2 Sheets—Sheet 1.

W. WALKER.

RECIPROCATING STEAM-ENGINES.

No. 194,198. Patented Aug. 14, 1877.

Fig. 1.

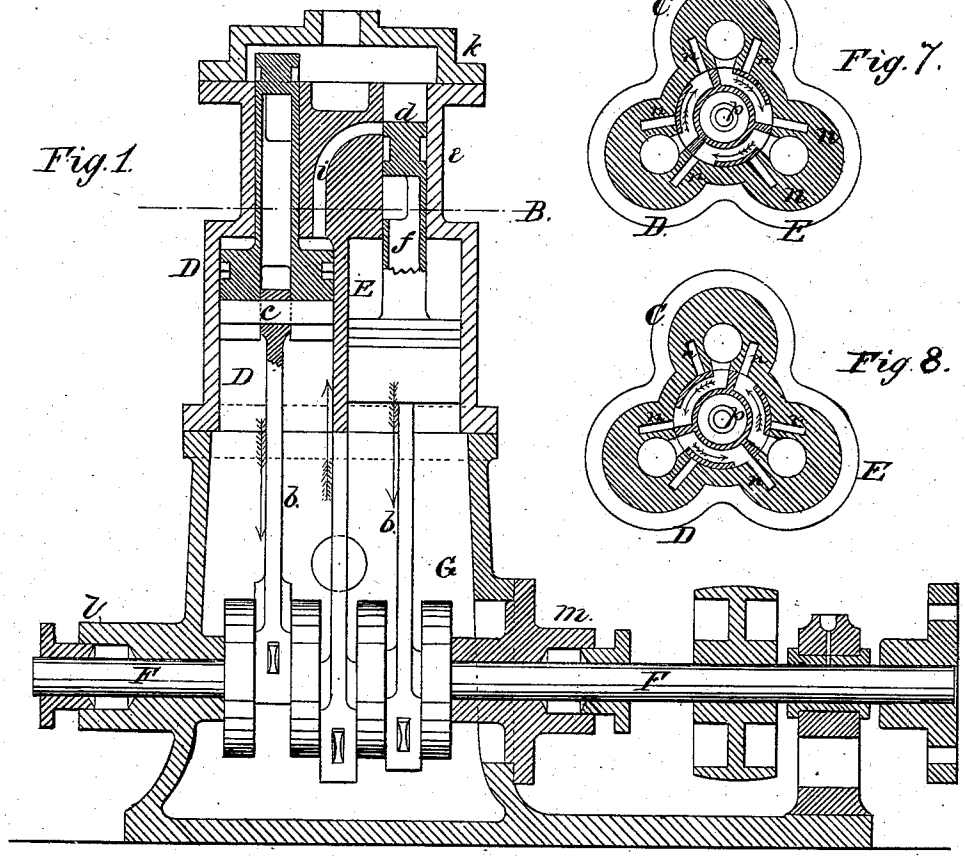
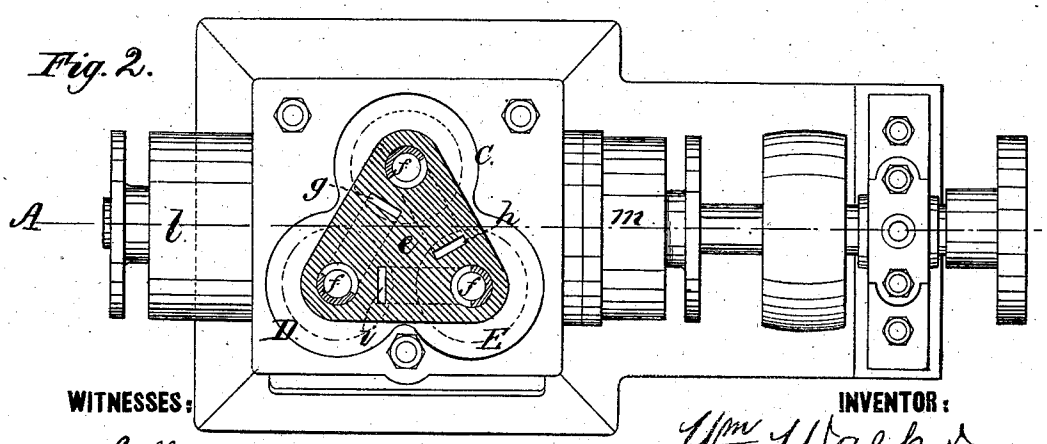


Fig. 7.

