(No Model.) 3 Sheets—Sheet 1.

A. W. OFELDT.

MULTIPLE CYLINDER STEAM ENGINE.

No. 513,650. Patented Jan. 30, 1894.

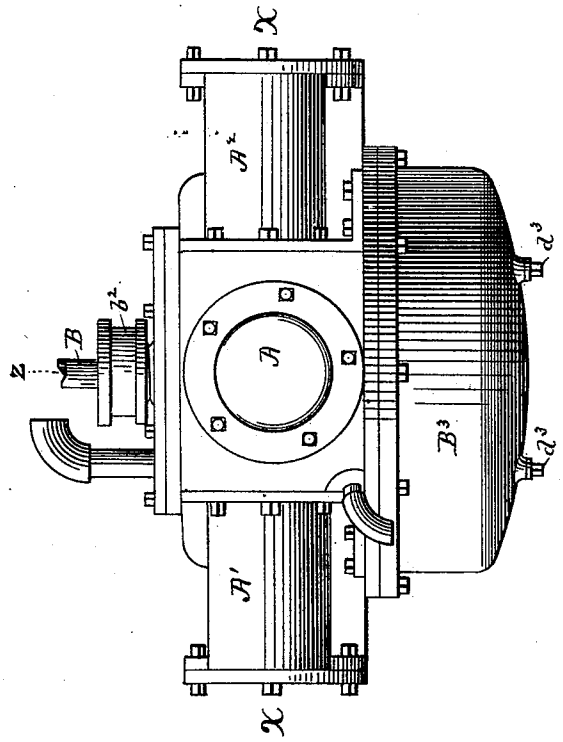

Fig. 2.

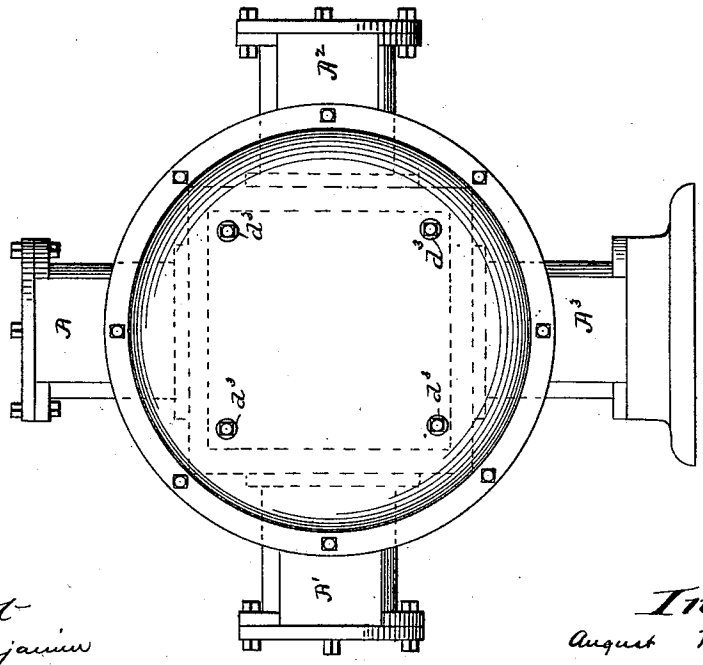

Fig. 1.

