(No Model.) 4 Sheets—Sheet 1.

F. E. SICKELS.

STEAM ENGINE.

No. 294,086. Patented Feb. 26, 1884.

Fig. 1.

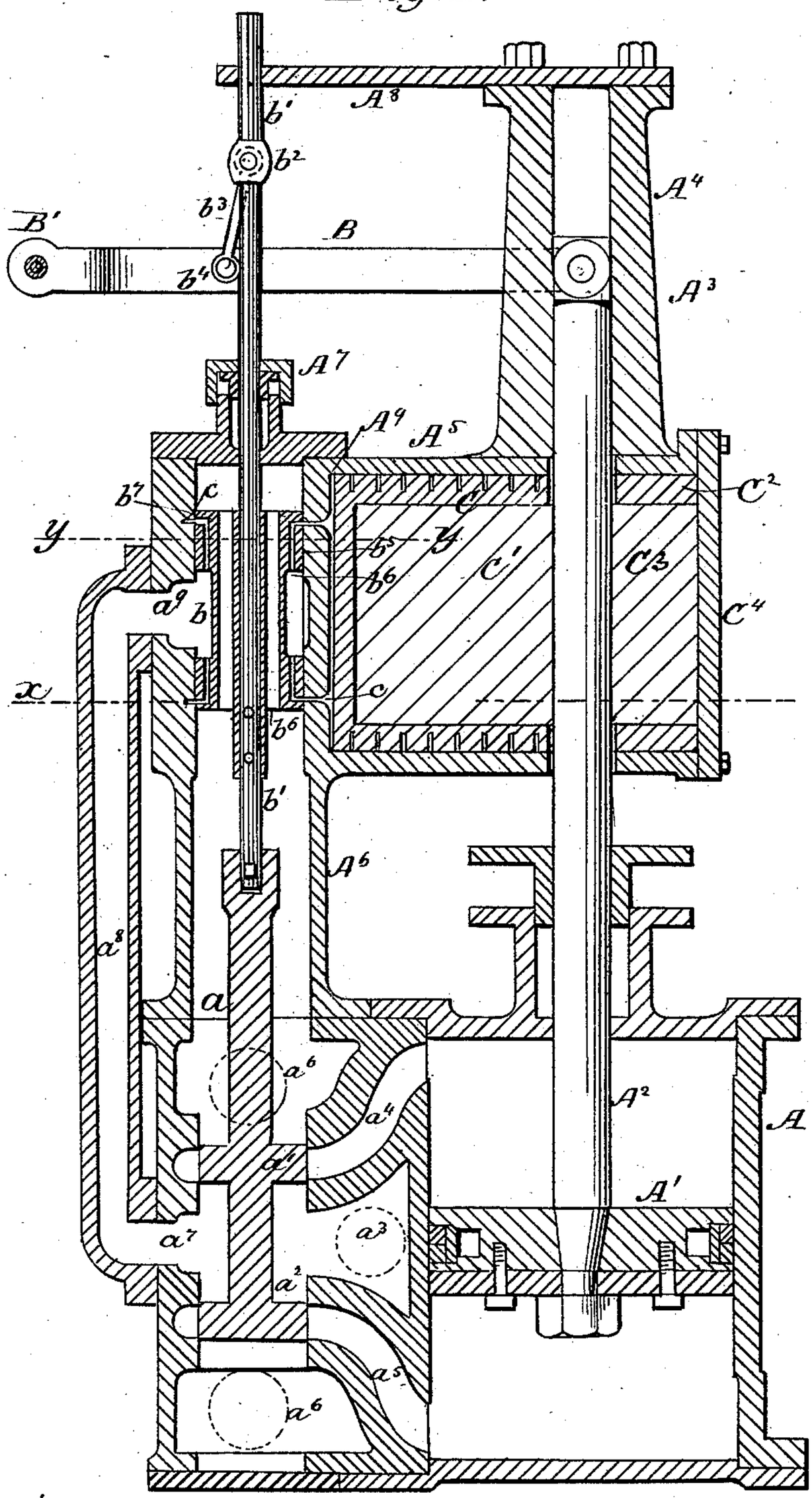

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Fig. 2.