Fig. 8.

Fig. 2.



WITNESSES:

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Colon & Kenion

INVENTOR:

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W. WALKER.

RECIPROCATING STEAM-ENGINES.

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Fig. 3.

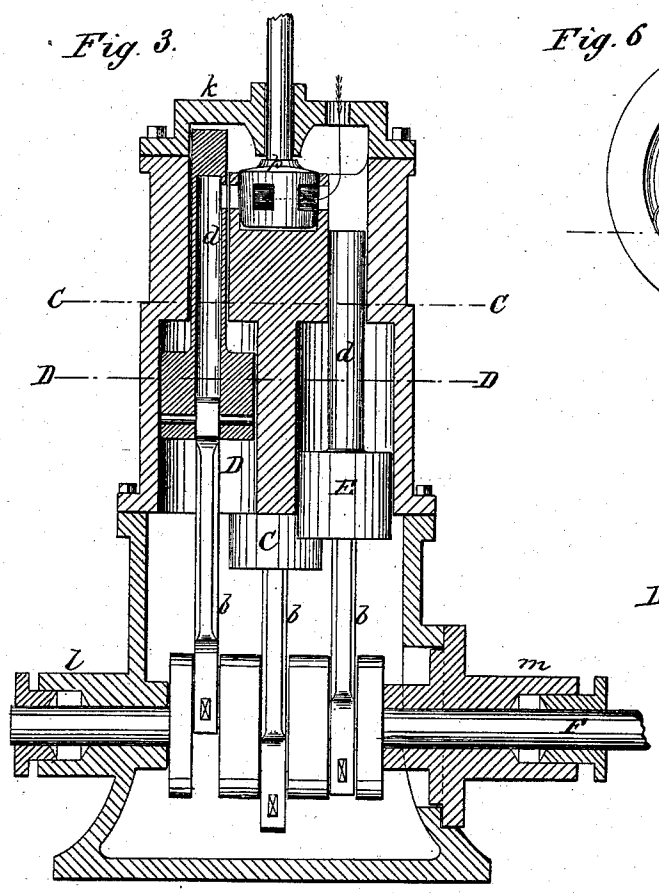


Fig. 6

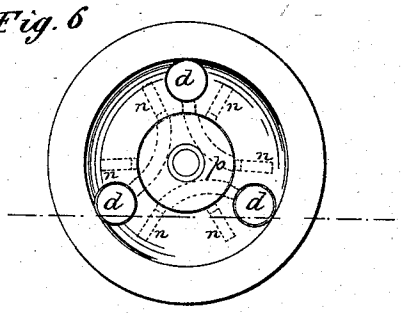


Fig. 5

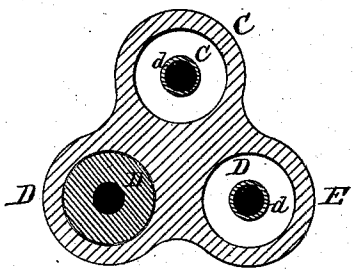


Fig. 5a.

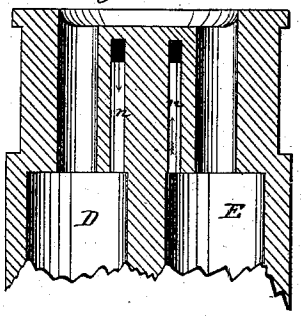
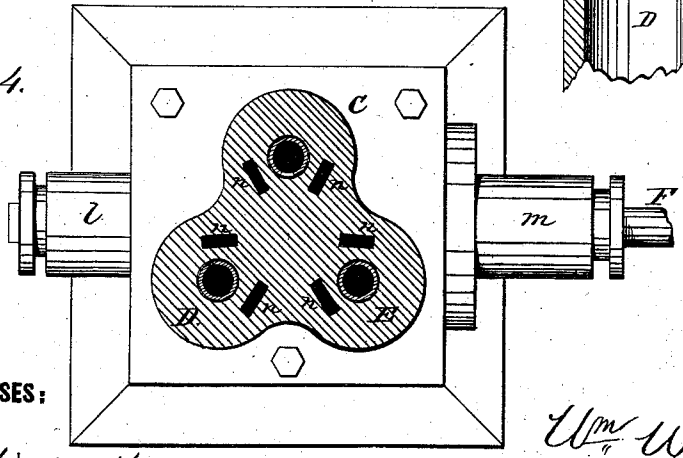


Fig. 4.



