No. 735,740. PATENTED AUG. 11, 1903.

M. N. FORNEY.

FLUID PRESSURE ENGINE.

APPLICATION FILED AUG. 8, 1902.

NO MODEL. 3 SHEETS—SHEET 1

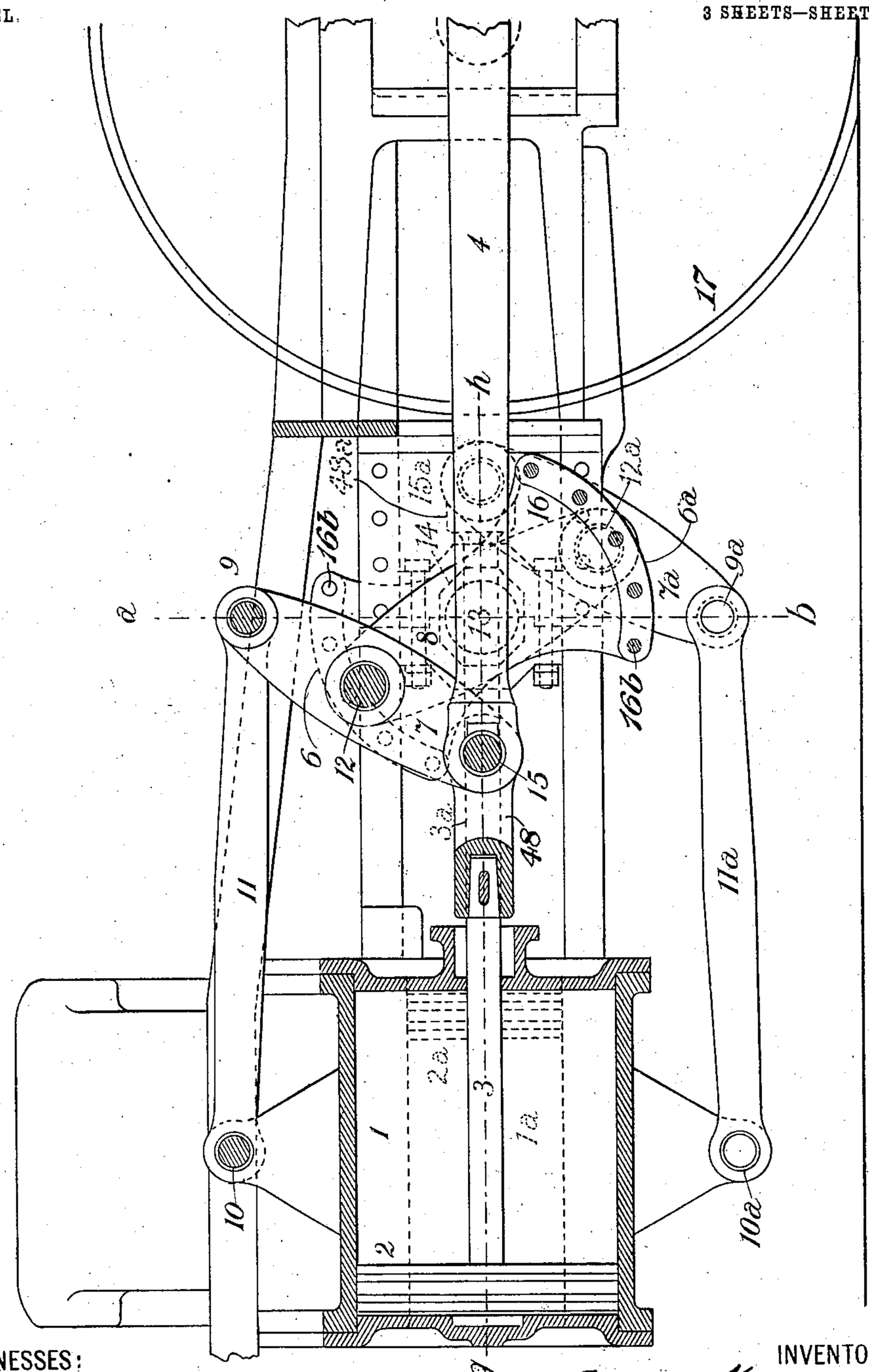

Fig. 1.