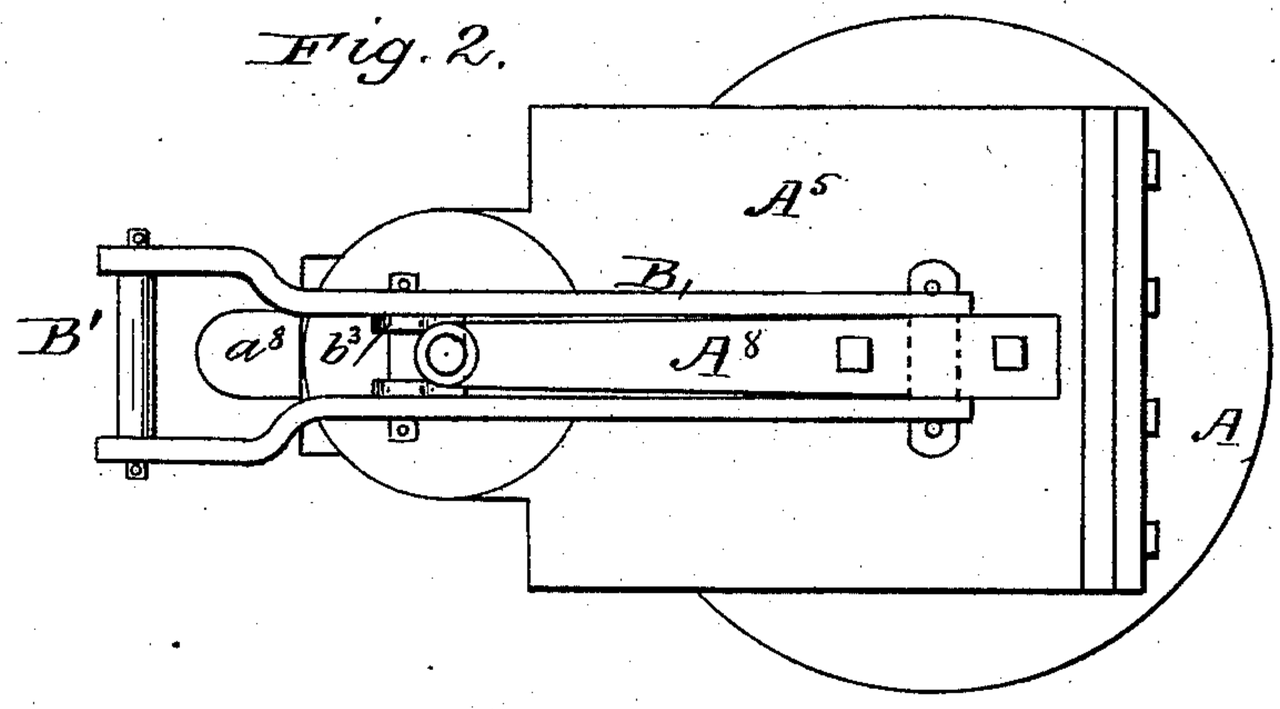


Fig. 3.

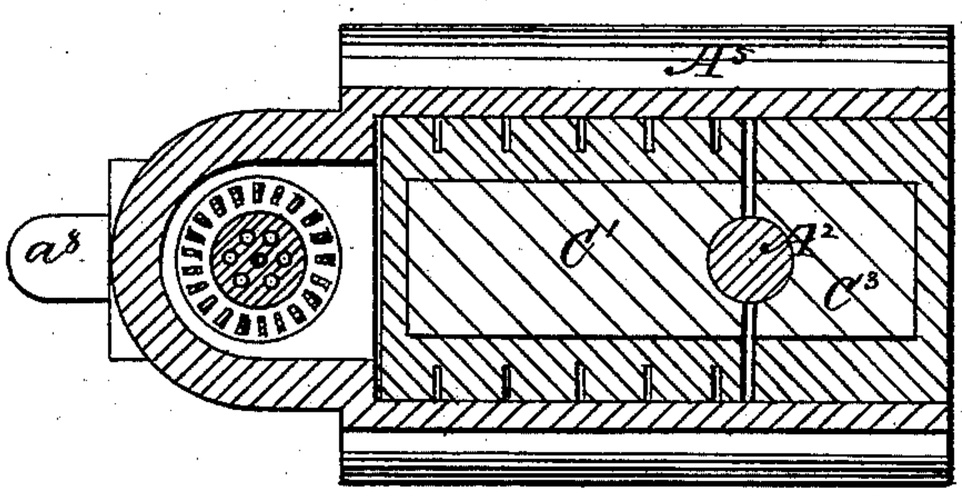


Fig. 4.

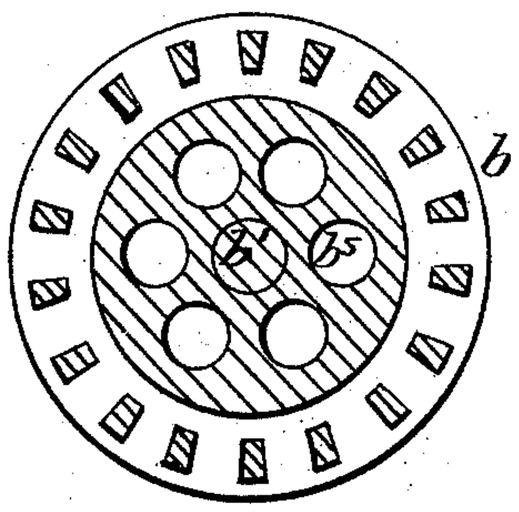
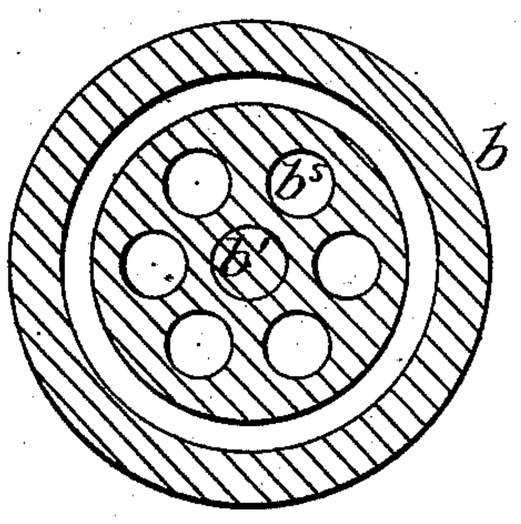


