No. 692,657. Patented Feb. 4, 1902.

W. H. HARRISON.

STEAM ENGINE INDICATOR.

(Application filed Feb. 26, 1900.)

(No Model.)

FIG. 1.

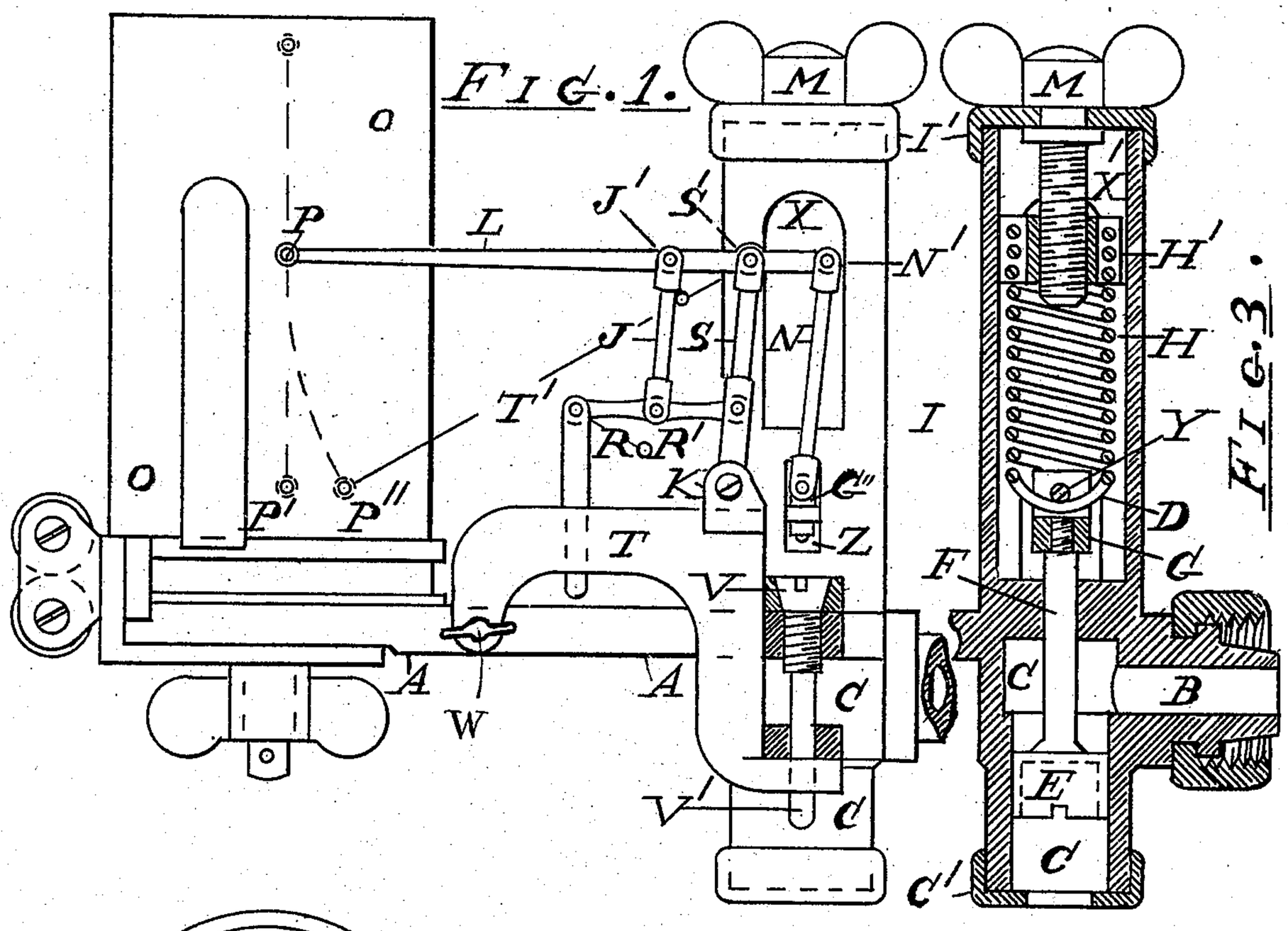


FIG. 3.