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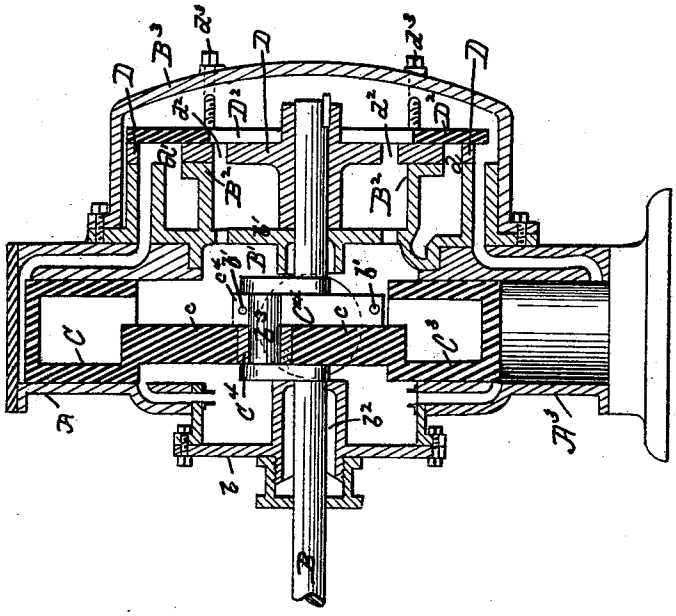

Fig. 4.

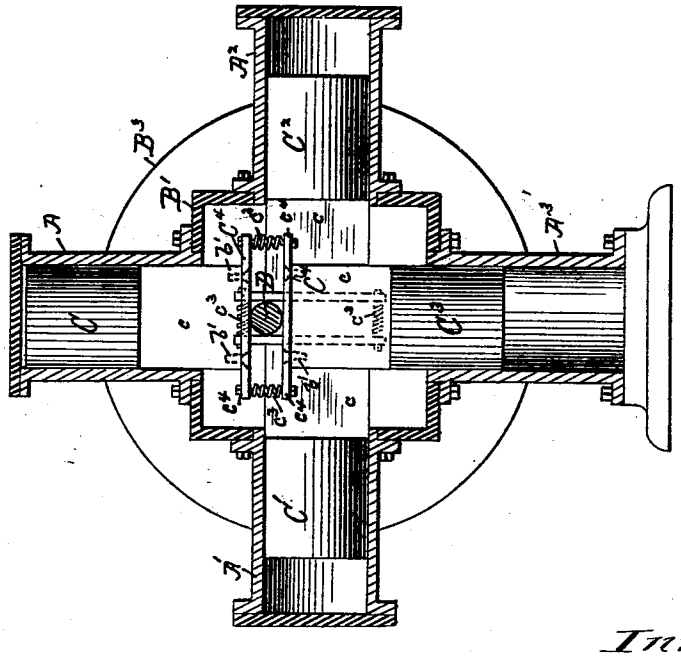

Fig. 3.

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(No Model.) 3 Sheets—Sheet 3.

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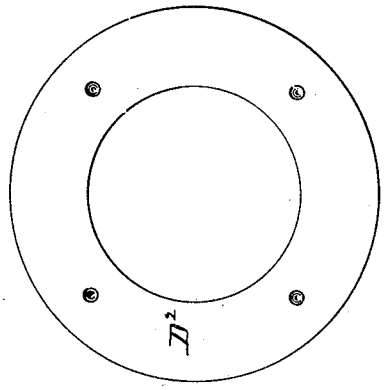

Fig. 6

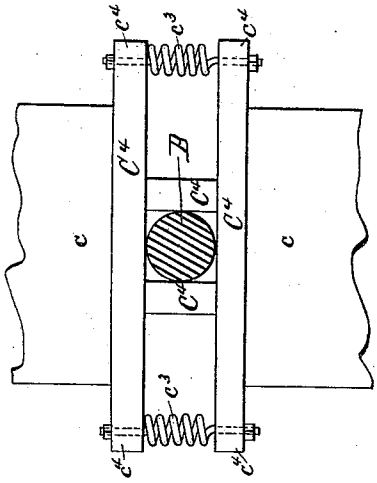

Fig. 7

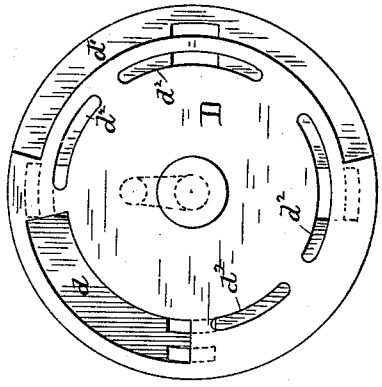

Fig. 5

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UNITED STATES PATENT OFFICE.