Fig. 5.



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4 Sheets—Sheet 3.

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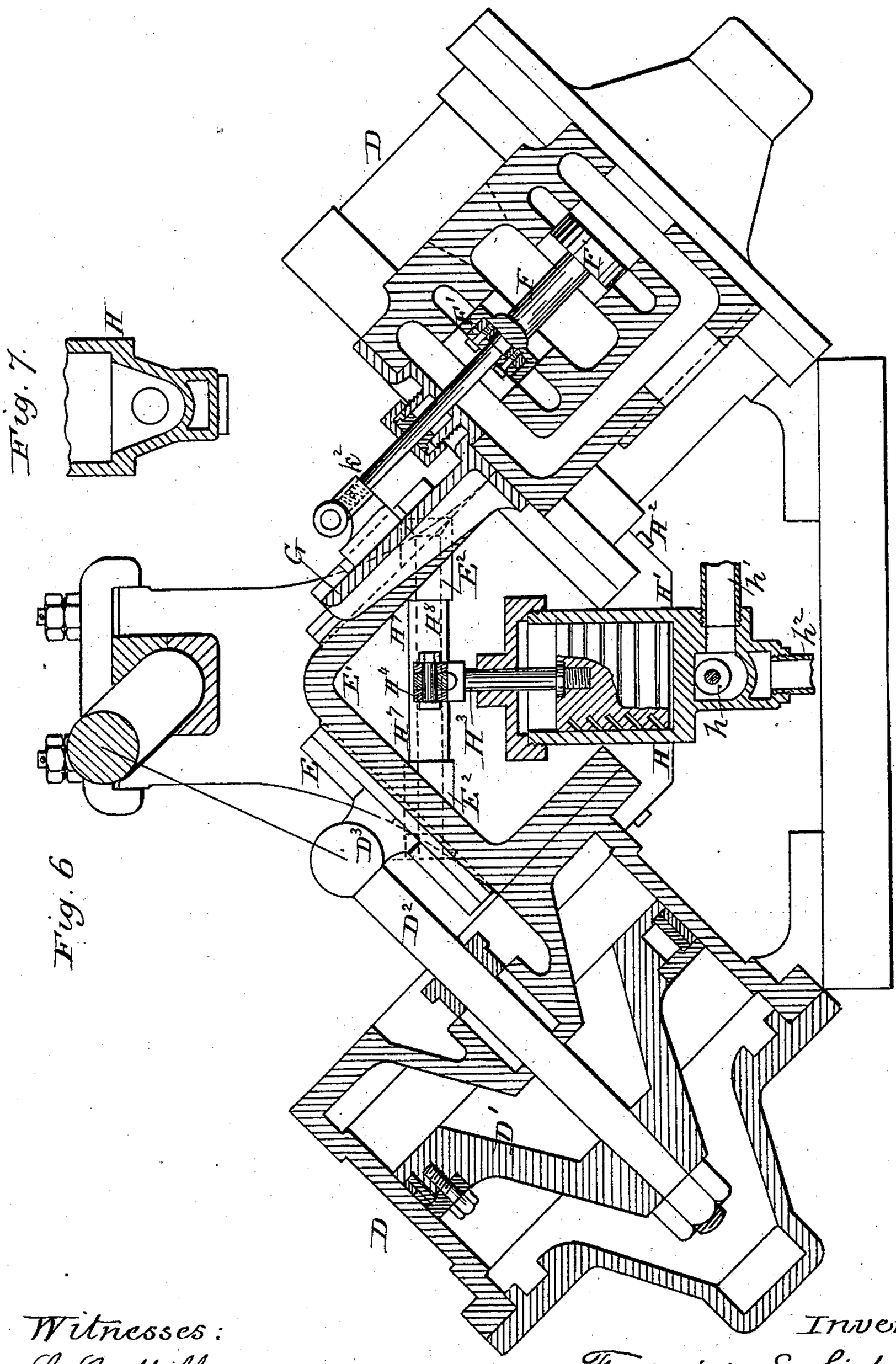

