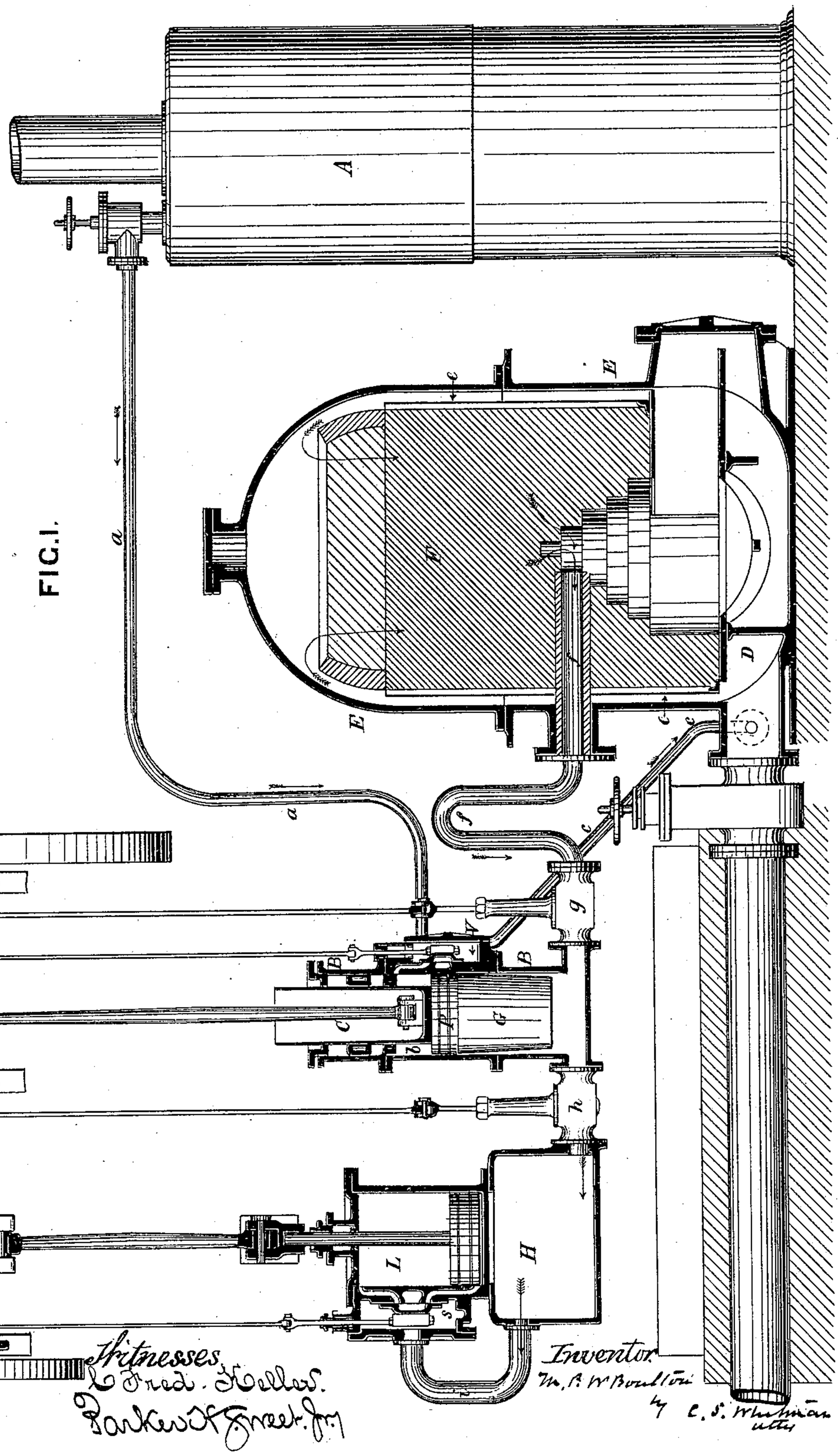
(No Model.) 3 Sheets—Sheet 1.

