(No Model.) 4 Sheets—Sheet 1.

G. DIXON.

FLUID PRESSURE ENGINE.

No. 516,594. Patented Mar. 13, 1894.

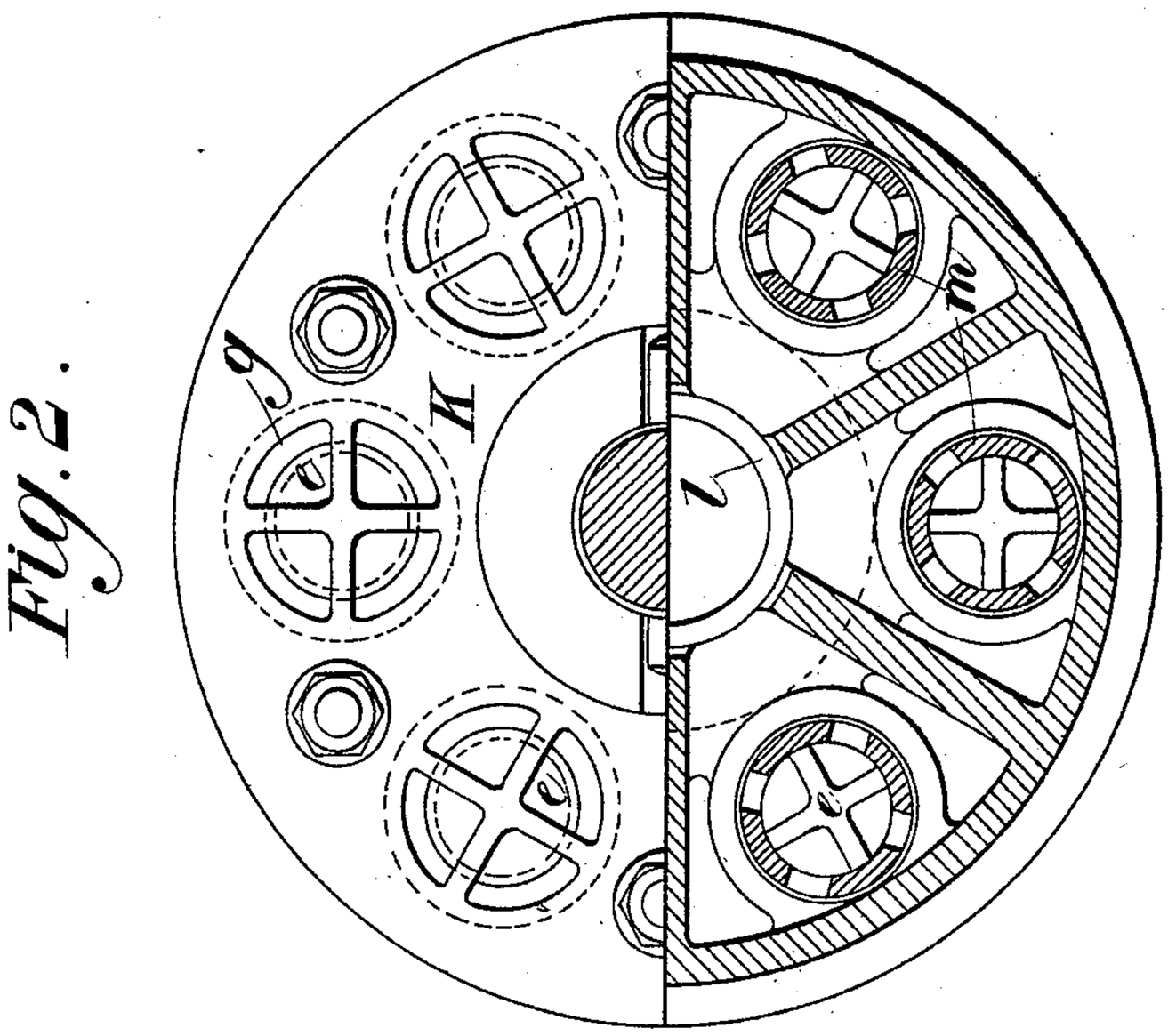

Fig. 2.

Fig. 1.

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(No Model.) 4 Sheets—Sheet 2.

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FLUID PRESSURE ENGINE.

No. 516,594. Patented Mar. 13, 1894.