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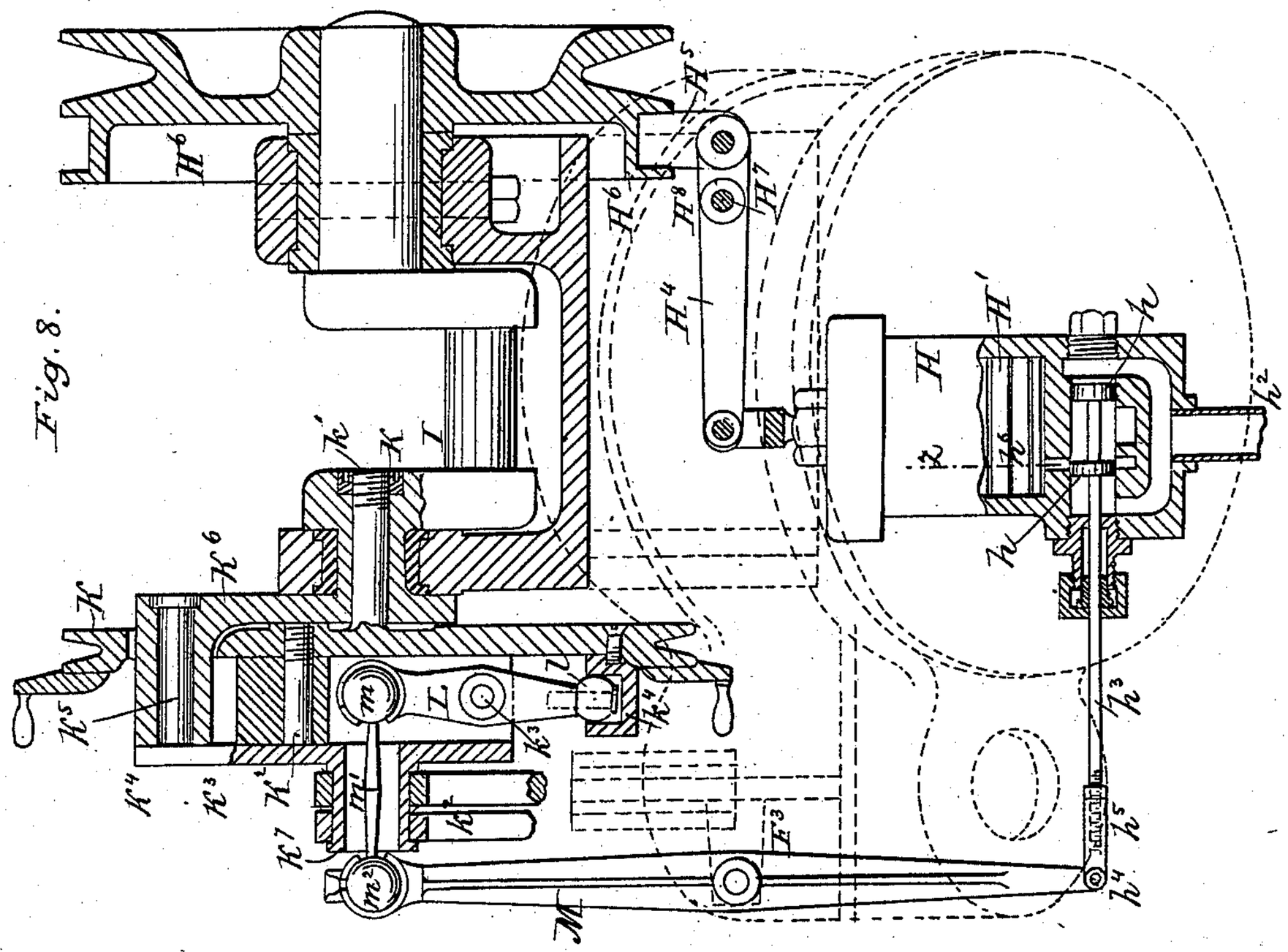

Fig. 8.