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NO MODEL. 3 SHEETS—SHEET 2.

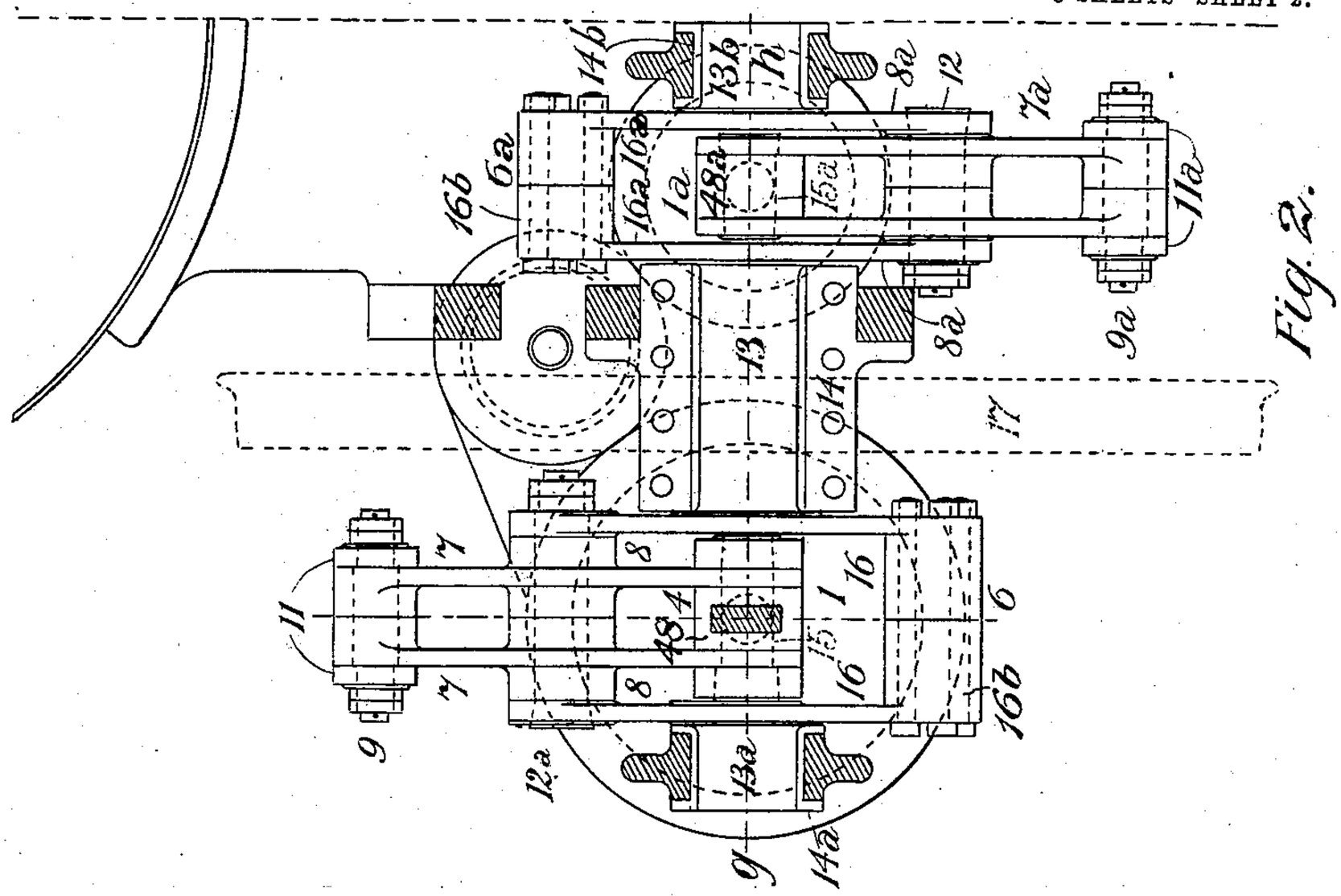

Fig. 2.