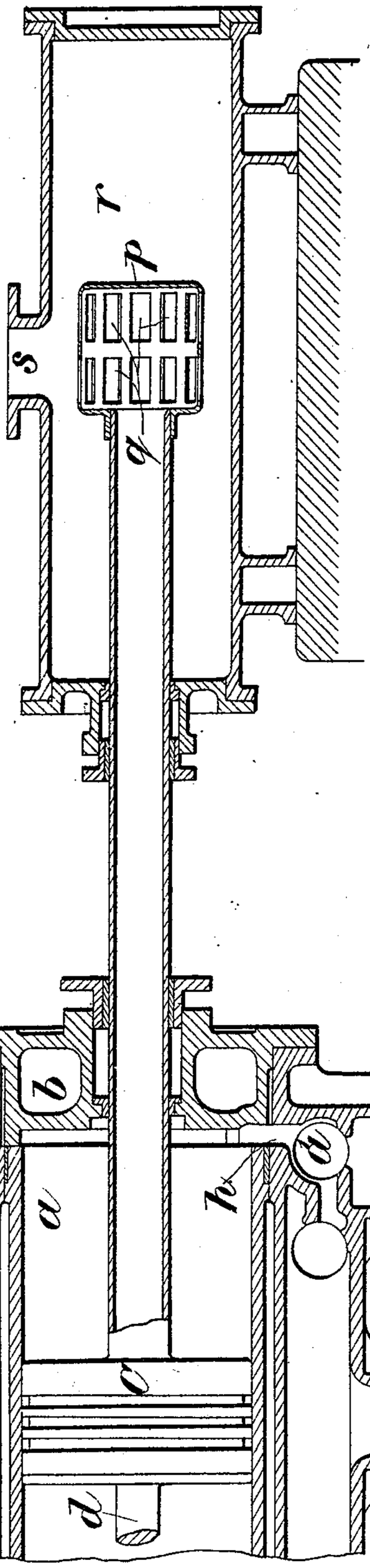

Fig. 3.

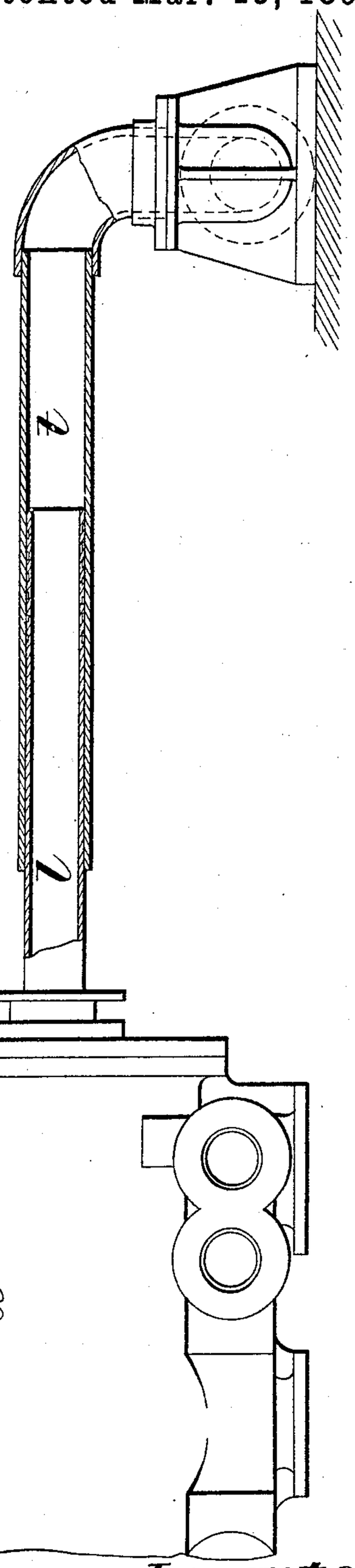

Fig. 4.

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(No Model.)

4 Sheets—Sheet 3.

G. DIXON.

FLUID PRESSURE ENGINE.