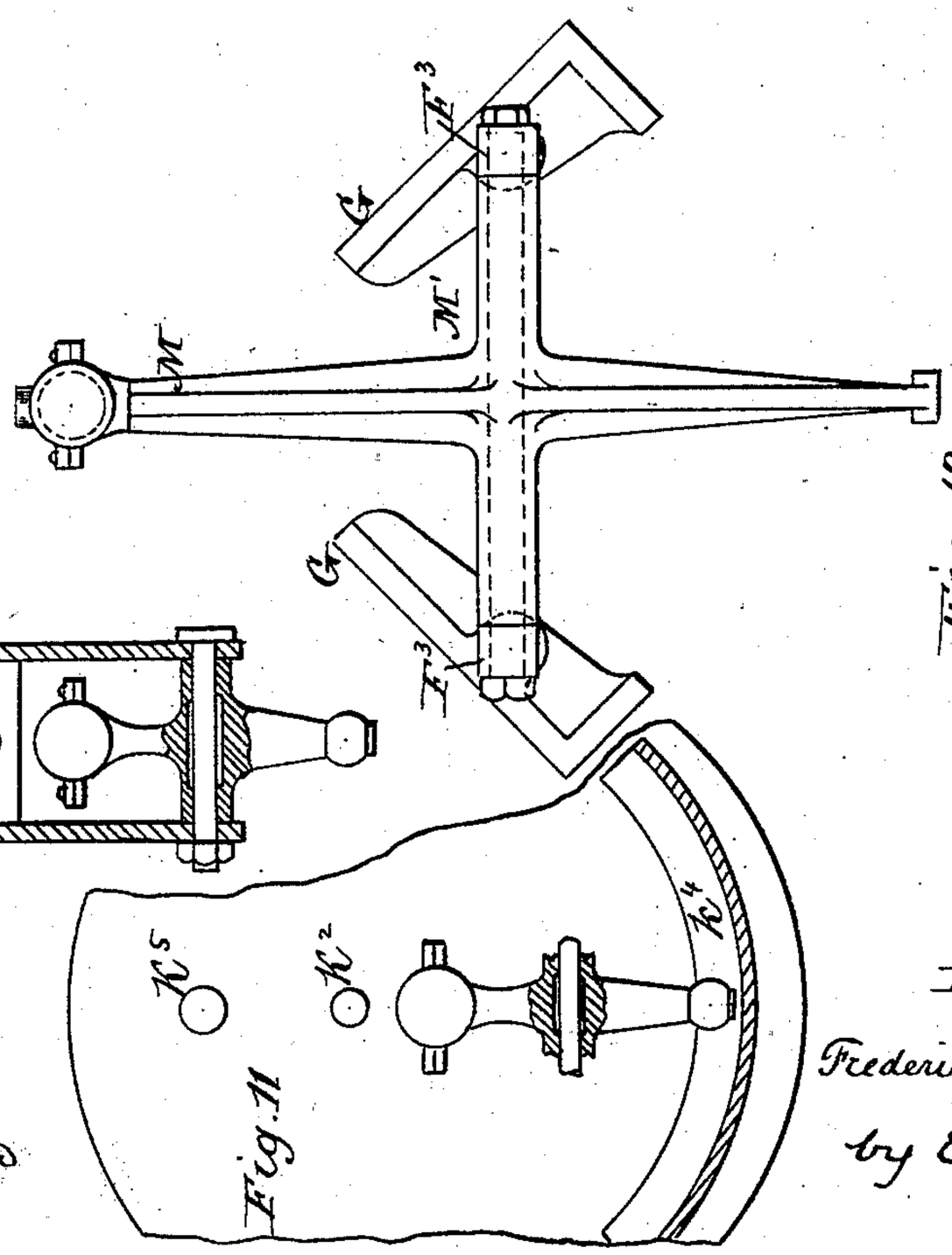

Fig. 9.

Fig. 10.

Fig. 11

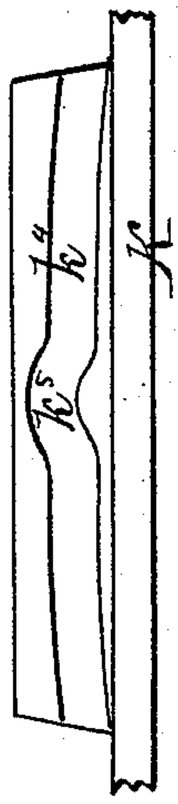

Fig. 12.

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UNITED STATES PATENT OFFICE.

FREDERICK E. SICKELS, OF NEW YORK, N. Y.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 294,086, dated February 26, 1884.

Application filed August 21, 1883. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK E. SICKELS, a citizen of the United States, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Steam-Engines, of which the following is a specification.

My invention relates to improvements on that class of steam-engines adapted to be controlled by the operator's hand, as described in the patent granted to me September 12, 1848, No. 5,765, which has what is there called a "regulating-connection," and it has variously been called a "sensitive valve-motion," or a "differential motion," and is also known by other names.

The objects of my improvements are to overcome the difficulties encountered in properly regulating this motion. One of these difficulties is caused by the steam, which, while it it is moving the engine and closing the steam-port, has a tendency to expand and force the piston farther than is required—*i. e.*, to "overrun," and thus reverse the motion and cause "jumping" or "dancing" of the piston, as it has been termed. This tendency to "jump" or "dance" is increased as the sensitiveness of the valve-motion is increased relatively to the motion of the piston.

The objects of my improvements are to overcome this tendency by means of an automatic steam-brake acting to stop the engine as the valve-motion comes to its central position, (and thus resist the expansive force of steam and the momentum of the moving parts,) and which brake is released as the valve-motion passes away from its central position and steam is applied to the driving-piston to produce motion in either direction. Now, as the automatic brake has to come into operation only as the main steam or admission ports are closed to stop the engine, and again be released as the steam-ports are opened, it must act with great rapidity at the moment it is desired to arrest the moving parts, and be as suddenly released as the main steam-ports are opened to cause the engine to move. I have heretofore applied a constant brake; but this entails, among other disadvantages, a constant resistance to be overcome while the engine is moving in doing its work. I now overcome this difficulty by means of a brake controlled by a valve operated by the same motion that applies the steam to move the engine, so as to preserve the same relative position of the main admission valve or valves, and what I call the "brake-valve."