M. P. W. BOULTON.

EMPLOYING STEAM FOR PRODUCING MOTIVE POWER.

No. 345,026. Patented July 6, 1886.

FIG. I.



(No Model.) 3 Sheets—Sheet 2.

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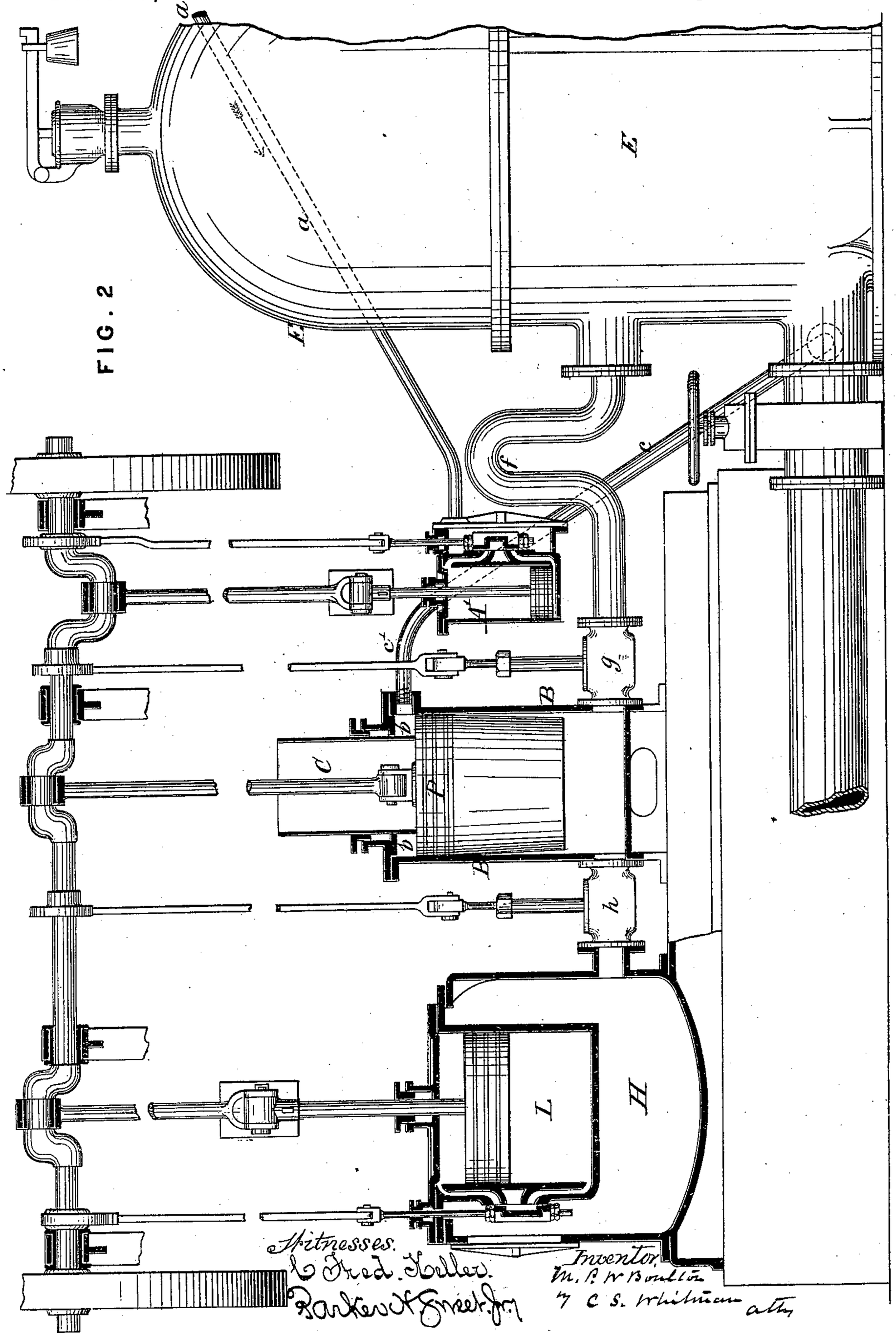
FIG. 2



Witnesses.
Fred. Keller.
Parker & Greeley.