AUGUST W. OFELDT, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO EDWARD R. GRANT, OF NEW YORK, N. Y.

MULTIPLE-CYLINDER STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 513,650, dated January 30, 1894.

Application filed July 12, 1893. Serial No. 480,227. (No model.)

To all whom it may concern:

Be it known that I, AUGUST W. OFELDT, a citizen of the United States, and a resident of Jersey City, county of Hudson, State of New Jersey, have invented certain new and useful Improvements in Multiple-Cylinder Steam-Engines, of which the following is a specification, reference being had to the accompanying drawings, forming part of the same.

My invention relates to multiple-cylinder engines in which the cylinders are arranged radially about a common crank-shaft, in pairs, with the cylinders in each pair located diametrically opposite to each other, and in which the pistons are connected to a common crank on the shaft; and my invention consists, primarily, in the combination with the cylinder-pistons of each pair thereof, of arms, rigid on the pistons, respectively, and extending inwardly of the engine and opposedly to each other, and with the faces of their inward ends abutting and bearing directly upon the common crank-pin, and a yielding connection between the opposed inward ends of said arms, in each pair thereof, substantially as and for the purpose hereinafter specified.

My invention consists, further, in the combination with the said cylinders and their respective ports and their pistons provided with the described rigid arms abutting and bearing directly upon the common crank-pin and united in pairs at their bearing-ends by a yielding connection, of a disk-valve fixed on and rotating with the crank-shaft, and governing the lead and cut-off of steam to said cylinders, successively, and maintaining the exhaust from each cylinder, successively, open during the entire time of the return stroke of its piston, and composed of a channeled and apertured disk working on a circular valve-seat on the engine-body, and an annulus fitted to the outward face of the valve-disk together with set-screws working in the wall of the valve-chamber and impinging upon the outward face of said annulus, all co-operating substantially as hereinafter set forth and for the purpose specified.

The object of my invention is to provide a multiple-cylinder engine which is simple and inexpensive in construction, which may be run continuously at a high speed, and which will be durable, and in which the wear, if any, upon the parts subjected to the greatest friction may be compensated without the necessity of removing said parts from the engine.

In the drawings: Figure 1 is a side elevation of a multiple-cylinder engine containing my invention. Fig. 2 is a plan of the same. Fig. 3 is a vertical section of the engine on line x, x, Fig. 2. Fig. 4 is a similar section on the line, z, z, Fig. 2. Figs. 5 and 6 are face or plan views of the disk-valve and its holding annulus; and Fig. 7 is an enlarged view of the devices constituting one feature of my invention.

A, A′, A^2, A^3, are the multiple cylinders, usually four in number, arranged radially about a crank-shaft B, and located in pairs with the cylinders of each pair diametrically opposite to each other, and the two pairs at right angles to each other, as shown. The several cylinders open at their inward ends into the central rectangular chamber B′, upon one side of which is formed the circular valve-seat B^2, as shown. The shaft B has bearing in the head *b* which closes the chamber B′, on one side of the engine, and also in the opposite wall of said chamber, at *b*′. The single stuffing box required in this engine is at b^2 in the head *b*; the opposite side of the engine being closed by the interiorly recessed annular head B^3 fitting outside the circumference of the valve-seat B^2 and constituting the valve-chamber.

C, C′, C^2, C^3, are the several pistons in the respective cylinders A, A′, A^2, A^3. In engines of this class the cylinders are usually single-acting, as shown. Each of the pistons has a rigidly extended arm or projection *c* reaching through the open inward end of its cylinder toward the crank-shaft; and the said arm *c* of the opposed pistons of each pair of cylinders reach respectively to opposite sides of the shaft-crank b^3, as shown.

The cylinders are furnished with the customary ports in engines of this class, as shown; and these ports are governed in the lead and cut-off, and the exhaust of steam to and from the several cylinders, successively, by a disk-valve D which is keyed to the shaft *b* and rotates with it, as shown, within the valve-chamber constituted by the head B^3.

