No. 749,170. PATENTED JAN. 12, 1904.

E. M. CORYELL.

SYNCHRONIZER FOR DUPLEX ENGINES.

APPLICATION FILED JUNE 17, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

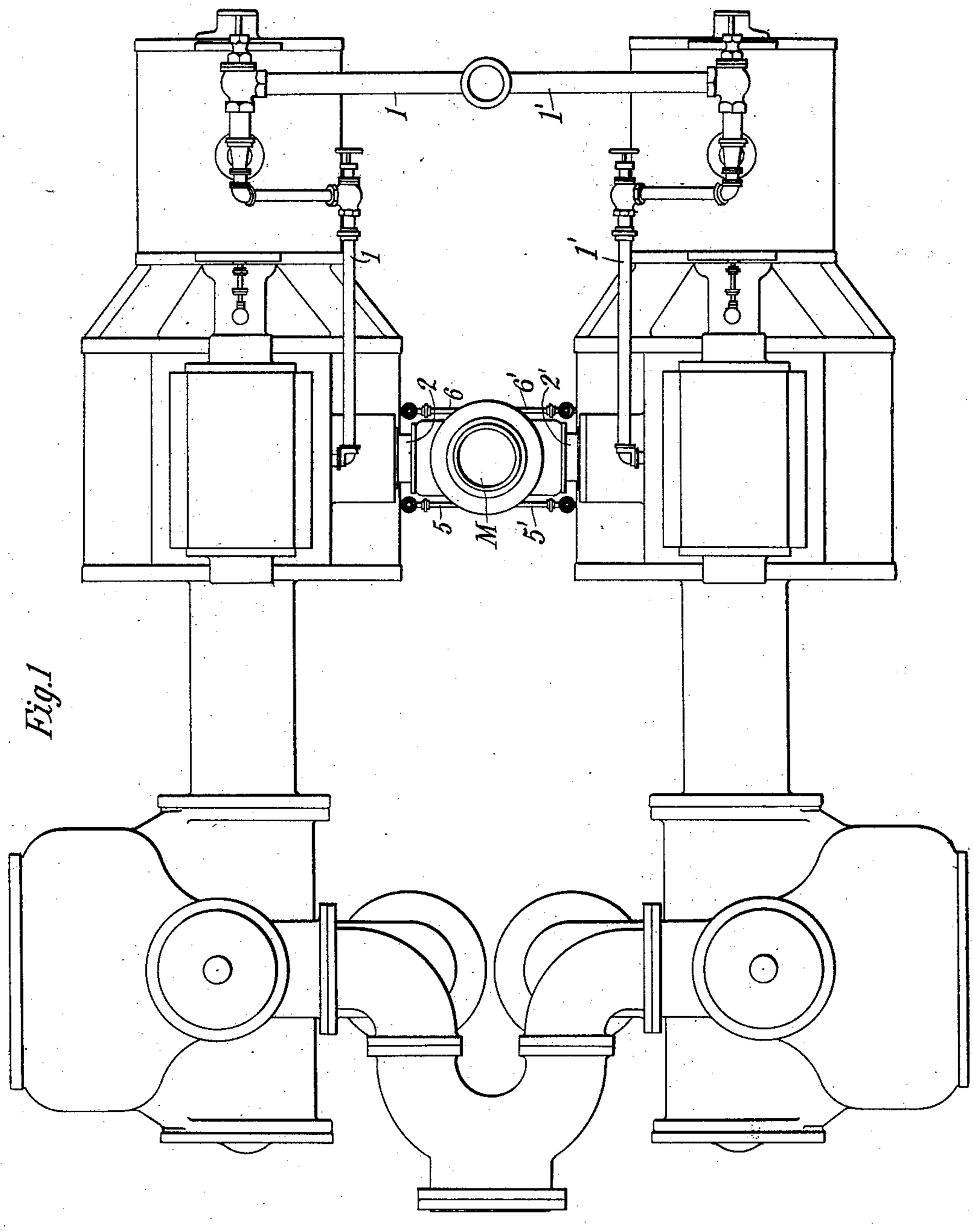

Fig. 1.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 2.