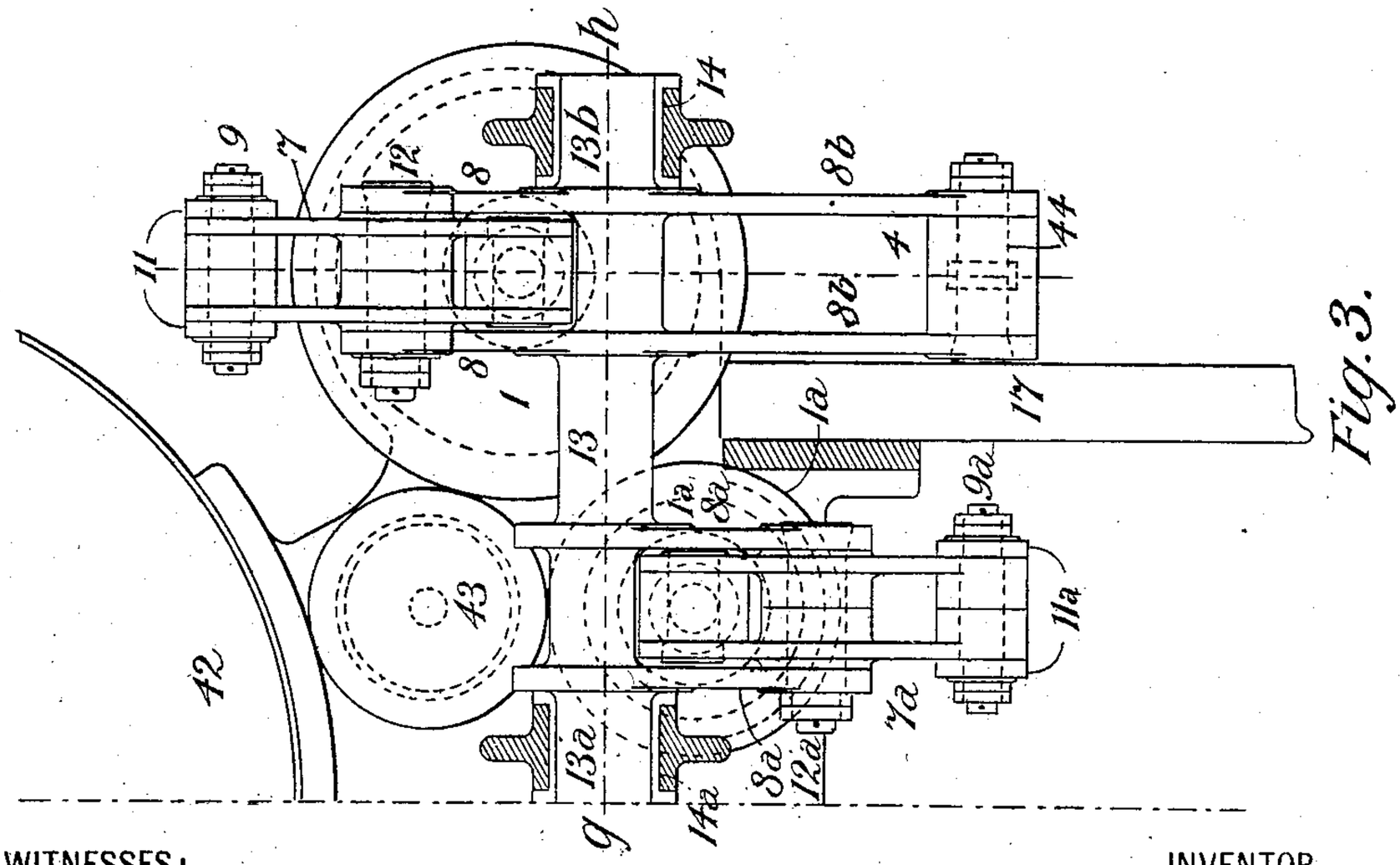

Fig. 3.

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No. 735,740. PATENTED AUG. 11, 1903.

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FLUID PRESSURE ENGINE.

APPLICATION FILED AUG. 8, 1902.