In engines of this class, as usually heretofore constructed, the pistons in each of the

several pairs thereof have been either formed of one piece of metal or rigidly connected together, and the two positively united pistons have been given a common connection to the crank, by either a slotted cross-head in which the crank-pin works directly, or by a sliding-block or box which receives the crank-pin and which works between guides in a yoke, the sections of the yoke being fixed on or rigidly connected to the pistons. In any of these constructions of the connection between the pistons themselves or between the pistons and the shaft-crank, the friction and consequent wear upon the crank-pin and the bearing therefor carried by the pistons are augmented by the rigidity of the several parts; and it is difficult, if not impossible, to compensate for such wear without removing the affected parts and dressing them with suitable tools and then replacing them. Furthermore, this stated rigidity of the parts and excessive wear thereof have obviously precluded the running of engines of this class of high-speed for any considerable period of time.

Another form of construction of engines of this class has employed friction rollers, or eccentrics or the equivalent, on the common-shaft, with the inward faces of the pistons themselves abutting and bearing directly and independently upon the said rollers or eccentrics. But the pistons being wholly independent of each other, they are held with their inward ends in contact with the said rollers or eccentrics only by the pressure behind them on the working-stroke, and when the engine is at rest, the pistons are liable to assume, by gravity, or for other extraneous reason, positions relatively to the shaft which withdraw their inward ends from contact with the rollers or eccentrics. Such displacement of the working parts of the engine is not desirable.

One feature of my invention is intended to overcome these difficulties and to conserve the ability of the engine to run at high speed continuously. In carrying out this feature of my invention, I construct and arrange the pistons in each of the pairs thereof separate from the opposite piston of the pair, and I cause the extended portion or arm c of each piston to project to and abut directly upon the crank-pin, as shown. When the engine is in operation, and during the working stroke of each piston, inwardly of the engine, the steam pressure behind the piston will hold the face of the end of the piston-arm to contact with the crank-pin and, during each half revolution of the crank caused by the "push" upon the crank-pin by said piston-arm, the crank-pin will traverse said face of the end of the piston arm; while the return stroke of each piston will be effected by the "push" of the crank-pin, during each other half of its revolution, upon said face of the end of the piston-arm, the pin traversing said face during such portion of its revolution. But, inasmuch, as the pistons may, as stated, owing to extraneous causes, when the engine is at rest, assume or be given such positions in their respective cylinders as would remove the end face of a piston-arm from contact with the crank-pin, it is desirable to establish such connection between the opposed ends of the piston-arms of each pair of pistons, that the pistons and their arms in each pair will, at all times, preserve their proper positions relatively to their mates in each pair, and to the crank-pin. For this purpose I make a yielding connection between the opposed ends of the piston-arms of each pair thereof, and this may be accomplished by means of springs c^3 reaching from one piston-arm end to the end of its opposite mate, at the side edges of the arms, the spring-ends being attached to the arm-ends, as by holding nuts, substantially as shown plainly in Fig. 7. The springs will give a yielding connection between the piston-arms ends; and while the said springs will serve to hold the pistons and their arms in proper position relatively to each other and the crank-pin when the engine is at rest, there will be no close and confined bearing at the connections of the piston-arms with the crank-pin, and friction, and consequent wear upon the piston-arm bearing-ends and the crank-pin will be reduced to a minimum.

Any other known and equivalent means for connecting the opposed ends of the said piston-arms may be employed in place of the springs shown; it being essential that the connection established shall be one which shall act only to hold the piston-arm ends loosely or yieldingly together, so that while they may be maintained in proper relation to each other and to the crank-pin, no friction, due to the connection, will be created between the said bearing-ends and the pin.