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UNITED STATES PATENT OFFICE.

WILLIAM WALKER, OF BURY, GREAT BRITAIN, ASSIGNOR OF ONE-HALF HIS RIGHT TO EDWARD BETTS AND ALFRED BETTS, OF WILMINGTON, DELAWARE.

IMPROVEMENT IN RECIPROCATING STEAM-ENGINES.

Specification forming part of Letters Patent No. **194,198**, dated August 14, 1877; application filed April 20, 1877.

To all whom it may concern:

Be it known that I, WILLIAM WALKER, of Bury, in the county of Lancaster, in the Kingdom of Great Britain, have invented certain Improvements in Steam-Engines, of which the following is a description:

My invention relates to multiple cylinder-engines. I arrange the cylinders in a group and form each piston with a shank, which slides in a bored passage, and acts as a valve to effect and control the admission and exhaust of steam to and from an adjoining cylinder in the group.

In the accompanying drawings, Figure 1 is a vertical section of the engine. Fig. 2 represents a horizontal section on the line B in Fig. 1. Fig. 3 is a sectional elevation of an engine of modified construction. Figs. 4 and 5 are cross-sections of Fig. 1, on lines C and D, respectively. Fig. 5ª is a vertical section on the line indicated in Fig. 6. Fig. 6 is a plan view of the engine with the cap *k* removed. Figs. 7 and 8 are sectional views, illustrating the two positions of the reversing-valve.

The three cylinders C, D, and E are formed in one casting, and are arranged in a group, with their axes equidistant; but, if preferred, the cylinders may be arranged in line. The crank-shaft F passes through a chamber, G, into which the exhaust is discharged from the cylinders. The crank-shaft passes between the axes of two cylinders, and the third axis in a direction parallel with the two axes. A piston is fitted to slide within each cylinder. Each piston is connected by a connecting-rod, *b*, with one of the crank-pins of the crank-shaft. The crank-pins are equidistant on the described circle. One end of each rod is jointed by means of a pin, *c*, to the piston. The other end is provided with a single brass or step, which bears upon the crank-pin, and is kept in place by a cotter. Each piston is cast or provided with a hollow shank, *d*, which is fitted to slide within a bored passage, which is formed in an extension, *e*, of the casting in which the cylinders are formed. Each passage is concentric with one of the cylinders. The upper part of each shank may or may not be provided with packing or with packing-rings. A hollow passage, *f*, is formed in each shank, and communicates with a port formed in the side of the shank.

The steam-ports *g*, *h*, and *i* are formed in the portion *e*. Each port leads from one of the bored passages of one cylinder to the steam-space of an adjoining cylinder. The upper ends of the shanks *d* serve to cover and uncover these ports. The upper ends of the bored passages open into a space formed by a bonnet, *k*, which is bolted to the end of the extension *e*. The steam-supply pipe is attached to this bonnet, and supplies steam to all the three bored passages.

The crank-shaft is arranged to revolve in bearings *l* and *m*, which are provided with glands or stuffing-boxes to prevent the escape of steam. If such escape will not be objectionable in any case, these stuffing-boxes may be dispensed with. The bearing *m* is formed in a removable part, to allow the cranks to be got into position within the chamber G. The crank-shaft may be provided with any required means for transmitting motion, or for coupling to shafting or machinery, and, if desired, may be provided with a fly-wheel, although a fly-wheel is not shown in the drawing.