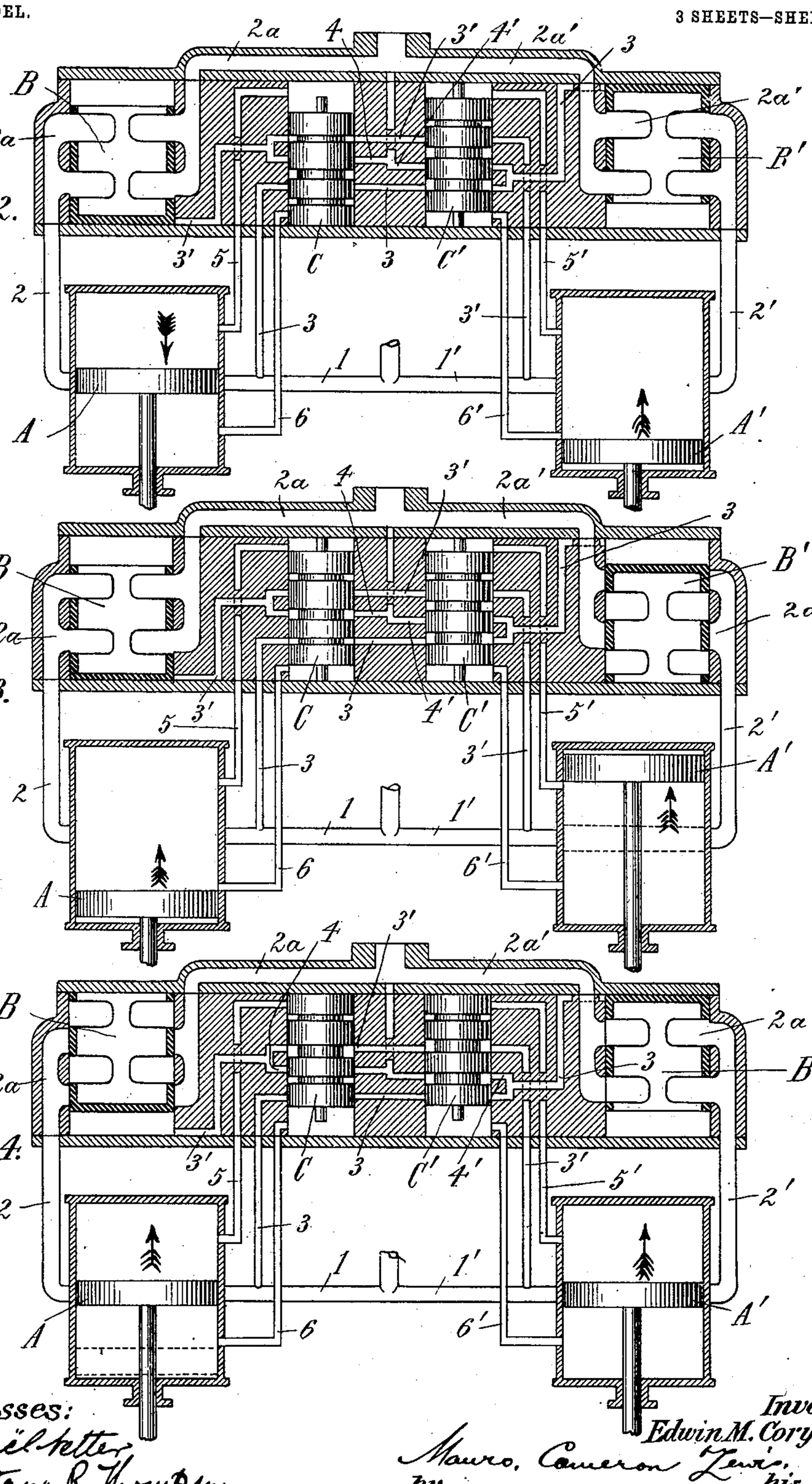

Fig. 3.

Fig. 4.