In the accompanying drawings, Figure 1 is a vertical section of an engine having means for stopping the motion of the piston-rod, constructed according to my improvement. Fig. 2 is a top view of the same. Fig. 3 is a horizontal section through the line *x x* of Fig. 1. Fig. 4 is a transverse section of the steam-valve, taken on the same line as Fig. 3, but on a larger scale. Fig. 5 is a transverse section of the valve on line *y y* of Fig. 1. Fig. 6 represents a vertical section of a double-cylinder engine working on a crank-shaft, and having my invention applied thereto, the section being through one of the cylinders on one side and through the valve-chest on the other, and through the brake-cylinder, valve-chest, and valve. Fig. 7 is a transverse section of the brake-valve casing, taken through the steam-port on line *z z* of Fig. 8. Fig. 8 is a longitudinal vertical section of the double-cylinder engine. Fig. 9 is a front view of the vibrating arm used to operate the brake-valve, its supports being at each end of its long central trunnion. Fig. 10 is a rear view, partly in section, of the regulating-connection carrying the brake-valve-vibrating arm. Fig. 11 is a front view of the hand-wheel, having in section the cam used to operate the vibrating arm; and Fig. 12 is a top view of said cam.

The invention will first be described in connection with a single-cylinder engine, as shown in Figs. 1 to 5, inclusive.

In said drawings, A represents a cylinder; A′, the piston therein; A^2, the piston-rod, having at its upper extremity a square block, A^3, fitting against guides A^4, mounted upon a hollow cylinder, A^5, forming a part of the frame A^6. The cylinder A is provided upon one side with the piston-valve, having a stem, *a*, carrying disks *a′* and a^2 at a suitable distance apart. Between said piston-valve and the main cylinder are placed the steam-port a^3, between the passages a^4 and a^5, leading to the end of the cyl-

inders, respectively. At each end of the valve-chamber the exhausts a^6 are located. Upon one side of said valve-chamber there is an opening, a^7, to lead steam through a pipe, a^8, to a valve-chamber, a^9, containing a piston-valve, b, that I call a "brake-valve;" and the combination of said valve, the brake controlled thereby, and the main admission-valve forms the principal part of my invention. The valve b is connected to the stem b', secured to the end of the stem a of the main valve. It passes through a stuffing-box, A^7, and extends sufficiently above said box to be connected to a hand-lever, B, under the control of the operator. The upper end of the stem b is retained vertically or supported laterally by a guide, A^8, secured at one end to the top of the guide A^4. The hand-lever B is formed of two bars, pivoted at one end to the block A^3 at the upper end of the piston-rod A^2. The outer end of the lever B carries between the two bars a handle, B'. Upon the stem b' is secured a cross-head, b^2, having pivoted thereto the upper end of two small links, b^3, and the lower end of said links are pivoted at b^4 to the bars B of the hand-lever. The valve b is in the form of a cylinder, having a disk, b^5, at each end. The body of the cylinder b is provided with longitudinal perforations extending the whole length, for the passage of steam, and balance the pressure of steam upon the disks at the end of said cylinder. Each disk b^5 is provided with an annular groove, b^6, open toward the middle portion of the cylinder b. Said groove b^6 opens, adjacent to the outer end of the cylinder b, into a series of radial openings, b^7, placed around the periphery of each disk, to conduct steam into annular ports c, formed into the casing of the cylinder b, and this opening c leads into the end of a shallow cylindrical chamber, A^9, formed between the inner end of the cyllnder A^5 and the head of an interior metallic cylinder, C, within which is placed a wooden plug, C'. The cylinder C is provided with a semicircular groove in the outer end thereof, of sufficient size for the free passage of a piston-rod, A^2. Opposite the end of the cylinder C, and in continuation thereof, is placed an abutting-ring, C^2, and opposite the outer end of the plug C' is placed a wooden plug, C^3, to support one side of the piston-rod A^2 against pressure exerted against its opposite side by the wooden plug C' under the action of steam admitted in the chamber A^9. The abutting ring C^2 and plug C^3 are sustained and kept in position by means of a cap, C^4, bolted to the end of the cylinder A^5.