FIG. 2.

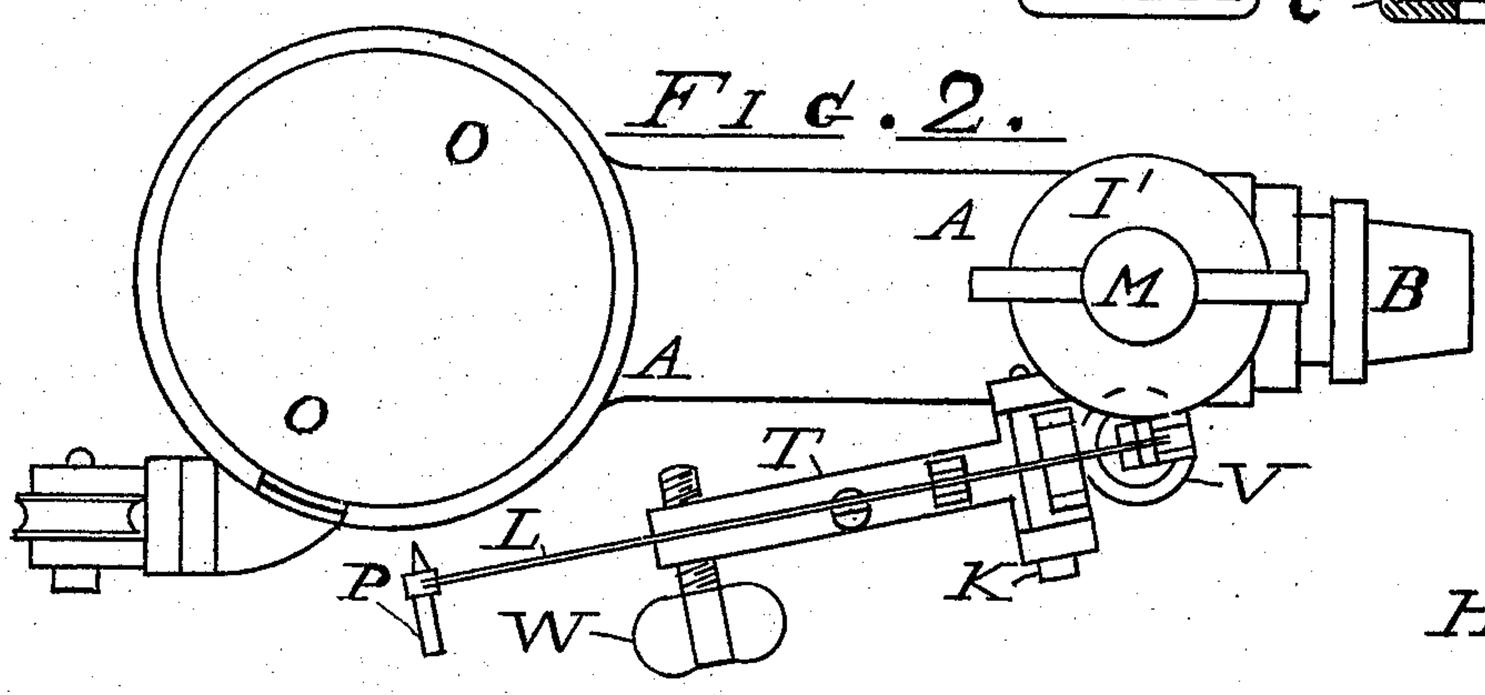


FIG. 4.