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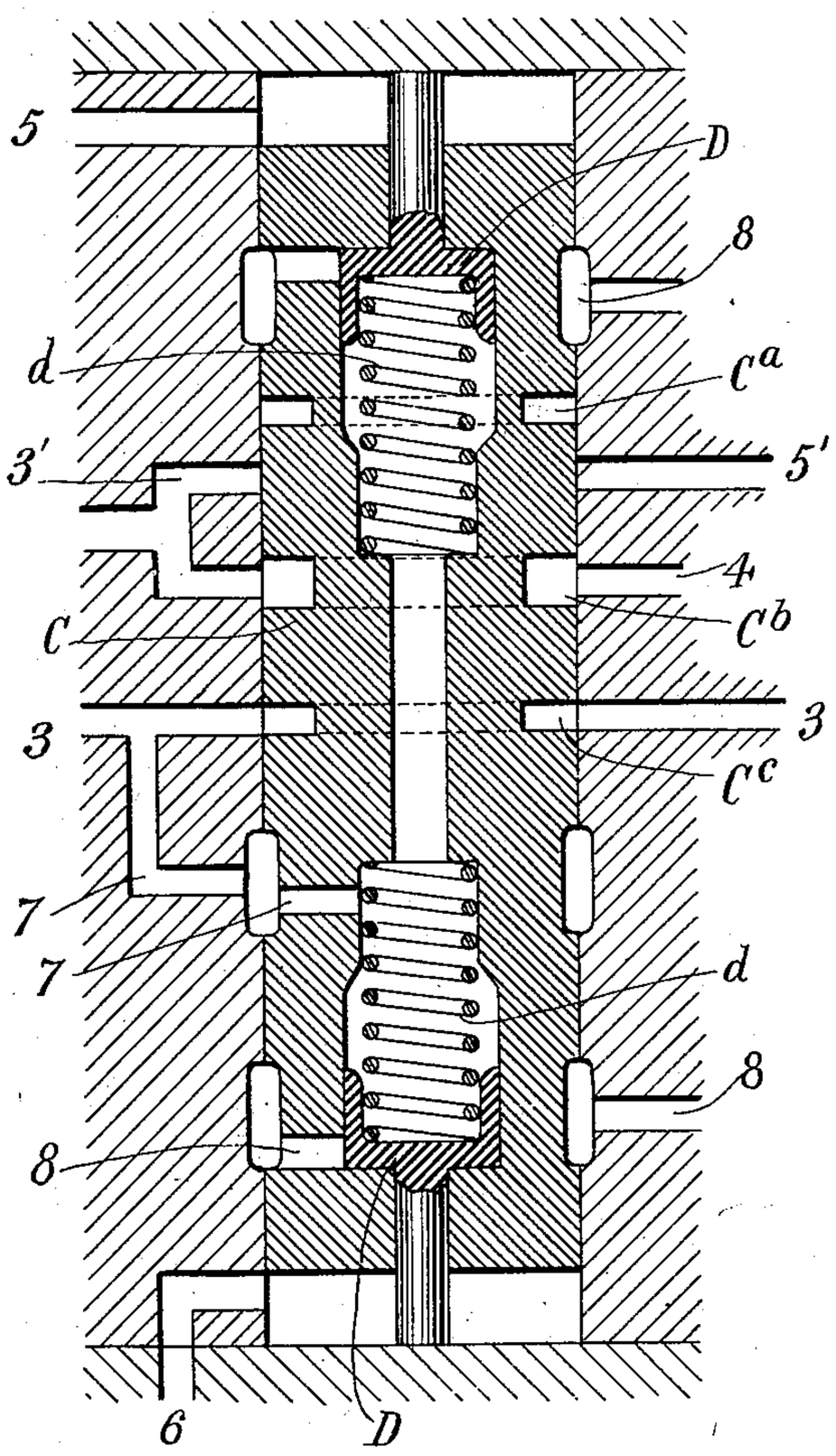
NO MODEL. 3 SHEETS—SHEET 3.

Fig. 5



Witnesses:
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No. 749,170. Patented January 12, 1904.

UNITED STATES PATENT OFFICE.

EDWIN M. CORYELL, OF NEW YORK, N. Y., ASSIGNOR TO JULIA E. CAMERON, OF NEW YORK, N. Y.