The parts C C' form the brake mechanism against the piston-rod A^2 by means of steam acting against the head of the cylinder C, as shown in Fig. 1, in which position the brake is shown as applied to the engine. If it is desired to release the engine and admit steam above the piston, for example, the operator lifts the handle B' a short distance. This elevates the stem b' a corresponding but smaller distance and brings the steam-port b^7 of the valve b above the annular ports C in the casing of said valve, and thus shuts off steam from both passages, and consequently from the chamber A^9, at the same time opening the lower passage, c, into the exhaust-chamber of the valve b, but under said valve, permitting the steam in the chamber A^9 to exhaust and escape through the ports a^6. The brake is thus released from its action upon the piston-rod A^2, and the piston can move downward without impediment until the head A^3 has become lowered enough, as well as the end of the hand-lever connected thereto, to lower the steam-valve b' by means of its links b^3, and thus bring the valve b, attached to said stem, again to the position shown in Fig. 1. The passages b^7 are thus brought again in line with the ports c, through which steam is admitted to the chamber A^9, against the head of the brake-cylinder C, and its plug C', bearing against the piston-rod, clamps it and arrests its motion. At the same time the stem a' of the valve of the main cylinder is brought down, and each disk a' a^2 closes the passage a^4 a^5, holding the engine at rest in that position until the handle is again moved.

In Figs. 6 to 12 the same invention is shown applied to a double-cylinder engine suitable for steam-steering and other purposes, which engine is substantially as shown in my patent of December 27, 1881, No. 251,477. In said figures the main cylinders are shown at D, each one being provided with a piston, D', piston-rod D^2, and cross-head D^3, the latter being retained by guides E, attached to the frame E'. Each cylinder is provided with steam and exhaust ports controlled by the piston-valve F, having a disk, F', at each end thereof. Each valve-stem is kept in position by guides G, bolted to the end of each steam-chest. The brake-cylinder H and its piston H' are placed between the main cylinders D, the cylinder H being bolted to the flange of the cylinder D at H^2. The brake-valve controlling the motion of the brake-piston H is a piston-valve having two disks, h, adapted to move longitudinally into the valve-chamber. Steam is admitted into said chamber through the pipe h' on the side thereof, and exhausts through the pipe h^2 into the bottom thereof. The valve-stem h^3 is controlled by the operator, as will be hereinafter explained. The brake-piston H' is provided with a stem, H^3, at the upper end of which is pivoted one end of the lever H^4, while the opposite end is connected with the brake-strap H^5, passing around the brake-wheel H^6. The lever H^4 has secured thereto, between its two ends, two transverse sleeves, H^7, one on each side thereof, through which passes a journal, H^8, pivoted within two boxes, E^2, projecting from the frame E', the latter being shown in Fig. 6.

The valve-stem h^3 is operated as follows: Within the axle of the main crank I passes the journal k of the hand-wheel K, said journal

being retained connected to the crank by means of the nut k', set in a recess in the crank. To the side of the hand-wheel K is secured a crank-pin, K^2, upon which is placed the sliding block K^3, that gives motion to the link or regulating connection K^4. This link carries a pin, K^5, that is pivoted to a crank, K^6, upon the engine-shaft. It carries, also, a hollow journal, K^7, upon which is mounted the valve-connecting rods k^2, leading to the main valves of the engine. To this link K^4 is pivoted at k^3 the vibrating arm L, the outer end of which is provided with a spherical roller, l, resting in a segmented trough, k^4, (see Figs. 11 and 12,) secured to the side of the hand-wheel K. This trough has in the middle of its length an outwardly-diverging projection, k^5, to throw the outer end of the arm L outwardly from the wheel K. The outer ends of the trough k^4 are slightly curved inwardly to make up for the vibration of the arm L while moved by the block K^3. The inner end of the arm L is provided with a spherical socket, to receive one end of the ball-shaped head m of the connecting-rod m', passing through the hollow journal K^7. The outer end of the connecting-rod m has also a ball-shaped head, m^2, that is received into the spherical socket of the vibrating arm M. This arm M is provided with hollow trunnions M', through which passes a bearing-bolt, secured at each end to ears F^3, cast upon the valve-guides G. The lower end of the arm is connected to the valve-stem h^3 at h^4, where a screw-socket, h^5, is provided, so that the length of the valve-stem can be regulated.

The operation is as follows, the parts being as shown in Figs. 6 and 8, in which the valves are shown in the middle portion and the brake on: If it is desired to start the machine, the operator takes hold of one of the handles upon the wheel K, and, moving it a short segment of a circle upon its shaft, slightly moves the pin K^2 to one side, and said pin moves the block K^3 in the same direction, and said block moves the link K^4 in the same direction and moves the arm L in the same direction, the lower end of said arm passing beyond the projection k^5 in the trough, and is moved in toward the engine. This throws the rod m' outwardly, causing the arm M to rock upon its journal and bring its lower end toward the engine, and with it the stem h^3 of the brake-valve, that closes the port h^6 against the entrance of live steam and opens it for the escape of steam already in the brake-cylinder H, and this releases the brake. In the meantime, the steam-valve having been moved by the vibration of the hollow journal K^7, attached to the link K^4, steam is applied to the engine, causing it to move in the same direction that the handle had been moved, until the link is vibrated so as to bring the valve driving pin or hollow journal K^7 back to the position from which it started, and as shown in the drawings, in which position the main steam-valves are again closed and the brake-valve has again moved and applied steam to the brake-cylinder and put on the brake.