I find it desirable to attach bearing-plates C^4 to the ends of the piston-arms, as by bolts b^4, as shown in Figs. 3 and 4; and, when this is done, said plates may be made of hardened steel, thus withstanding wear and consequently promoting the durability of the engine, while springs c^3 may pass through the extended ends c^4 of said plates, as shown in Fig. 7; and, any wear at the said bearing-plates and crank-pin will be compensated by the action of the springs. The necessity for removing these parts from the engine and dressing them with tools, in order to compensate for any wear, is thus wholly avoided; and not only is a loose or yielding bearing of the piston-arms upon the crank provided, but also a bearing which is automatically adjustable to compensate for wear.

Another feature of my invention, and one which in co-operation with the feature hereinbefore described, enables an engine of this class to be operated continuously at high speed, consists in the rotary disk-valve D, keyed to and rotating with the shaft as shown and described, whereby I am enabled to provide an inlet-port d in the valve which may

be of such length or duration during the working-stroke of each piston as to cut off at any point of the stroke which may be desired; and to provide an exhaust port d' in the valve, of such a length as to have it remain fully open during the entire return-stroke of each piston; and, by the devices I show, I make this rotary disk-valve a balanced-valve, whereby the high-speed of the engine in all its parts may be obtained.

To balance the valve D, I desirably provide the lateral steam apertures d^2 through the valve-disk, and I provide the annulus D^2, which fits to the perimeter of the valve, on the outer side, and between which annulus and the valve-seat the valve rotates. I also preferably provide set-screws d^3 working in threaded apertures in the recessed head B^2 and projecting to and bearing upon the outer face of the annulus D^2, whereby the annulus and the valve may be adjusted relatively to each other and to the valve-seat. By means of this construction and arrangement of the described parts, the valve may be operated at high speed with a minimum of friction, in conjunction with the other parts of the engine, and whatever slight wear there may be upon the valve or its seat, may be compensated by the adjustment of the annulus D^2, by means of the set-screws d^3, without disturbing the structure of the engine whether it is in operation or at rest.

It will be understood that the exhaust from the cylinders passes through the valve and its seat into the central chamber B′ of the engine and thence out of said chamber, as is frequently done in engines of this class.

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

1. In a multiple-cylinder engine in which the cylinders are arranged radially about a common crank-shaft in pairs, with the cylinders of each pair diametrically opposite to each other, the combination with the cylinder-pistons of each pair, of arms, rigid on the pistons, respectively, and extending inwardly and opposedly to each other and with the faces of their inward ends abutting and bearing directly upon the common crank-pin, and a loose or yielding connection between the opposed inward ends of said arms, substantially as and for the purpose set forth.

2. In a multiple-cylinder engine in which the cylinders are arranged radially about a common crank-shaft, in pairs, with the cylinders of each pair diametrically opposite to each other, the combination with the cylinder-pistons of each pair, of arms, rigid on the pistons, respectively, and extending inwardly and opposedly to each other toward the common crank-pin, and bearing-plates attached to the inward ends of said arms and abutting, respectively, directly upon said crank-pin, together with a loose or yielding connection between said bearing-plates on each said pair of arms, substantially as and for the purpose set forth.

3. In a multiple-cylinder engine having cylinders arranged radially about a common crank-shaft, in pairs, with the cylinders of each pair diametrically opposite to each other, and with the cylinder-pistons of each pair thereof provided, respectively, with arms, rigid on the pistons, and extending inwardly to and abutting at the faces of their inner ends directly upon the common crank-pin, and a loose or yielding connection uniting the opposed inward ends of the arms of each pair of pistons, the combination with said pistons and their cylinders and the ports thereof, of a valve composed of a channeled and apertured disk fixed on and rotating with the crank-shaft, a circular valve-seat on the engine-body to which said disk-valve works, and an annulus resting to the outward face of said disk, together with set-screws through the wall of the valve-chamber and impinging upon the outward face of said annulus, all cooperating substantially as and for the purpose specified.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 8th day of July, 1893.

AUGUST W. OFELDT.

Witnesses:
A. G. N. VERMILYA,
A. S. FITCH.