SYNCHRONIZER FOR DUPLEX ENGINES.

SPECIFICATION forming part of Letters Patent No. 749,170, dated January 12, 1904.

Application filed June 17, 1903. Serial No. 161,935. (No model.)

To all whom it may concern:

Be it known that I, EDWIN M. CORYELL, of New York city, State of New York, have invented a new and useful Improved Synchronizer for Duplex Engines, which invention is fully set forth in the following specification.

This invention has in general the same objects explained in my pending application, Serial No. 83,328, filed November 22, 1901—namely, to insure the proper synchronism of action in a duplex engine. The piston of one engine is arranged one-quarter of its cycle (ninety degrees) in advance of the piston of the other engine. If the former tends to outstrip the latter, its exhaust is automatically retarded, and if the latter tends to gain on the former its exhaust in turn is retarded. In this respect the present invention differs from my former one, wherein one member only is controlled.

The invention will best be understood by reference to the accompanying drawings, in which—

Figure 1 is a general plan view showing my synchronizer applied to a pair of compound engines with pump connections. Figs. 2, 3, and 4 are diagrammatic views shown as sections through the synchronizing device and illustrating different phases of the operation. Fig. 5 is a longitudinal section of a detail.

Before describing the detailed construction and operations of my improved synchronizer I will set forth its general principles. One piston, as A, is arranged about one-quarter of a cycle (ninety degrees) behind the other piston, A′, so that when either piston is in the middle of its steam-cylinder the other piston will be at one end of its cylinder, and vice versa. So long as the two members maintain this relation and work in proper synchronism the exhaust for each is normal; but if either piston travels a little too fast its exhaust is checked by its choke-valve B or B′. Normally these valves do not interfere with the exhaust, but are operated to effect the choke by means of live steam, which normally cannot reach them, but is admitted upon the shifting of spool-valves C and C′. The latter are operated in substantially the manner shown in my pending application.

So long as pistons A and A′ maintain their proper relation spool-valves C and C′ will maintain their own proper relation one-quarter cycle apart and the passage of live steam to choke-valves B and B′ is prevented.

In Figs. 2 to 4 the parts shown on the left-hand side are practically duplicated throughout on the right and will be indicated there by the same reference letters or numbers primed. 1 and 1′ are conduits that lead live steam to the respective steam-cylinders, where the steam is admitted alternately at opposite ends above and below pistons A and A′, respectively, in the usual manner, and 2 and 2′ are exhaust-passages, each connected alternately with opposite ends of its steam-cylinder in the usual manner, any desirable construction of valve-chest and main valve being employed. All this is old and forms no part of my present invention. Considering that each piston A or A′ passes, first, from the bottom of the cylinder to the middle; second, next to the top; third, then back to the middle, and, fourth, down to the bottom again, we find its complete cycle to consist of four steps, and the two pistons are arranged to operate normally one-quarter of a cycle (ninety degrees) apart. We will assume in Fig. 2 that piston A′ at the lower part of its cylinder is traveling upward and that piston A in the middle of its cylinder is traveling downward just one-quarter of a cycle behind piston A′, which is leading. This relative position must be retained. If piston A′ tends to increase its lead, it must be retarded. If piston A tends to catch up with piston A′, it in turn must be checked.

Above the cylinders I have indicated the synchronizing apparatus M. The exhaust from each cylinder passes through this, being indicated by 2^a 2^a and $2^{a'}$ $2^{a'}$.

B and B′ are choke-valves, which, as by means of slots registering with the exhaust-passages, normally permit free exhaust, but

can be shifted, as in the hereinafter described manner, to choke or retard the exhaust, and choke-valve B will be so shifted to retard the exhaust in front of piston A when the latter tends to travel too fast, and in like manner choke-valve B′ will be shifted to retard piston A′.

Choke-valve B is a hollow cup having a flat bottom that rests normally against the seat, permitting the exhaust to pass freely through when in this position, in which it is normally held by the exhaust-steam or by atmospheric pressure. It would be shifted to choke the exhaust by live steam entering through ducts and passage 3′ 3′ 3′ if spool-valves C and C′ were removed. The other choke-valve B′ is like the left-hand one and is similarly operated through passages 3 3 3, only it is shown as inverted.