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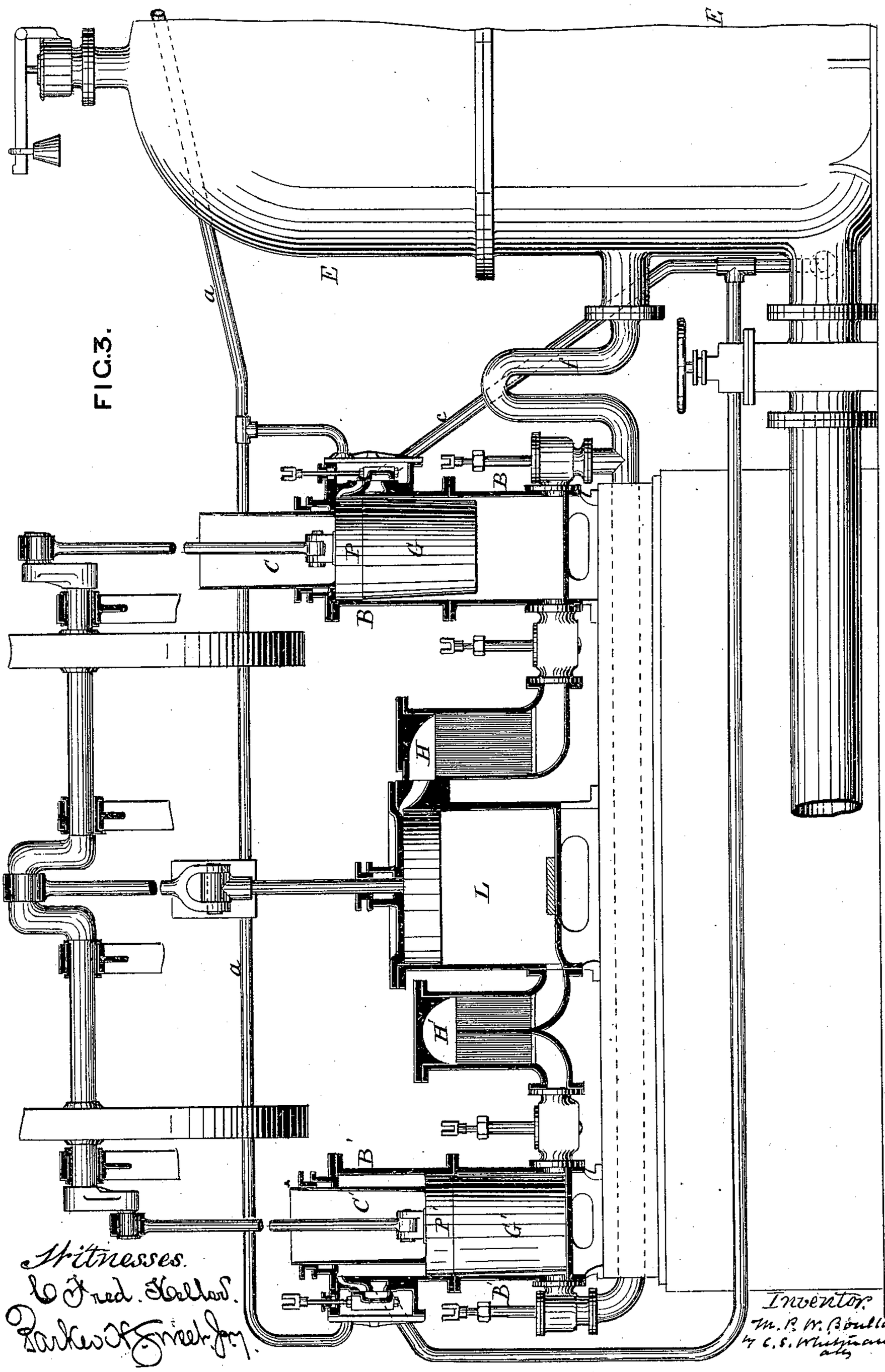
FIG. 3.