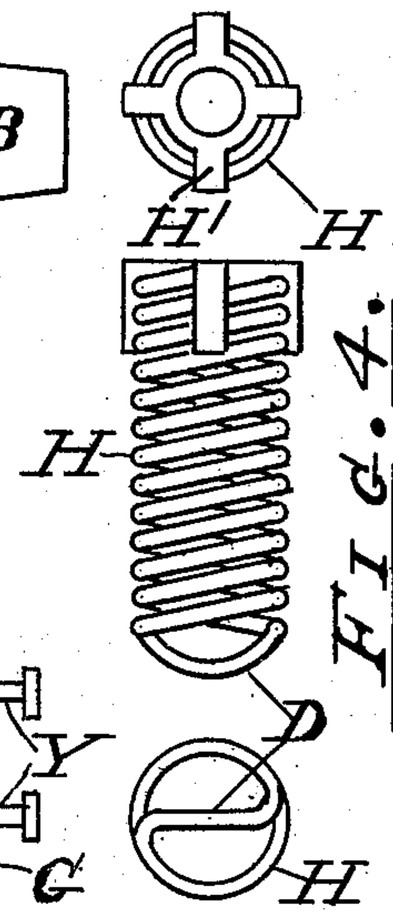
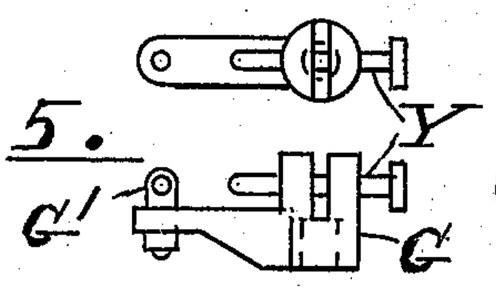


FIG. 5.



WITNESSES:

William C. Harrison.

Thomas P. Harrison

INVENTOR.

William H. Harrison

UNITED STATES PATENT OFFICE.

WILLIAM H. HARRISON, OF BRAINTREE, MASSACHUSETTS.

STEAM-ENGINE INDICATOR.

SPECIFICATION forming part of Letters Patent No. 692,657, dated February 4, 1902.

Application filed February 26, 1900. Serial No. 6,451. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM HENRY HARRISON, of Braintree, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Steam-Engine Indicators, of which the following is a specification.

My invention relates to that class of steam-engine indicators in which the range of the motion of the strong and heavy parts, (the piston, the piston-rod, and spring,) made small to avoid false vibrations, is multiplied by a lever combined with a parallel motion of very light weight, causing the pencil at the end of the lever to move up and down in a straight line parallel to the axis of the drum.

This specification refers to improvements in that invention described in United States Letters Patent issued to me August 22, 1899, No. 631,463, for a steam-engine indicator. In that patent claim 4 reads: "The piston E and piston-rod F in the cylinder C C having at its closed top an inlet B above said piston E for the working fluid and at the bottom a free passage to the atmosphere," and that claim covers a novelty in design which renders possible my other improvements.

In the drawings with this specification, Figure 1 represents an elevation with the spring removed and a small section at the right through the lugs of the swing-arm; Fig. 2, a plan; and Fig. 3, a vertical section parallel to the front, taken through cylinder, inlet-pipe, cross-head, spring, and spring-case. Fig. 4 shows three views of my improved spring, and Fig. 5 two views of the cross-head. All the views are full-sized working drawings; but I do not limit myself to the dimensions or proportions there shown or given in the text.

A A represent the principal piece or base, having the cylinder C C, the inlet-pipe B, and the spring-case I at the right, all these being very conveniently formed in one piece of metal.

O O represent the closed drum for the paper, with its grooved wheel and small pulleys for the cord at the left.

The inlet-pipe B is fitted with the usual cone-joint union to connect with suitable cocks on an engine or pump. The fluid-pressure from an engine or pump brought through the inlet B into the closed-top cylinder C C above the piston E forces the piston downward, and the piston-rod F, which passes with a sliding fit, allowing a slight leak through the thick top of the cylinder C C and threaded into the bottom end of the boss G of the cross-head G G′, as shown in Fig. 3. The cross-head G G′ has the single arm, which makes it of light weight and small frictional surface. The arm projects through the front slot Z and has a small eye at G′, in which is mounted a swivel G″, with a knuckle-joint connection for the motion-link N. The top of the boss G of the cross-head G G′ is slotted down sufficiently to allow a free entrance for the foot D of the double coil-spring H and also to admit the pin Y above the foot D, as shown in Fig. 3. This is the connection which causes a tension in spring H and a resistance to the motion of the piston E. The pin Y is easy to insert and remove with the fingers, and the head shown in the drawings is to facilitate this. The head H′ of the spring H threads on the range-screw M. The range-screw M is supported by the spring-case head I′, and its vertical axis coincides when in place with the axes of the cylinder C C, the piston-rod F, and the spring-case I. I′, the head of the spring-case I, is threaded on with a free fit. The lead or pitch of the thread in the head I′ should be the same as on the range-screw M to avoid cramping when the two are run down together.