NO MODEL

3 SHEETS—SHEET 3.

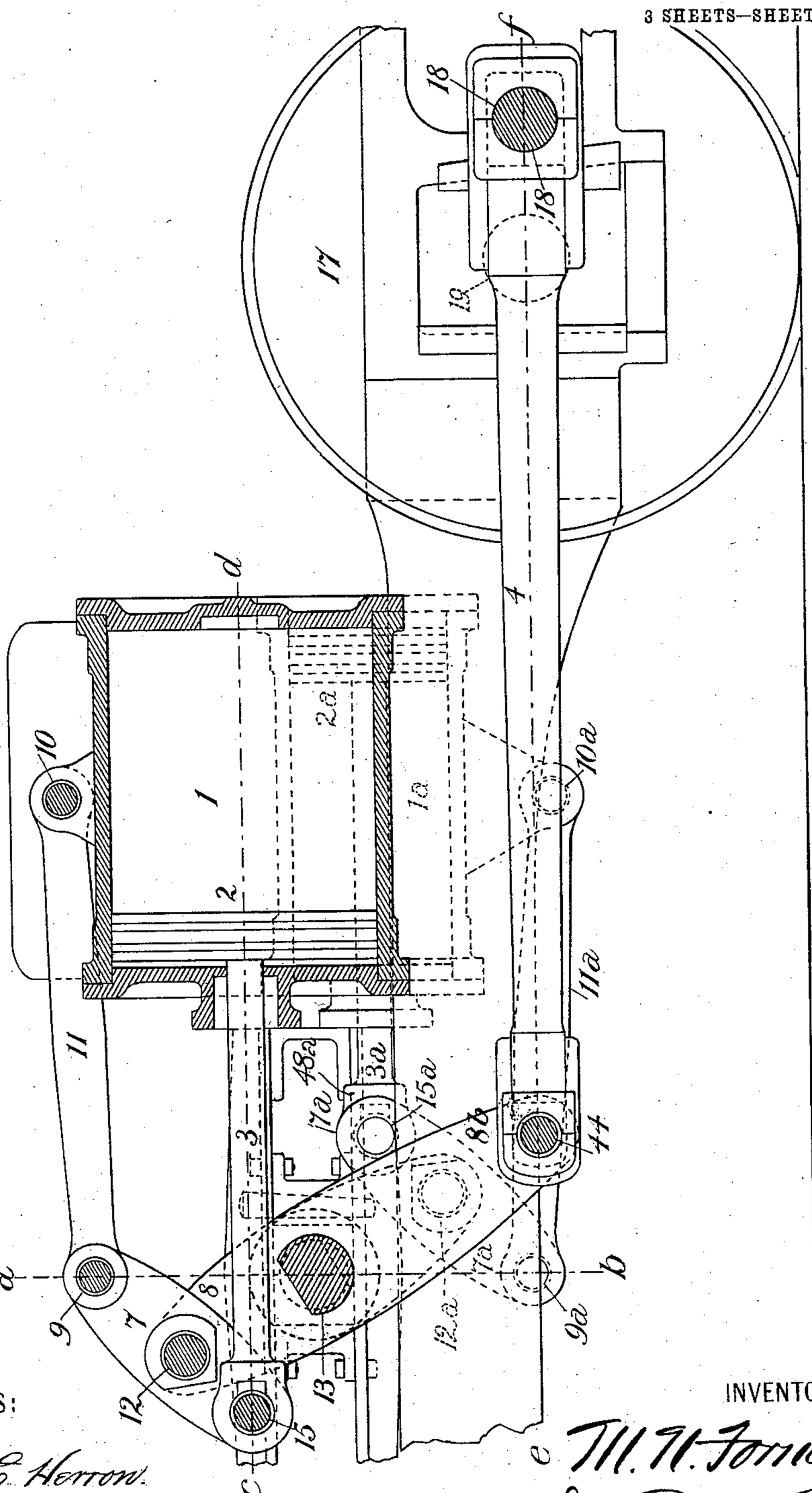

Fig. 4.

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No. 735,740. Patented August 11, 1903.

UNITED STATES PATENT OFFICE.

MATTHIAS N. FORNEY, OF NEW YORK, N. Y.

FLUID-PRESSURE ENGINE.