Witnesses.
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UNITED STATES PATENT OFFICE.

MATTHEW P. W. BOULTON, OF TEW PARK, COUNTY OF OXFORD, ENGLAND.

EMPLOYING STEAM FOR PRODUCING MOTIVE POWER.

SPECIFICATION forming part of Letters Patent No. 345,026, dated July 6, 1886.

Application filed July 8, 1885. Serial No. 170,992. (No model.) Patented in England November 6, 1884, No. 14,684.

To all whom it may concern:

Be it known that I, MATTHEW PIERS WATT BOULTON, a citizen of England, residing at Tew Park, in the county of Oxford, England, have invented a new and useful Method of Employing Steam for Producing Motive Power, (for which I have made application for Letters Patent in Great Britain, No. 14,684, bearing date November 6, 1884,) of which the following is a specification.

In a patent granted to E. Perrett and myself on the 24th of February, 1885, No. 312,959, was described apparatus in which steam heated by passage through a heater of special construction was used for producing motive power.

According to my present invention, while the construction of the heater remains the same, the method of operating with it for the production of motive power differs in respects which I proceed to explain.

Instead of introducing the steam directly from the boiler to the heater, I introduce it first into a cylinder in which it acts at moderate temperature, and discharge it from this in a chamber connected with the heater, which chamber may be regarded as a cool part of the heater. The steam in the cylinder which first receives it may be expanded to any extent desired, and so reduced in pressure. Thus in this case the pressure in the heater is lower than the pressure in the boiler, and the difference of pressure in the two vessels may be great. The steam, having been discharged from the cylinder where it first acts, is caused to pass through the heater, after which it performs work in its heated state. If highly heated, it is proper that the piston on which it works should be protected by a shield.

The operations above described may be performed in one cylinder, if it be differential. In such cases the steam from the boiler enters the annular space round the trunk of the differential cylinder, and the steam which has passed through the heater works on the other side of the piston where the area is larger, the piston on this side being furnished with a shield, if the heat requires it.

If the operations are performed in two cylinders, then it is generally convenient that the first cylinder which receives the steam from the boiler should be double-acting; also in the same case it is frequently convenient that the cylinder which receives the steam from the heater should communicate at its cool end with the chamber into which the exhaust of the first cylinder is discharged, this chamber, as previously explained, being in connection with the heater, but at a moderate temperature. After acting in the hot cylinder the steam may proceed to a further cylinder in which it expands or completes its expansion, and it is generally desirable that it should do this in order that its expansive force may be properly utilized. It is desirable not to employ a shielded piston, except when necessary, and thus when the steam passes from the hot cylinder to a further cylinder, it may be desired in many cases to work in this cylinder with a piston of ordinary construction—*i. e.*, one not furnished with a shield. At the same time it may be desired that the steam should issue from the hot cylinder at a high temperature. I therefore in some cases adopt the following construction. Between the hot cylinder which receives the steam from the heater, and that into which it next passes, I provide a chamber furnished with plates or bodies like those of a regenerator. The steam, at its first issue from the one cylinder to the other, being highly heated, deposits heat in these plates or bodies, and thus arrives with diminished heat at the piston of the cylinder to which it is traveling, on account of which it is easier to hook that piston without a shield. As the expansion proceeds, the temperature of the steam falls, and in passing in contact with the plates or bodies on its way from the hot cylinder to the expansion-cylinder the steam takes up the heat previously deposited in them, or a portion of it. Two hot cylinders may be employed in connection with one expansion cylinder, so as to render the latter double-acting; and generally the number and arrangement of the cylinders may be varied.