C′ is a rim with a free passage from cylinder C C to the atmosphere for the escape of the fluid leakage around the piston E. This rim C′ is a safety-catch for the piston and is not a necessity for the correct working of the instrument. It is threaded with a free fit on the bottom of the cylinder C C and may be exchanged for a dust-proof cap when required. A free passage to the atmosphere from the side of the piston opposite to which the steam is applied is an important detail in any indicator. A steam-tight piston which is at the same time free from friction in its cylinder is practically an impossible thing, so to avoid the friction we allow the piston to leak around its edge, and this leakage becomes greater as we run up into high pressures. If there be too much constriction of the outlet-passage, the pressures will back up against the piston to an unknown intensity, and the pressure shown by the diagram will be less than is in

the working cylinder. Hence we find in the old instruments attempts made toward a free passage to the atmosphere which were not always successful, the passage being too small or too crooked in consequence of constructional difficulties or ignorance of the true requirements.

In Fig. 1, I is the ventilated spring-case, having the vertical front slot Z, which controls and limits the motions of the single-arm cross-head G G′. The arch-topped front opening X is matched by a similar opening X′ at the back in Fig. 3, which comes down the full depth of the spring-case I, but is mostly concealed behind the spring H and attachments. The opening X′ facilitates the insertion and changing of my improved double-coil spring H and the pin Y. T is the new swing-arm, having lugs at V and V′ on the right, which match with similar lugs formed on the cylinder C C. The drop at the left is to allow the adjusting-screw W to engage the edge of the base A A. The pivot-screw V V′ has its axis coincident with the center of the eye at G′ on the cross-head G G′ and parallel to the axis of the cylinder C C. The pivot-screw V V′ permits the swing-arm T to swing smoothly through a semicircle in a plane parallel to the base A A and also enables a small friction to be put on to prevent too free a motion. K is a journal carrying the lower end of the fulcrum-link S. The toggle-bar R′, constituting a part of the parallel motion, is jointed at one-third the whole height of fulcrum-link S. Consequently the horizontal motion from the toggle-bar R′ will be multiplied by three at the fulcrum S′ of the lever L. At T′ on the swing-arm T is jointed the toggle-bar R. These toggle-bars R and R′ must be of equal length and also equal center to center the distance S′ to J′ on the lever L. In this drawing the distance S′ J′ is one-sixth the distance S′ P, which is the long arm of the lever L; but other ratios may be used. At J′ is jointed the pendent link J, having a length equal to two-thirds the length of the fulcrum-link S. The joint at T′ has its center at the same height above the base A A as the center of the joint in fulcrum-link S, which carries the end of the toggle-bar R′. The toggle-bars R and R′ are united by a free joint in the lower end of the pendent link J, which carries the vertical motion of J′ and which is in amplitude one-sixth the vertical distance moved by the pencil F on the drum O O on account of the ratio of the lever lengths S′ J′ to S′ P. Considering for an instant the pendent link J as removed and the fulcrum S secured against shifting, swing the pencil P downward through an arc of thirty degrees and mark on the paper the dotted line P P′, which is the segment of a circle. Consider now the pendent link J in its place, as shown in the drawings. The pencil P on being moved down through the arc of thirty degrees will mark the dotted straight vertical line P P′ and, moving the lever L through an angle of elevation of thirty degrees, will produce an equal upward extension of the line P′ P, and the horizontal motion to the right of the pencil P, represented by the distance P′ P″, has been balanced by an equal motion to the left of the lever-fulcrum S′. The toggle-bar R being one-sixth the length of the long arm S′ P of the lever L and the vertical motion from the pendent link J being also one-sixth the vertical motion of the pencil P, the angle of elevation or depression for the toggle-bar R is always equal to that of the lever L and the horizontal motion of the right-hand end joint of the toggle-bar R is always one-sixth of the horizontal motion of the pencil P, but in the opposite direction. The toggle-bar R′, swinging also through the same angle as the lever L, produces a sixth of the horizontal distance of the motion of pencil P, and the two bars R and R′ counted together produce a motion at the end joint of the bar R′ in the fulcrum-link S equal to one-third the horizontal motion of pencil P. I have shown the lever ratio in the fulcrum-link S to be three. Then one-third multiplied by three equals one. Consequently the horizontal distance which the pencil P makes in swinging naturally on its lever L through any vertical arc is opposed and balanced by an equal horizontal motion of the fulcrum S′, and the pencil P is constrained to move in the straight vertical line P′ P and extension, and my construction is a true parallel motion within the limits of thirty degrees of elevation and depression and a free-working end for the lever L.