No. 516,594. Patented Mar. 13, 1894

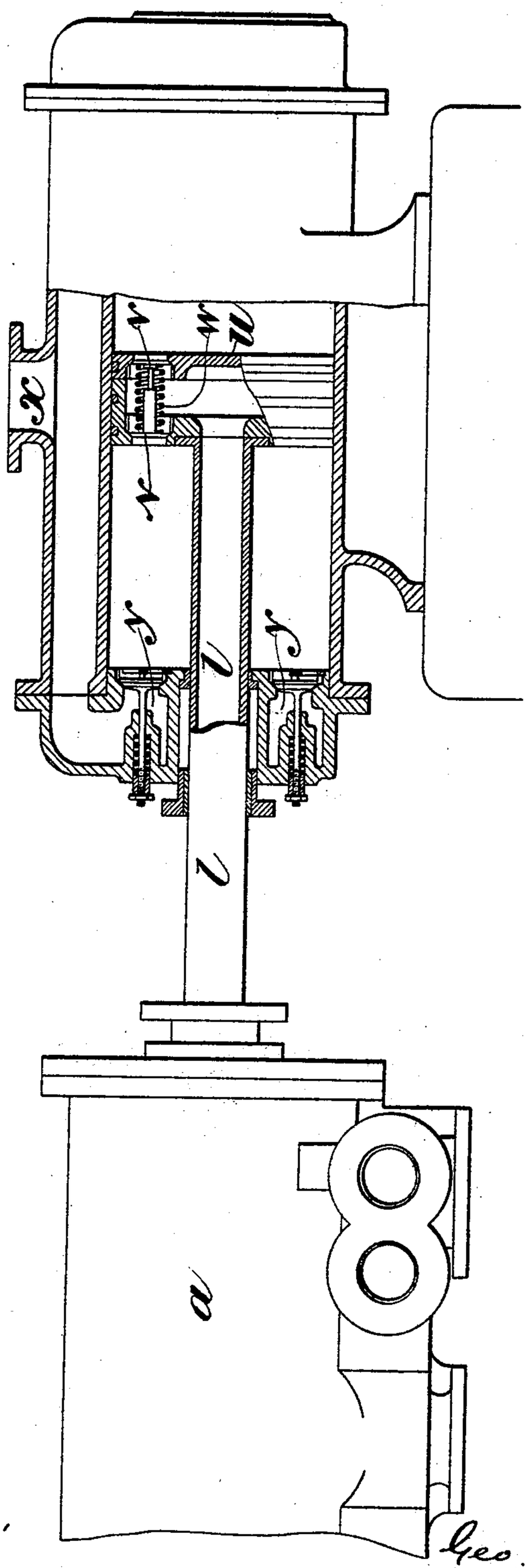

Fig. 5.

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(No Model.) 4 Sheets—Sheet 4.

G. DIXON.

FLUID PRESSURE ENGINE.

No. 516,594. Patented Mar. 13, 1894.