Figure 1 of the accompanying drawings shows a longitudinal section of an arrangement of engine according to my invention. A is the boiler; E, the heater. B is a differential cylinder fitted with the piston P, which has on its upper side the trunk C, and on its lower side the shield G. L is another double-acting cylinder of ordinary construction. H is a reservoir between the two cylinders B and L. The steam supplied from the boiler A first passes by the pipe *a* into

the annular space *b* around the trunk C. Having expanded in this to the extent desired, it passes by the pipe *c* into the heater E, its passage being governed by the slide-valve V. It first passes into the chamber D, then through the annular space *e;* from this through the interstices of the fire-backs F, and afterwards by the pipe *f* to the lower end of the cylinder B, its passage into this being governed by the valve *g*. It enters B in a highly-heated state, and expands in it, acting on the shield G, and causing the piston P to make its upstroke. During the downstroke of P the steam from this cylinder passes into the reservoir H, its passage being governed by the valve *h*. The reservoir H supplies steam to the double-acting cylinder L in the usual way, *i* being the pipe which conducts the steam from H to L, and *s* being the slide-valve which governs the passages for the admission and eduction of the steam. The exhaust-steam from L passes off either into the atmosphere or into a condenser, as may be desired. The two cylinders are connected to a common crank-shaft, on which are placed the eccentrics and cams for working the various valves.

In the arrangement or construction above described, other things remaining the same, the valve V might be omitted. In this case there would be free communication between the annular space *b* and the heater, and the steam in this space would not perform useful work on the engine, as the resistance of the upstroke would be equal to the work performed in the downstroke. The entry of the steam into this annular space would, however, have some advantage, as serving to keep the upper part of the cylinder L cool. This arrangement, being a modification of the plan previously described in the specification to the patent previously referred to, is not claimed as part of the present invention.

Fig. 2 is a longitudinal view of a modified arrangement of engine. A′ is an ordinary double-acting cylinder. The steam coming by the pipe *a* from the boiler first acts in this cylinder, and after expanding in it to the extent desired, it passes through the pipe *c* to a chamber at the bottom of the heater E, as previously described. This pipe *c* has a branch, *c′*, communicating with the annular space *b* round the trunk C, so that this annular space is always filled with cool steam at the pressure of the heater. The steam discharged from the cylinder A′, after passing through the heater E, flows through the pipe *f* into the lower part of B, acting against the shielded side of the piston P. After discharge from B it passes to the reservoir H, and thence to the double-acting cylinder L, as previously described with reference to Fig. 1.

Fig. 3 is a longitudinal view of another modification. Here B and B′ are two differential cylinders, each receiving steam by the pipe *a* from the boiler. This steam first acts in the annular spaces around the trunks C C′, and afterward is discharged from these into the heater, and operates in a highly-heated state in the lower parts of the cylinders B B′, acting against the shielded sides G G′ of their pistons P P′. It subsequently passes to the double-acting cylinder L, which is fitted with a piston of ordinary construction. In its way to L it passes through chambers H H, provided with plates or bodies like those of a regenerator. The cylinder L has exhaust-valves (which are not shown in the drawings) delivering the steam at the proper times to the atmosphere or to a condenser, as may be desired. The cranks of the two cylinders B B′ are placed opposite to each other, and the crank of the cylinder L is placed coincident with that of B.

One heater only, E, is shown in the drawings; but it will be understood that two or more heaters may be employed for the purpose of maintaining continuous action.

Although in what precedes I have described the usual form of engine in which a piston works in a cylinder, it is obvious that engines of other kinds—such as various forms of rotary engines—might be used instead of those which have cylinders and pistons, and it is to be understood that in the following claim the term "cylinder" includes equivalents for cylinders employed in such engines.

Having thus described the nature of my invention, and the best means I know for carrying the same into practical effect, I claim—

A mass, F, of heated porous refractory material and its casing E, in combination with a steam-engine cylinder, a pipe conveying the exhaust-steam to said refractory material, a second steam-engine cylinder, and a pipe conveying the said steam from said refractory material, after having passed through the said material and been superheated thereby, to the said second cylinder for further work therein.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of June, 1885.

M. P. W. BOULTON.

Witnesses:

OLIVER IMRAY,

JNO. P. M. MILLARD.