4 4′ indicate back passages that, spool-valves C and C′ being removed, would permit steam to exhaust from behind the choke-valves. These valves merely retard without cutting off entirely all escape of exhaust. The spool-valves C and C′ control these passages 3 and 3′ and are themselves actuated in the manner described in my said pending application, which feature forms no part of this invention, but will be briefly described later on. Valve C has circumferential or zonal grooves C^a C^b C^c, and valve C′ has similar grooves $C^{a'}$ $C^{b'}$ $C^{c'}$. These grooves in valve C are so located relative to the passages 3 and 3′ that when C is at the bottom or the top of its stroke passage 3′, leading to choke-valve B, is clear, while passage 3, leading to check-valve B′, is closed, as in Fig. 2, and when in the middle of its stroke passage 3′ is closed, while passage 3 is clear, Fig. 3. Similarly the grooves of the other valve C′ are so arranged that at the middle of its stroke passage 3 only is clear, Figs. 2 and 3. At the top or the bottom of its stroke passage 3′ only is clear, Fig. 4, so that as long as one spool is at the middle and the other at the end (either end) of the stroke there is no continuous passage for live steam to enter behind either choke-valve; but whenever the two spools become abreast in the middle passage 3 is clear throughout and choke-valve B′ is lifted to retard piston A′, and when the two spools are at either end of their strokes, both spools at the bottom or both spools at the top or one at the bottom and the other at top, then passage 3′ is clear throughout and choke-valve B is lifted to retard piston A. Upon the foregoing assumption that piston A′ normally leads piston A by one-quarter cycle then spool-valve C′ normally leads spool-valve C by the same amount, as will be explained later. Consequently one of the two should always under normal conditions be in the middle of its stroke while the other is at one end, so that normally the choke-valves are not lifted to choke or retard the exhaust for either cylinder.

Now for actuating the two spool-valves duct 5 leads from about one-fourth of the way from one end of one steam-cylinder to one end of the small cylindrical seat of spool-valve C and duct 6 leads from about one-fourth of the way from the other end of the same steam-cylinder to the other end of the same spool-valve cylinder, while corresponding ducts 5′ and 6′ in like manner connect the other steam-cylinder with the cylindrical seat of spool-valve C′. When a piston A or A′ occupies an intermediate position between the outlets of these ducts, then the pressure in one duct will exceed the pressure in the other and will force its spool-valve C or C′ to the other end of its stroke; but when the piston occupies a position toward either end, so that both ducts 5 and 6 are uncovered on the same side of the piston, whether on the live steam or on the exhaust side, then there is the same pressure in both ducts and the coil-spring, Fig. 5, forces the spool back to the middle, being aided by live steam that enters, as through a branch 7, from passage 3 to exert pressure behind the head of a plunger in the spool.

Referring to Fig. 5, in each end of spool-valve C is a plunger D, having an enlarged cup-shaped inner end that forms a seat for coil-spring *d* and affords a surface for steam-pressure. Live steam may be admitted behind these plungers, as through passages and ports 7 7, and it assists springs *d d* in protruding the plungers. Passages 8 8 extend from beneath the plunger-heads to the common exhaust. When the pressure coming through passage 5 exceeds the pressure through passage 6 upon the lower end of spool C, the spool is shifted to the bottom of its seat, plunger D being forced in and spring *d* being compressed; but when equilibrium of pressure is restored spring *d* and the live steam project plunger D—that is, restore spool C to the middle position.

The operation of the entire apparatus may now be understood.

First. Fig. 2 shows a normal condition in which piston A in the middle of its stroke is following piston A′ at the lower part of its stroke at the proper interval, spool C at the bottom of its stroke and spool C′ in the middle together cut off both passage 3 3 and passage 3′ 3′, and the two choke-valves B and B′ are seated and permit the regular exhaust from each steam-cylinder.