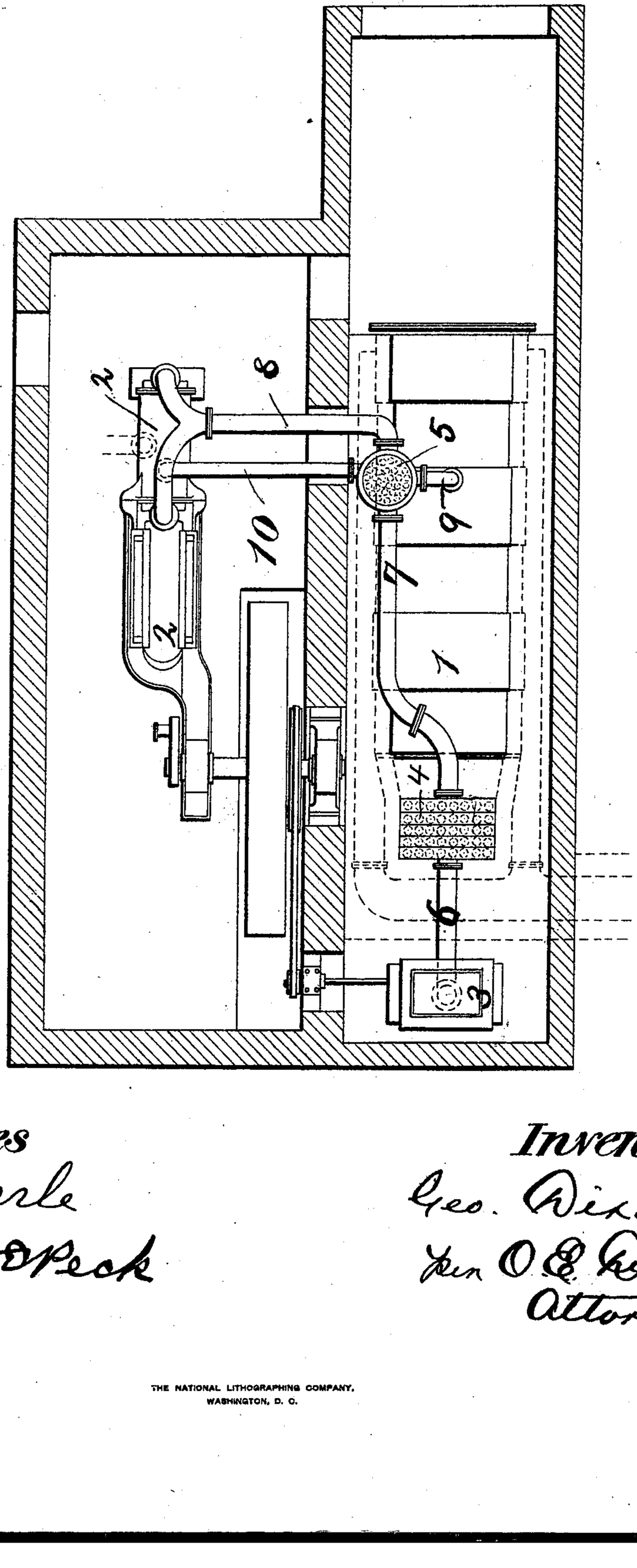

Fig. 6.

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UNITED STATES PATENT OFFICE.

GEORGE DIXON, OF BOLTON, ASSIGNOR TO HIMSELF AND JAMES MUSGRAVE, OF SAME PLACE, AND EDWARD FIELD AND FRANCIS SANDERS MORRIS, OF ADELPHI, ENGLAND.

FLUID-PRESSURE ENGINE.

SPECIFICATION forming part of Letters Patent No. 516,594, dated March 13, 1894.

Application filed August 16, 1893. Serial No. 483,303. (No model.) Patented in England September 29, 1892, No. 17,372; in France July 20, 1893, No. 231,648; in Belgium July 26, 1893, No. 105,724; in Luxemburg July 27, 1893, No. 1,865; in Canada September 9, 1893, No. 44,224; in Italy September 30, 1893, LXVIII, 47; in Spain September 30, 1893, No. 14,832, and in Brazil November 6, 1893, No. 1,643.

To all whom it may concern:

Be it known that I, GEORGE DIXON, a subject of the Queen of Great Britain and Ireland, residing at Bolton, in the county of Lancaster, England, have invented Improvements in Fluid Pressure Engines, (for which I have obtained Letters Patent in Great Britain, No. 17,372, dated September 29, 1892; in Belgium, No. 105,724, dated July 26, 1893; in France, No. 231,648, dated July 20, 1893; in Luxemburg, No. 1,865, dated July 27, 1893; in Italy, No 47, Vol. LXVIII, dated September 30, 1893; in Canada, No. 44,224, dated September 9, 1893; in Brazil, No. 1,643, dated November 6, 1893, and in Spain, No. 14,832, dated September 30, 1893,) of which the following is a specification.

In the specification of another application for Letters Patent filed by me of even date herewith, Serial No. 483,301, there is described a method of working fluid pressure engines according to which, in order to reduce the consumption of steam in the engine, heated air or gas is introduced into the engine cylinder during the period of exhaust, this heated air or gas being caused to take the place of the mixture which has already done work so that when the piston is nearing the end of its stroke and the exhaust port closed, the hot air or gas is compressed into the clearance spaces, and on the completion of its stroke, when steam is admitted for the return stroke, the surfaces with which it comes into contact will have been by the use of the hot air or gas raised to such a temperature that initial condensation is much reduced or even practically prevented. The presence of the heated air or gas will also have an important influence as experiments have shown that when steam is mixed with air or gas sufficiently heated great expansion takes place so that considerable economy may be expected from this source.

In the specification of another application for Letters Patent filed by me of even date herewith, Serial No. 483,302, I have described a construction of fluid pressure engine whereby the method of working such an engine in the manner described can be efficiently carried out.

Now my present invention has reference to a further construction of engine for carrying out the method of working fluid pressure engines hereinbefore referred to. According thereto the heated air or gas is introduced into the cylinder by means of valves placed in a hollow piston, into which it is conveyed by means of a hollow piston rod, which passing through the end or cover of the cylinder, terminates in an air reservoir. Stuffing boxes of ordinary or suitable kind are provided for the rod to pass through. The hollow rod may be made to drive an air pump, the air pump bucket or piston being secured to its outer end. The bucket or piston is provided with suitable valves for admitting the air or gas to the hollow rod. The air pump or blower may also be driven in any other suitable way for compressing the air, either before or after it is heated. Where a sufficiently high pressure of steam is available two or more cylinders may be employed the steam being expanded in one or more cylinders in the usual way and exhausted therefrom and hot air or gas being introduced as hereinbefore described into the final or low pressure cylinder. The heated air or gas may be employed to superheat the steam after it leaves the boiler, by causing the steam to pass through vessels or pipes surrounded by the heated air or gas. The cylinders, covers, and valve chests or receivers may be jacketed and surrounded by hot air or gas circulating in the jackets to prevent radiation and maintain a suitable temperature. The air may be heated by means of the waste gases on their way to the chimney or by any other suitable means. The waste gases themselves may be employed in the engine cylinder in lieu of heated air after being purified of all grit or other matter likely to injure the working parts of the engine. Such purification of the gases might