SPECIFICATION forming part of Letters Patent No. 735,740, dated August 11, 1903.

Application filed August 8, 1902. Serial No. 118,968. (No model.)

To all whom it may concern:

Be it known that I, MATTHIAS N. FORNEY, of the borough of Manhattan, in the city and State of New York, have invented a certain new and useful Improvement in Fluid-Pressure Engines, of which improvement the following is a specification.

My present invention is an improvement on that set forth in Letters Patent of the United States No. 489,648, granted and issued to me under date of January 10, 1893, and is more particularly designed for application to compound steam-engines, but is applicable to other fluid-pressure and to binary engines which are not compound; and its object is to facilitate and further improve the means whereby the reciprocating elements of engines of such character are made to counterbalance each other by a more convenient disposition of their parts, which results in a reduction of cost of the engines.

The improvement claimed is hereinafter fully set forth.

In the compound engine set forth in Letters Patent No. 489,648 aforesaid the piston-rod of the low-pressure cylinder is directly connected to what is termed a "primary" lever, which is in turn articulated to a pair of "secondary" levers, which oscillate in journals or trunnions supported in fixed bearings, the system of levers forming a "parallel" motion, which constrains the piston-rod to move in a straight line. In this construction the axes of the journals or trunnions of the secondary levers are in a plane which coincides with the axis of one of the cylinders, which is the line in which the center of its piston-rod moves. The piston-rod of the high-pressure piston is connected to the lower end of the secondary lever; but as these move in a path which is an arc of a circle to secure rectilineal movement of this piston-rod it requires to be and is shown as connected to the levers by means of a guide, cross-head, and short links.

Under my present invention the guide, cross-head, and short connecting-links of Patent No. 489,648 are wholly dispensed with, and my improvement is adapted to application in connection with cylinders the relative location of which may be substantially varied.

In the accompanying drawings, Figure 1 is a vertical longitudinal central section through one of the low-pressure cylinders of a four-cylinder compound locomotive-engine, illustrating an embodiment of my invention; and Fig. 2, a transverse section on the line *a b* of Fig. 1 looking toward the cylinders and with the oscillating levers shown in elevation and in a vertical position to facilitate clearness of representation. Fig. 3 is a transverse section on the line *a b* of Fig. 4 through one of the side frames and the bearings of the secondary lever of a four-cylinder compound locomotive-engine, illustrating another embodiment of my invention, the cylinders being disposed as in Figs. 1 and 2, but the engine being "back-connected"—that is to say, having the oscillating levers located in front of the cylinders and the connecting-rods passing below the low-pressure cylinders from the secondary levers to the driving-wheel crank-pins. Fig. 4 is a vertical longitudinal central section through the low-pressure cylinder of the construction shown in Fig. 3.

Referring first to Figs. 1 and 2, my invention is herein illustrated as applied in a four-cylinder compound locomotive-engine, the axes of the high and low pressure cylinders 1 1^a of which are located in the same horizontal plane, those of the high-pressure cylinders being on the inside of the engine-frame and those of the low-pressure cylinders on the outside. The cylinders 1^a 1, which are of the ordinary construction, are fitted, respectively, with pistons 2^a 2, secured upon piston-rods 3^a 3, the outer ends of which are not, as in common practice, secured to cross-heads sliding on guides, but are coupled, through a system of oscillating levers presently to be described, to a connecting-rod 4, through which their movements are transmitted to a crank-pin (not shown) on one of the driving-wheels of the locomotive. Motive fluid is admitted to and exhausted from the cylinders by any suitable valve mechanism, which, as it does not form part of my present invention, is not herein set forth.

The system of oscillating levers above referred to, which forms what is known as a "parallel motion," by means of which the outer ends of the piston-rods are caused to move in straight lines, thereby dispensing

with the cross-heads and guides ordinarily employed for this purpose, is except as to the modification in form of the secondary lever hereinafter described substantially similar to that set forth in a separate application filed by me of even date herewith, Serial No. 118,969, and is in this instance of the following construction: Two double-armed lever-bars 7 7, which collectively may be termed a "primary" lever, are coupled at their lower ends to a pin 15, fixed in a forked head 48, fixed upon the outer end of the low-pressure piston-rod 3, and are also coupled at their upper ends by a pin 9 to a pair of radius-links 11, the opposite ends of which are coupled to a pin 10, fixed on the top of the low-pressure cylinder 1.