Instead of the steam applying the brake, the brake may be released by the steam if a weight is employed to set the brake, it being only necessary to reverse the action of the brake-valve; or a spring may be substituted for a weight. This weight or spring should be attached to the brake-lever or brake, to put on the brake when the steam is used to hold it off.

Instead of the brake-cylinder and piston, any receptacle capable of having a movement under the pressure of steam may be used to operate the brake—such as a bellows, reservoir, or an elastic diaphragm—as the motion necessary to set and release the brake can be very small, and the brake can be made like a clutch, to hold and release the engine by positive or yielding stops, it being preferable to arrest the engine with a stop nearly positive, and yet having enough elasticity to avoid a violent jar as it comes into action.

Air or any elastic gas under pressure may be used instead of steam with an engine having a brake-valve and brake, substantially as herein described, as the jumping or dancing is liable to occur with any elastic gas, and will be corrected by the action of the automatic brake-valve and brake, as herein shown, when they are combined with a sensitive valve-motion in the operation of a steam-engine having such sensitive valve-motion, either on a single or double engine working with one, two, three, or more distributing and reversing valve or valves, and having simple or complex movements and connections to these valves, as the jumping or dancing is created by the joint action of the expansion of the propelling-gas and the momentum of the moving parts, and this excess of motion can be corrected by a brake-valve and brake acting to stop the engine, as the jumping or dancing is liable to occur without regard to the number and kind of valves and connections that may be used in the engine or engines. The operation is only required to encounter the additional resistance offered in working a small valve to apply or release the brake while encountering the resistance due to the friction of the admission valve or valves. In cases where a valve or valves are used to reverse the action and separate distributing valve or valves are used in connection therewith, the brake-valve must be set to apply and release the brake, as the reversing valve or valves alter the distribution of the steam to produce motion of the engine in either direction; and the kind of brake-valve shown in Figs. 1, 2, 3, 4, and 5 may be used, as it releases the brake in moving either way from a central position, while the reversing valve or valves would give steam in moving in either direction from a central position.

When a cam is used to operate the brake-valve, as in Fig. 12, the shape of the cam may be made to suit the valve, as shown in Fig. 8, which moves only in one direction to release

the brake. If a valve is used, as shown in Figs. 1, 2, 3, 4, and 5, the cam may be made to move it both ways from a central position to release the brake. The brake-valve must be adjusted to apply the brake, as the valve or valves controlled by the sensitive valve-motion shut off the supply of steam in bringing the engine to a state of rest, and the greater the number of valves between the boiler and the steam-piston the less (other things being equal) dancing will occur. The brake may bear continuously and be only set tight by the action of the brake-valve as the dancing is likely to occur.

In steam-engines having two cylinders, with distributing valve-gear to each cylinder, and the passages brought together, so that one main reversing-valve operated by a differential or sensitive valve-motion is used for both cylinders, the brake-valve should be connected to this sensitive valve-motion, so that as the reversing-valve closes the brake-valve will apply the brake or allow it to act so as to stop the engine and prevent dancing; but the tendency to dance will depend on the sensitiveness of the reversing valve-motion as compared with the motion of the engine as modified by the extent of the passages between the various valves. The tendency to dance will increase with the promptness with which the pressure of steam is reversed upon the piston or pistons of the engine or engines, other things being equal, and the brake-valve must be set to act with greater promptness as the tendency to dance increases, so as to stop the engine before it moves far enough to reverse the steam and jump back or dance, thus fixing the position of the piston with a degree of accuracy that would be otherwise unattainable with the use of a sensitive valve-motion alone, and at the same time allowing the operator to work the engine with ease.

Having now fully described my invention, I claim—

1. In a steam-engine, a valve mechanism constructed substantially as described, and so combined with a brake-valve as to act automatically to apply the brake, substantially as set forth.

2. In a steam-engine, a brake-valve connected with the main valve and automatically operated by the valve mechanism of the main valve to apply the brake, substantially as described.

3. In a steam-engine, a brake-cylinder and brake-valve connected with and automatically operated by the valve mechanism of the engine to apply the brake, substantially as described.

4. In a steam-engine, the combination of a brake-lever and its connection, as described, a brake-valve, and operating mechanism to automatically admit the steam upon the brake-piston to apply the brake, substantially as described.

5. In a steam-engine, the combination of the main steam and exhaust passages, a steam-brake cylinder, and steam-passages leading thereto, with a brake valve and lever to automatically apply the brake controlling the steam to the main and brake cylinders, substantially as described.

6. In a steam-engine, the combination of a brake with a valve mechanism, constructed substantially as described, which valve mechanism is adapted to be moved by the operator to start the engine and release the brake, and is automatically moved to stop said engine, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

FREDERICK E. SICKELS.

Witnesses:

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L. C. HILLS.