be effected by means of apparatus such as shown in and described with reference to Fig. 7 of the drawings appended to the specification of Letters Patent of the United States granted to Edward Field, dated December 2, 1890, No. 442,027.

In the accompanying drawings, Figure 1 shows in longitudinal section, and Fig. 2 partly in cross-section, and partly in end elevation, an arrangement of hollow piston with valves and hollow rod for admitting heated air and gas into the engine cylinder. Fig. 3 is a longitudinal section partly in side elevation illustrating an engine cylinder fitted with a hollow piston of the kind referred to and means for introducing heated air or gas to the interior of said piston. Figs. 4 and 5 are sectional elevations illustrating modified arrangements for introducing heated air or gas into the hollow piston. Fig. 6, shows in a plan, a general arrangement of the system applied to a stationary engine.

Referring to Figs. 1, 2 and 3, *a* is the engine cylinder; *b* one of its covers with stuffing box; *c* a hollow piston secured to a piston rod *d; e e* are valves for controlling the admission of heated air or gas from the hollow piston to the cylinder; *f f* are their seats; *g g* are ports for conducting the heated air or gas into the cylinder, these ports are, as shown, so shaped and arranged as to deliver the heated air or gas into the cylinder in a longitudinal direction, such as is favorable for ejecting through each exhaust port *h* in turn, the mixture which has just previously done work in the cylinder. The valves *e* are connected together in pairs by springs *i* the spring which connects two valves acting to keep both valves normally against their seats. *l* is a hollow rod secured to one side of the piston and serving for the introduction thereto of heated air or gas. For each pair of valves there is provided in the example shown a removable casing *m* in which the valve seats *f f* are formed, and which is made with slots or openings *m'* for the passage of hot air or gas. When all the casings *m* are in place they are secured by the junk ring *n*. The arrangement is such that the valves are held closed by the springs *i* until, owing to the opening of the exhaust valves, the pressure of fluid in the cylinder is sufficiently reduced to allow the pressure of heated air or gas to open the valves on the corresponding side of the piston. The heated air or gas then flows into the cylinder, ejecting (through the exhaust port *h*) the mixture which has just before done work, and on the closing of the exhaust valve a portion of the heated air or gas is compressed into the clearance space of the cylinder as the piston *c* completes its stroke.

In the arrangement for introducing heated air or gas to the hollow piston shown in Fig. 3, the hollow rod *l* carries at its outer end a head *p* having ports *q* so arranged as to secure an equal admission of air to the interior of the rod whichever way it is traveling. The reservoir *r* in which the rod works communicates with the heater by means of pipes attached to the branch *s*.

Fig. 4 shows a modification in which the hollow rod *l* slides telescopically in the pipe *t*, which is in communication with the heater.

Fig. 5 shows an arrangement wherein the hollow piston rod *l* drives an air pump. In this case the bucket or piston *u* of the pump is provided with the air valves *v* for admitting heated air or gas to the hollow rod *l*, the valves *v* being kept normally against their seats by springs *w* acting in compression. The branch *x* communicates with the heater; *y y* are the admission valves to the pump. The valves *e* shown in the drawings for the admisssion of the heated air or gas to the engine cylinder are intended to be opened by a slight fluid pressure generally say about one-half pound to one pound per square inch in excess of the back pressure of the exhaust which slight pressure can be maintained by a fan, blower, or air pump that may be placed in any suitable position for causing a current of heated air or gas to flow into the cylinder; or the inflow of heated air or gas to the cylinder may be caused by creating a partial vacuum in the cylinder by means of a suitable exhauster.