The secondary lever 8 of the oscillating-lever system instead of consisting of two parallel lever-bars fixed upon the ends of an intermediate journal, as in my application, Serial No. 118,969, above referred to, is in this instance a rocker of substantially H form, which is made up of a pair of upper arms 8 and a pair of lower arms 8^a, the inner or adjoining upper and lower arms being connected by a central rocking shaft 13, fitted in a bearing 14, and the outer upper and lower arms carrying end journals 13^a 13^b, fitted in bearings 14^a 14^b. Each pair of arms 8 8^a is prolonged on the opposite side of the common axial line of the journals 13^a 13 13^b by extensions 16 16^a, in line with the arms, and for convenience of manufacture these secondary levers are built up in three parts, the extensions 16 16^a being provided with end lugs 6 6^a, which afford large bearing-surfaces and which abut against each other and are connected by bolts 16^b.

The upper arms 8 8 of the secondary lever are coupled to the primary lever 7 by a pin 12, located intermediate of its end connecting-pins 9 15. The lower arm of the secondary lever is coupled by a pin 12^a intermediate of its ends to a second primary lever 7^a, said second primary lever corresponding substantially with the first primary lever 7 and similarly thereto formed of two double-armed lever-bars set side by side. The lower arm of the second primary lever 7^a is coupled by a pin 9^a to the rear ends of a pair of radius-links 11^a, the forward ends of which are coupled to a pin 10^a, fixed on the bottom of the high-pressure cylinder 1^a. The upper end of the second primary lever 7^a is coupled by a pin 15^a to a head 48^a, fixed on the outer end of the high-pressure piston-rod 3^a. A connecting-rod 4 extends from the head 48 of the low-pressure piston-rod to a crank-pin (not shown) on the axle of the front driving-wheels 17.

Briefly stated, under the above construction each of the piston-rods is coupled to one end of a separate primary lever, and said levers are coupled at their opposite ends to radial links attached to fixed bearings and are coupled intermediately to opposite ends of a secondary lever or rocker which oscillates in fixed bearings in a plane intersecting the axes of the cylinders. By proportioning the primary and secondary levers and their points of connection properly to each other the ends of the two primary levers to which the piston-rods are coupled will move in approximately straight lines. This approximation may be made so close to a true straight line that the departure therefrom will not be of any practical importance.

When the cylinders of locomotive-engines are located close to the front driving-wheels, the connecting-rods must be coupled to the second or to the third pair of driving-wheels back of the cylinders and must of course clear the front wheels and crank-pins, to do which they must be coupled to the outer ends of the main crank-pins sufficiently far from the wheels to clear the pins on the front wheels. This necessarily spreads the cylinders considerably far apart, and if they are, as is now frequently the case, of comparatively large diameter there may not be sufficient room for them on railroads on which there is but little side clearance. A further structural modification designed to satisfactorily comply with these conditions is shown in Figs. 3 and 4. Referring to said figures, it will be seen that the low-pressure cylinder is placed outside of the engine-frame and the high-pressure cylinder inside, as in the construction shown in Figs. 1 and 2; but the low-pressure cylinder 1 is located sufficiently high up to permit the main connecting-rod 4 to work backwardly below it to a connection with the front driving-wheels, and the system of oscillating levers is located in front of the cylinders instead of in rear of them, as in the preceding instances. Although the front driving-wheels 17 are located close to the cylinders, the distance from their axle to the oscillating levers is sufficient to admit of the use of connecting-rods of the requisite length, which can therefore be coupled to crank-pins on these wheels, and as there are no wheels in front of them which must be cleared the connecting-rods can be coupled to these pins close to the wheels. The cylinders may therefore be placed more closely together transversely of the engine and for a determined amount of clearance may be made of larger diameter than is practicable when the connecting-rods are coupled to the outer ends of the crank-pins. This is a matter of substantial importance in the design and construction of the large locomotives which are characteristic of the advanced present practice.