Second. Fig. 3 shows piston A passing up from the bottom of its stroke and its spool C balanced in the middle position; but piston A′ instead of occupying its middle position (dotted lines) has gone too fast and is in the upper quarter. Consequently its spool C′ has just been shifted to the middle position, pas-

sage 3 3 3 becomes clear throughout, and steam having entered behind choke-valve B′ unseats it and checks the exhaust through $2^{a'}$, thus retarding piston A′. Valve B′ is thus held and piston A′ thus retarded (checked, but not stopped) until piston A has regained its proper relative position, by which time the spools have shifted and the steam behind valve B′ escapes through passage 3 4′, whereupon the valve B′ is reseated and the normal operation is resumed.

Third. Fig. 4 shows that piston A, going too fast, has reached its middle position before piston A′ has vacated its middle position, A has gained on A′, each spool-valve C and C′ has just been shifted to one end of its seat, passage 3′ 3 ′3′ is opened, and choke-valve B has become unseated to retard piston A.

In the foregoing detailed description the words "top" and "bottom," "right" and "left," &c., are used for convenience only. For example, the pistons, spools, &c., may travel horizontally instead of vertically, as shown in Figs. 2 to 4. Various modifications may be made in the construction of parts and in the relative arrangement. For instance, the grooves in one spool may be separated by different intervals from those between the corresponding grooves on the other spool, or, the spaces being identical, the intervening portions of passages 3, 3′, 4, and 4′ may be angularly disposed to attain the same relative arrangement. Other changes more or less obvious may be made without departing from the spirit of my invention.

A duplex engine employed for excavation in phosphate beds has excavated one hundred and twenty (120) more cubic yards of earth per day when equipped with the present synchronizer than without it.

Having thus described my invention, I claim—

1. The combination with a duplex engine comprising the usual main steam-cylinders and pistons, the latter a quarter-cycle apart, two auxiliary valves and valve-chambers, and four ducts leading each from one end of one of the chambers aforesaid to one-fourth of the way from one end of one of said cylinders, whereby said auxiliary valves are reciprocated a quarter-cycle apart, of a choke-valve in the exhaust-passage from one cylinder and a steam-passage for actuating said choke-valve, the said passages being closed by the first of said auxiliary valves when the same is at the top or bottom of its stroke, and closed by the second said auxiliary valve when the latter is at the middle of its stroke, and a similar choke-valve for the exhaust from the other cylinder having likewise a steam-passage for actuating it, said last-named passage being closed when said first auxiliary valve is at the middle of its stroke and when said second auxiliary valve is at the top or the bottom of its stroke.

2. The combination with a duplex engine, of a retarding device for the exhaust of each engine member, and a pair of auxiliary valves each actuated automatically by one engine member of said duplex engine and the two coacting to shift either one of said retarding devices to choke the exhaust from its engine member when the piston thereof travels too fast.

3. The combination with a duplex engine, of two auxiliary valves each reciprocated by the relative steam-pressure through passageways leading from near each end of one of the two steam-cylinders, the two main pistons being one-quarter cycle apart, and the two auxiliary valves having similar relations to each other, of a choke-valve in the exhaust-passage from each member, and a steam-passage leading from behind each choke-valve and controlled by both auxiliary valves.

4. The combination with a duplex engine of a retarding device for the exhaust of each member thereof, and two auxiliary valves each reciprocated by one engine member and the two coacting to shift either one of said retarding devices.

5. The combination with the two members of a duplex engine, each containing the usual main piston and inlet and outlet ports and main valve, and one of said main pistons being one-quarter cycle in advance of the other, of a device located in the exhaust-passage of each member and movable to check said passage for retarding its main piston, and two auxiliary valves each reciprocated through suitable passages by the relative steam-pressure in one of said members, and the two auxiliary valves aforesaid coacting to shift its choking device and retard the main piston.

6. The combination with a duplex engine, of a choke-valve for the exhaust from each engine member thereof, and means for actuating the same.

7. The combination with a duplex engine, of a synchronizing device that comprises automatic means for retarding the exhaust from each of the two engine members, and auxiliary automatic means for actuating said retarding means.

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

EDWIN M. CORYELL.

Witnesses:
C. A. L. MASSIE,
R. L. SCOTT.