In the general arrangement of the system shown in Fig. 6. 1 is the boiler; 2 the engine; and 3 the fan or blower, which may be of the well known "Root" type. 4 is the air heater, constructed, in this example, with metal pipes through which the air passes, the hot gas circulating around the outsides of these pipes; but this arrangement might obviously be reversed. The heater is shown placed in the boiler flue. 5 is a super-heater through which the steam and air pass one within and the other around metal pipes. The pipes 6, 7, 8, constitute the air supply; they respectively connect the blower to the heater; the heater to the superheater; and the superheater to the engine cylinder; the pipes 9, 10, conduct the steam, respectively, from the boiler to the superheater and from the superheater to the engine.

The air heater may be placed in any suitable position; it may either take the heat directly from the furnace of the boiler; or it may take only the waste heat on its way to the chimney; or the heater may be divided, part being heated by waste heat, and part by direct heat; or a special furnace may be provided. In iron, steel, or other works, the waste heat from the various furnaces in use may be utilized to heat the air.

As will be evident, this invention may be carried out in various forms and applied in engines designed for various purposes whether stationary, marine or locomotive, simple or compound, and whether the steam be expanded once or twice or other number of times successively. Again instead of introducing the hot air or gas into the cylinder entirely

through valves in the sides or ends of the cylinder or through a hollow piston, it might be introduced into the cylinder partly through valves in the cylinder sides or ends (or both) and partly through a hollow piston.

In lieu of air valves of the forms shown in the drawings valves of any other suitable construction might be employed such for examples as slide valves, Corliss valves, or piston valves these being actuated as well understood by any suitable means such as eccentrics, levers, cams, or slip motions for admitting or cutting off the supply of hot air or gas to the cylinder at any required point of the stroke taking care to provide against the opening of the valves for admitting hot air or gas to the cylinder until after the pressure in the cylinder has been reduced below the available pressure of hot air or gas and also to provide for the closing of the air or gas admission valves before the proper time for commencement of the compression of the hot air or gas in the cylinder.

Engines according to this invention may be constructed with two or more cylinders in each or some of which steam direct from the boiler may be used in conjunction with heated air or gas introduced into the cylinder as and for the purpose above set forth.

What I claim is—

1. In a fluid worked engine, an engine cylinder provided at one or at each end thereof with an inlet or inlets controlled by a valve or valves and fitted with a piston formed with another inlet or inlets controlled by a valve or valves, said inlets serving respectively for admission of steam and for admission of hot gases such as air or products of combustion substantially as described.

2. In a fluid worked engine, an engine cylinder having separate inlets for hot gases and for steam to one or to each working end thereof, the inlet or inlets for hot gases being formed in the motor piston substantially as herein described.

3. In a fluid worked engine, an engine cylinder having an inlet or inlets for steam and fitted with a hollow piston formed with one or more inlet ports opening toward the working end or ends of said cylinder, a hollow rod connected at one end to said piston and communicating with the interior thereof, and a vessel for containing hot gases, said vessel being also in communication with the interior of said hollow rod substantially as described.

4. In a fluid worked engine an engine cylinder fitted with a hollow piston formed with one or more inlet ports controlled by a valve or valves and opening toward the working end or ends of said cylinder, a vessel to contain hot gases, and a hollow rod connected to said piston and arranged to work in said vessel, said rod serving to place the said vessel in communication with the interior of said piston substantially as described.

5. In a fluid worked engine, the combination with an engine cylinder fitted with a piston formed with one or more inlet ports each controlled by a valve and opening toward the working end or ends of said cylinder, of a pump comprising a cylinder formed with one or more inlets for hot gases and fitted with a hollow piston provided with one or more inlet ports opening toward the compressing side of said pump cylinder and controlled by a valve or valves and a hollow rod connecting the engine and pump pistons and serving to place their interiors in communication with each other substantially as herein described for the purpose specified.

6. The combination of an engine cylinder provided at each end with a port or ports serving alternately as a steam port and as an exhaust port, valves for controlling the admission of steam and exhaust of motive fluid, a hollow piston formed at its respective sides with ports controlled by non-return valves, springs that normally hold said valves against their seats but each adapted to permit the appropriate valve or valves to automatically open when the pressure at either side of said engine piston falls below that of the hot gases supplied to the interior of said piston, a pump cylinder provided at its ends with inlets for hot gases controlled by non-return valves, a hollow pump piston formed at its respective sides with inlet ports fitted with non-return valves opening inward, springs adapted to hold said valves against their seats at each suction stroke of the pump piston and to permit said valves to open during each compression stroke, and a hollow rod connecting the engine and pump pistons and serving to place the interior of the one in communication with that of the other substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GEORGE DIXON.

Witnesses:

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JAMES HAMMOND,
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