It is easy to construct a working indicator with "a piston E and piston-rod F in the cylinder C C having at its closed top an inlet B above said piston E for the working fluid and at the bottom a free passage to the atmosphere" and bring the motion of the piston E by a suitable piston-rod up through the center of the spring-case head I′, the head H′ of the spring H being threaded direct to the head I′. To do this requires the cylinder C C and spring-case I to be moved down until the flange of the spring-case head I′ clears the top of the bed A A by a half inch or less, which space is filled by a sleeve formed on the swing-arm T and, encircling the spring-case I with a free fit, keeps the lower joint of the motion-link N concentric with the common axis of spring-case I and cylinder C C and permits the swing-arm T and its attachments to move through a large arc parallel to the base A A. This design, however, is not so compact and symmetrical as that shown in my present drawings. In my former patent, No. 631,463, I showed the single-coil spring H with nuts K and K′ to match with cross-head G G′ and range-screw M, working mostly in tension; but the point of attachment of this single-coil spring H is at the side of the nut K, where the wire takes a fair hold in the nut, and the axis of the tension coincides with neither the axis of the spring nor the piston-rod F. The

one-sided action of the single-coil spring H presses the piston-rod F to the side, producing friction and a halting motion for the pencil P. In my present drawings, Fig. 4 shows three views of my improved double-coil spring, which has for its foot D a curve formed in the middle of the wire. The remainder of the wire being wound in two separate spirals, like the threads of a double-threaded screw, forms the body H, which is the elastic part. With this construction when in use the strain at one side is balanced by an equal strain at the other side, and the resultant is a true vertical tension in the axis of the cylinder C C, and there is no tendency to make friction on the piston-rod F or the piston E. The head H′ of the spring is externally made to hold firmly about a turn of each spiral and internally threaded to match the range-screw M or other suitable connection in an indicator.

I am aware of Patent No. 256,281 to Gilman W. Brown, entitled "Spring connection for indicator-pistons." Brown here shows a single wire wound in two separate spirals, with the middle part of the wire, which is the lower end of his spring, made straight and fitted with a small ball at the middle for centering. My spring differs from Brown's by the lower end, which I call the "foot" D, being curved in the wire for the easy insertion of the pin Y, which renders the centering-ball of Brown unnecessary and the spring cheaper to make. The Brown spring was the best possible for working in compression inside the cylinders of the old indicators. It is now known to those who have investigated that a spring inside the cylinder, as in the old indicators, is annealed by the great temperature of modern high-pressure steam and permanently loses its spring temper whether it be in steel or hard-drawn wire; also, with any spring working in compression the piston has a tendency for pressing sidewise, making undue friction. These are my reasons for putting the spring outside the cylinder and working it in tension.

I claim as my invention—

1. In a steam-engine indicator, a base A A, a drum O O, and a pencil-moving mechanism having the motion-link N jointed to the swivel G″ and to the end of the lever L, in combination with the lever L bearing the pencil P, the fulcrum-link S, the pendent link J, the toggle-bar R, the toggle-bar R′, the swing-arm T, and the pivot-screw V V′, concentric with the said swivel G″.