In the construction shown in Figs. 3 and 4 the location of the axis of the high-pressure cylinder 1^a below that of the low-pressure cylinder 1 enables the valve-chest 43 to be placed above and in the same vertical plane as the high-pressure cylinder and admits of the employment of a secondary lever or rocker of the same general character as that shown in Figs.

1 and 2, but which differs structurally therefrom in being integral, the arms and journal-bearings being forged or cast together, although it might be made in separate parts, if preferred, as well as in being provided with a pair of downwardly-extending arms 8^b between its central and outer end journals, which arms are made of such length that the axis of a pin 44, fixed in their lower ends, shall have substantially the same stroke or throw as the pistons. The main connecting-rod 4 is coupled to the pin 44, and the pressure exerted on the two pistons is transmitted, through the lever system, to the connecting-rod and the crank-pin to which it is coupled. In other particulars the relation of the levers of the oscillating-lever system one to another and to their fixed bearings and the piston-rods is substantially the same as in the instances before described and referred to.

I claim as my invention and desire to secure by Letters Patent—

1. The combination of two reciprocating members having their axes in separated planes at right angles to the axis of a driving-shaft, a rocking shaft having arms at its opposite ends, a fixed bearing in which said rocking shaft is centrally journaled, two movable fulcrums, two primary oscillating levers, each connected to one of the reciprocating members and to one of the movable fulcrums, and the two levers connected, respectively, to opposite arms of the rocking shaft, whereby the reciprocating members are constrained to move in approximately straight lines and in opposite directions to each other, a driving-shaft, a crank thereon, and a rod connecting the system of levers with the crank.

2. In a fluid-pressure engine, the combination of a pair of cylinders having their axes in separated planes at right angles to the axis of a driving-shaft, a piston and piston-rod in each of said cylinders, a rocking shaft having arms at its opposite ends, a fixed bearing in which said rocking shaft is centrally journaled, two movable fulcrums, two primary oscillating levers, each connected to one of the piston-rods and to one of the movable fulcrums, and the two levers connected, respectively, to opposite arms of the rocking shaft, whereby the piston-rods are constrained to move in approximately straight lines and in opposite directions to each other, a driving-shaft, a crank thereon, and a rod connecting the system of levers with the crank.

3. In a fluid-pressure engine, the combination of a pair of cylinders having their axes in separated planes at right angles to the axis of a driving-shaft, a piston and piston-rod in each of said cylinders, a rocking shaft having arms at its opposite ends, a fixed bearing in which said rocking shaft is centrally journaled, two radial links, each coupled at one end to a fixed pivot, two primary oscillating levers, each coupled, at its opposite ends, to one of the piston-rods and to one of the radial links, and the two levers connected, respectively, to opposite arms of the rocking shaft, a driving-shaft, a crank thereon, and a rod connecting the system of levers with the crank.

4. In a fluid-pressure engine, the combination of a pair of cylinders having their axes in separated planes at right angles to the axis of a driving-shaft, a piston and piston-rod in each of said cylinders, a double-armed rocker of substantially H form having supplemental end arms and journals, fixed bearings supporting said end journals, two movable fulcrums, two primary oscillating levers, each connected to one of the piston-rods and to one of the movable fulcrums, and the two levers connected, respectively, to opposite arms of the rocker, a driving-shaft, a crank thereon, and a rod connecting the system of levers with the crank.

5. In a fluid-pressure engine, the combination of a pair of cylinders having their axes in separated planes at right angles to the axis of a driving-shaft, a piston and piston-rod in each of said cylinders, a rocking shaft having arms at its opposite ends, a fixed bearing in which said rocking shaft is centrally journaled, two movable fulcrums, two primary oscillating levers, each connected to one of the piston-rods and to one of the movable fulcrums, and the two levers connected, respectively, to opposite arms of the rocking shaft, an extension fixed to one of the arms of the rocking shaft, a driving-shaft, a crank thereon, and a rod connecting the extension of the rocking-shaft arm with the crank.

MATTHIAS N. FORNEY.

Witnesses:
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M. L. CONROY.