the steam in the inner end of the cylinder can only pass slowly from it into the steam chest through the small opening O'. When the piston moves outward the outer end of the cylinder will have been put in communication with the exhaust—and the steam in the inner end of the cylinder acting expansively the movement takes place quickly—the smallness of the opening O' through which steam can enter the cylinder M from the steam chest is therefore no hinderance to the piston making a quick outward movement. The piston may be cushioned at the outer end of its stroke by causing it to pass over and close the opening leading into the pipe No. 2 or by other equivalent means.

What I claim is—

1. The combination of a steam (or other fluid) engine cylinder, steam chest, pipe supplying



steam thereto, throttle valve and governor acting thereon, valve for controlling passage of steam to cylinder of engine—cut off valve for controlling passage of steam to first valve  
 5 a cylinder open at one end to steam chest and at the other communicating with a valve by which it can either be opened to the steam supply or to the exhaust (or other place of lower pressure)—means for operating this  
 10 valve by the action of the governor—a piston working in the cylinder and connections from piston to the cut off valve whereby an inward movement of the piston toward the steam chest shifts the cut off valve in a direction to  
 15 make the cut off earlier and an outward movement in a direction to make it later.

2. The combination of a steam (or other fluid) engine cylinder, steam chest, pipe supplying steam thereto, throttle valve and governor  
 20 acting thereon, hollow piston rod of piston working in cylinder extending into the steam chest—sleeve in steam chest surrounding the end of the hollow piston rod, oblique ports in sleeve and in piston rod—a cylinder open at  
 25 one end to steam chest and at the other communicating with a valve by which it can either be opened to the steam supply or to the exhaust (or other place of lower pressure)—means for operating this valve by the action  
 30 of the governor—a piston working in the cylinder and connections from the piston to the

sleeve whereby an inward movement of the piston turns the sleeve in a direction to make the cut off earlier and a movement in the opposite direction to make it later.

3. The combination of a steam (or other fluid) engine cylinder, steam chest, pipe supplying steam thereto, throttle valve and governor acting thereon, hollow piston rod of piston working in cylinder extending into the steam  
 40 chest—sleeve in steam chest surrounding the end of the hollow piston rod, oblique ports in sleeve and in piston rod—a cylinder open at one end to steam chest and at the other communicating with a valve by which it can  
 45 either be opened to the steam supply or to the exhaust (or other place of lower pressure)—means for operating this valve by the action of the governor—a piston working in the cylinder and connections from the piston to the  
 50 sleeve whereby an inward movement of the piston turns the sleeve in a direction to make the cut off earlier and a movement in the opposite direction to make it later, and means for causing any inward movement to take  
 55 place slowly while the outward movement is left free to take place quickly.

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