The action of the engine is as follows: To avoid repetition I will distinguish the pistons by the letters with which the cylinders are marked. When the piston E is moving downward or toward the crank-shaft, and is nearing the end of the stroke, the end of the shank *d* on the piston uncovers the port *i*, and steam is thereby admitted to the cylinder D. The shank of the piston D in like manner causes steam to be admitted to the cylinder C, and the shank of the piston C regulates the admission of steam to the cylinder E. As the crank with which the piston of the cylinder E is connected is one-third of a revolution ahead of the crank to which the piston D is coupled, the shank on the piston E is nearing the end of its upward stroke when the piston D reaches the termination of its downward stroke. At this time the opening in the side of the shank on the piston E arrives opposite to the end of the port *i*, and establishes a communication between the cylinder D and the chamber G, and

the exhaust-steam flows through the port *i* and the passage *f* in the shank on the piston E into the said chamber. The shank on the piston D in like manner exhausts the cylinder C, and the shank on the piston C exhausts the cylinder E. The arrangement permits the passage for the supply of steam to each cylinder to remain open for about one-third of a revolution of the crank-shaft, or for a smaller period, according to the lap, and the exhaust to remain open for about one-third of a revolution. The exhaust-steam is conveyed away from the chamber G by a suitable pipe attached to the chamber.

I do not confine myself to the casting of the cylinders together, as they may be formed in separate castings, and be bolted or fastened together.

As each piston is only single-acting, and in consequence of the steam exerting a constant pressure in the same direction upon the ends of the shanks *d*, the moving parts are kept in compression—that is to say, taking, for example, the vertical form of engine illustrated, the pressure upon the crank-pins is always exerted in a downward direction.

Figs. 3 to 8, inclusive, show the modified construction of the engine when a reversing-valve, *p*, is employed for the purpose of changing the direction of motion of the crank-shaft. On each side of the bored passage in which the shank *d* slides is formed a vertical port, *n*, which communicates, at its lower end, with the space above the piston. The conical valve *p* is fitted to revolve within a correspondingly-shaped recess bored in the extension *e* in the center of the group of cylinders. This valve is formed with three steam-passages.

When the valve is in the position represented in Fig. 3, the steam from E flows through one of the two ports *n* into D, the steam from D into C, and the steam from C into E, as indicated by the arrows. When the valve is slightly turned on its axis into the position indicated in Fig. 4, the steam from E flows through the other of the two ports *n* into C, the steam from C into D, and the steam from D into E, as indicated by the arrows, the direction of motion of the crank-shaft being reversed. A further rotation of the valve shuts off the flow of steam and arrests the movements of the engine.

The steam finds access successively to the spaces above the respective pistons C D E by passing from the space beneath the cap *k* down successively through the bored passages as the shanks *d* recede therein, and thence through a part of the valve. For example, in Figs 3 and 5[a] the course of the live steam is shown by the arrow. It is just entering the space above piston D through the port *n* (see Fig. 6,) on the right of its shank *d*. Thus, when the engine is running in one direction the live steam passes from a bored passage through the valve *p* to the port *n*, which is on the right of the contiguous left-hand bored passage, (see dotted lines, Figs. 6 and 7;) but when the engine is reversed the steam passes successively from each bored passage to the left of the contiguous right-hand bored passage. The exhaust takes place back through the same port *n* and valve *p* down through the shanks *d*, which latter cut off the live steam, and at the same time open an escape for the exhaust.

It will be understood the valve *p* is stationary when the engine is running, and is shifted only when it is desired to reverse the engine.

I do not confine myself to the tri-cylinder arrangement, as, for example, four cylinders might be arranged in a group with the crank-shaft midway between the two pairs of cylinders.

I do not claim a tri-cylinder engine such as is shown or described in Patent No. 176,823.

I claim—

In a tri-cylinder engine, the combination of pistons C D E, each having a shank, *d*, with a bored exhaust-passage extending from a side opening down through both the shank and piston, the steam-passages leading from each bore in which the shanks work down through the casting or frame of the engine to the cylinders, and the steam-chamber above the shanks, all as shown and described, whereby steam is admitted to the piston-cylinders in succession when the shanks *d* recede sufficiently for their upper ends to uncover the port, and the exhaust takes place alternately with admission of live steam through the side opening in the shanks and the passage extending vertically through them and the pistons, as specified.

W. WALKER.

Witnesses:

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HUGH G. GRANT.