2. In a steam-engine indicator a pin Y, in combination with the cross-head G G′ having the boss G slotted at the top and internally threaded at the bottom, the spring H, the piston-rod F, and the piston E.

3. In a steam-engine indicator, a spring having the foot D formed by a curve in the middle of a single wire, and the elastic part or body H wound in two separate spirals from the remainder of the wire with the internally-threaded head H′, in combination with a cross-head G G′, having the boss G slotted at the top and internally threaded at the bottom, the piston-rod F, and the piston E.

4. In a steam-engine indicator, a cross-head G G′ having the boss G slotted at the top and internally threaded at the bottom, and the swivel G″, in combination with the piston-rod F, and the piston E.

5. In a steam-engine indicator, a base A A, a drum O O, a piston E and piston-rod F in a cylinder C C having at its closed top an inlet B above said piston E for the working fluid and at the bottom a free passage to the atmosphere, a spring-case I, a spring H, and a cross-head G G′ with a swivel G″, in combination with a pencil-moving mechanism having the motion-link N jointed to the swivel G″ and to the end of the lever L, the lever L, the fulcrum-link S, the pendent link J, the toggle-bar R, the toggle-bar R′, the swing-arm T, and the pivot-screw V V′ concentric with said swivel G″.

6. In a steam-engine indicator, a base A A, a drum O O, a piston E and piston-rod F in a cylinder C C having at its closed top an inlet B above said piston E for the working fluid and at the bottom a free passage to the atmosphere, a spring-case I, and a range-screw M, in combination with a spring having the foot D formed by a curve in the middle of the wire and the elastic part of body H wound in two separate spirals from the remainder of the wire with the internally-threaded head H′, a cross-head G G′ having the boss G slotted at the top and internally threaded at the bottom, the pin Y, and the swivel G″, and a pencil-moving mechanism having a motion-link N jointed to the swivel G″, and to the end of the lever L.

7. In a steam-engine indicator, a base A A, a drum O O, a piston E and piston-rod F in a cylinder C C having at its closed top an inlet B above said piston E for the working fluid and at the bottom a free passage to the atmosphere, a spring-case I, and a range-screw M, in combination with a spring having the foot D formed by a curve in the middle of the wire and the elastic part or body D wound in two separate spirals from the remainder of the wire with the internally-threaded head H′, a cross-head G G′ having the boss G slotted at the top and internally threaded at the bottom, the pin Y, and the swivel G″, a pencil-moving mechanism having the motion-link N jointed to the swivel G″ and to the end of the lever L, the lever L, the fulcrum-link S, the pendent link J, the toggle-bar R, the toggle-bar R′, the swing-arm T, and the pivot-screw V V′ concentric with said swivel G″.

8. In a steam-engine indicator, a base A A, a drum O O, a piston E and piston-rod F in a cylinder C C having at its closed top an inlet B above said piston E for the working fluid and at the bottom a free passage to the atmosphere, a spring-case I, a spring H, and an

upward central extension of the piston-rod F, in combination with a pencil-moving mechanism having the motion-link N jointed to an upward extension of the piston-rod F and to the end of the lever L, the lever L, the fulcrum-link S, the pendent link J, the toggle-bar R, the toggle-bar R′ and the swing-arm T with a sleeve encircling the spring-case I.

9. In a steam-engine indicator, a pivot-screw V V′ having its axis concentric with the swivel G″ on the cross-head G G′ and parallel to the axis of the cylinder C C, and threaded into the lug formed on said cylinder C C having the conical head V and the cylindrical tail V′, in combination with the two lugs on the swing-arm T, and a pencil-moving mechanism.

10. In a steam-engine indicator, an adjusting-screw W threaded in a hole through a downwardly-projecting end of the swing-arm T, in combination with the base A A, the drum O O, and the lever L bearing the pencil P movable angularly with the swing-arm T.

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

WILLIAM H. HARRISON.

Witnesses:
WILLIAM C. HARRISON,
WALTER T. HARRISON.