(No Model.)

A. F. HALL.

STEAM ENGINE INDICATOR.

No. 538,515. Patented Apr. 30, 1895.

Fig. 1.

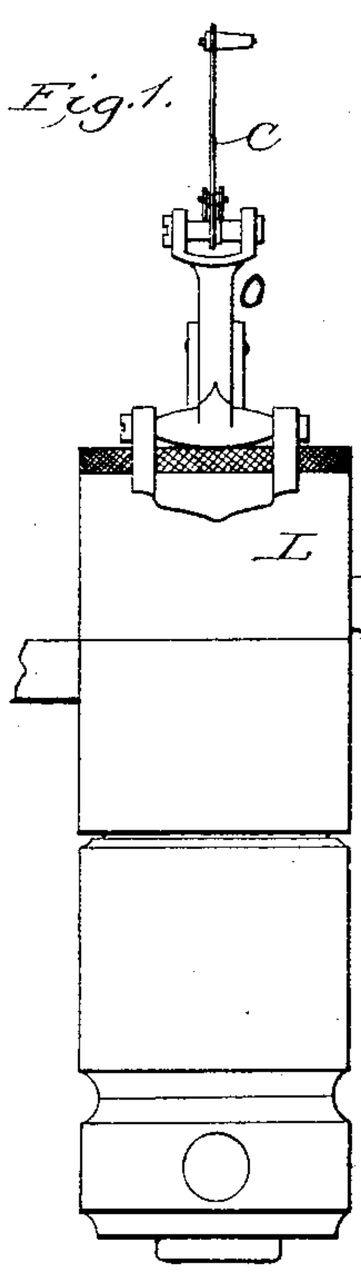


Fig. 2.

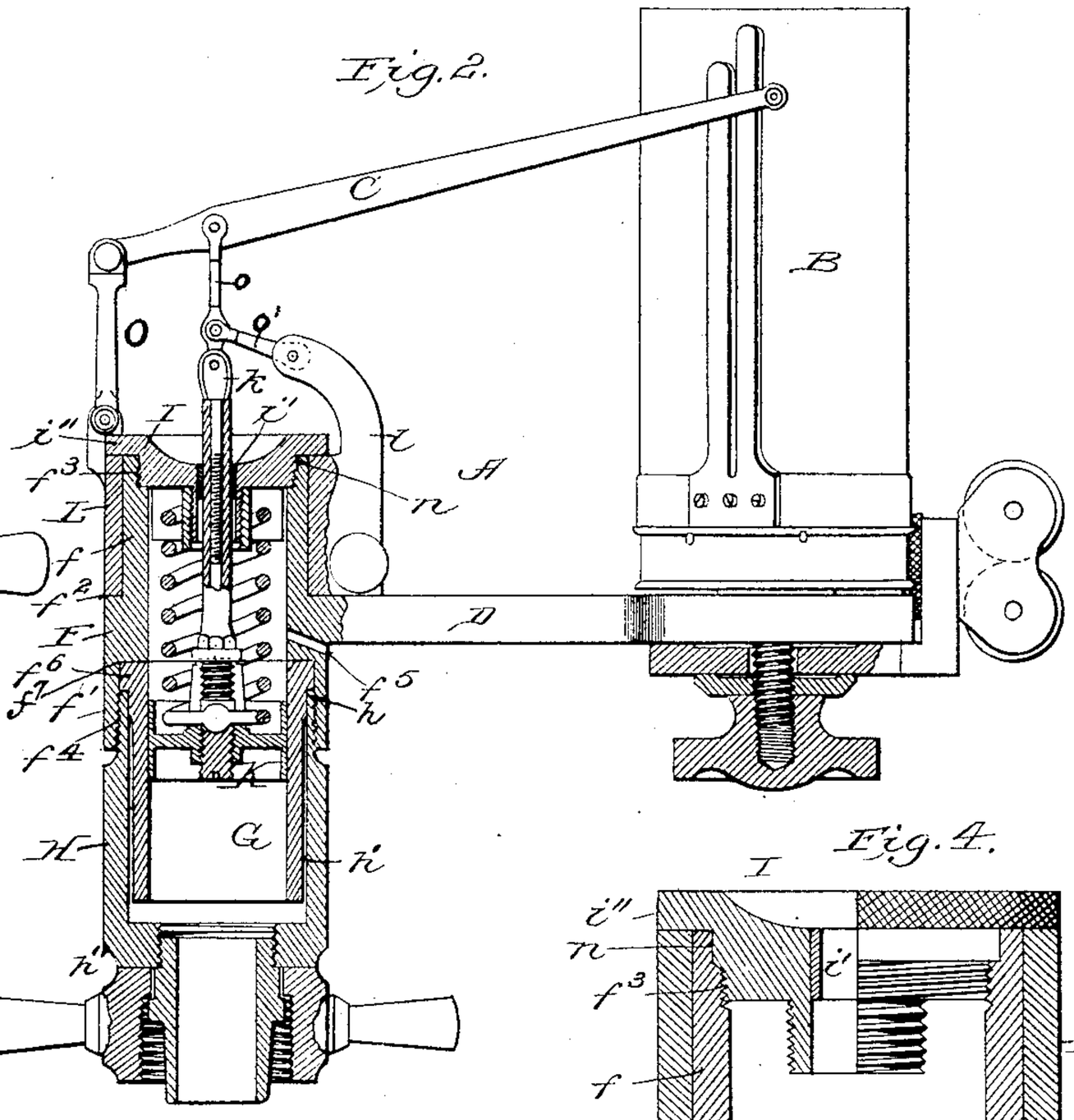


Fig. 3.

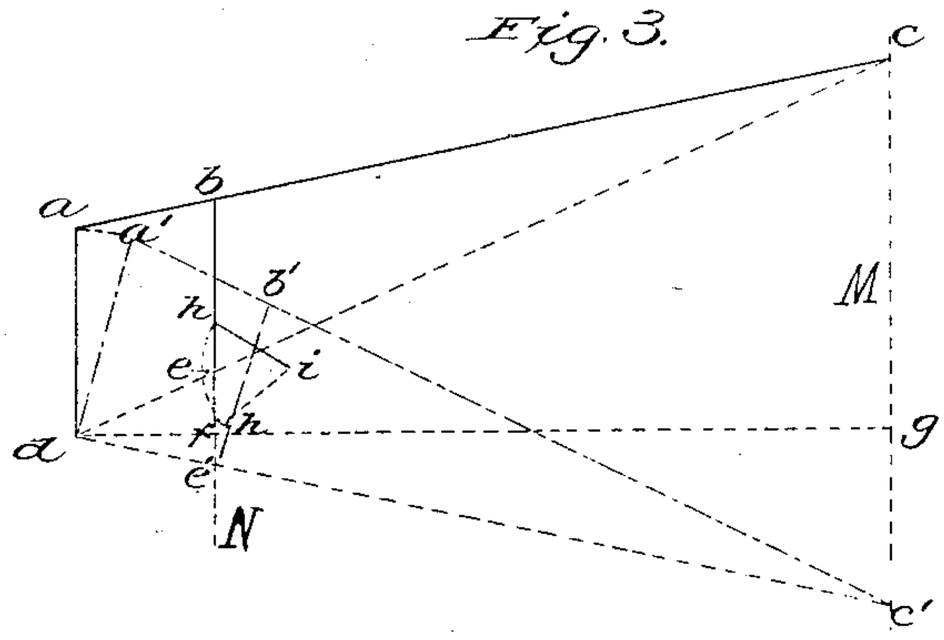
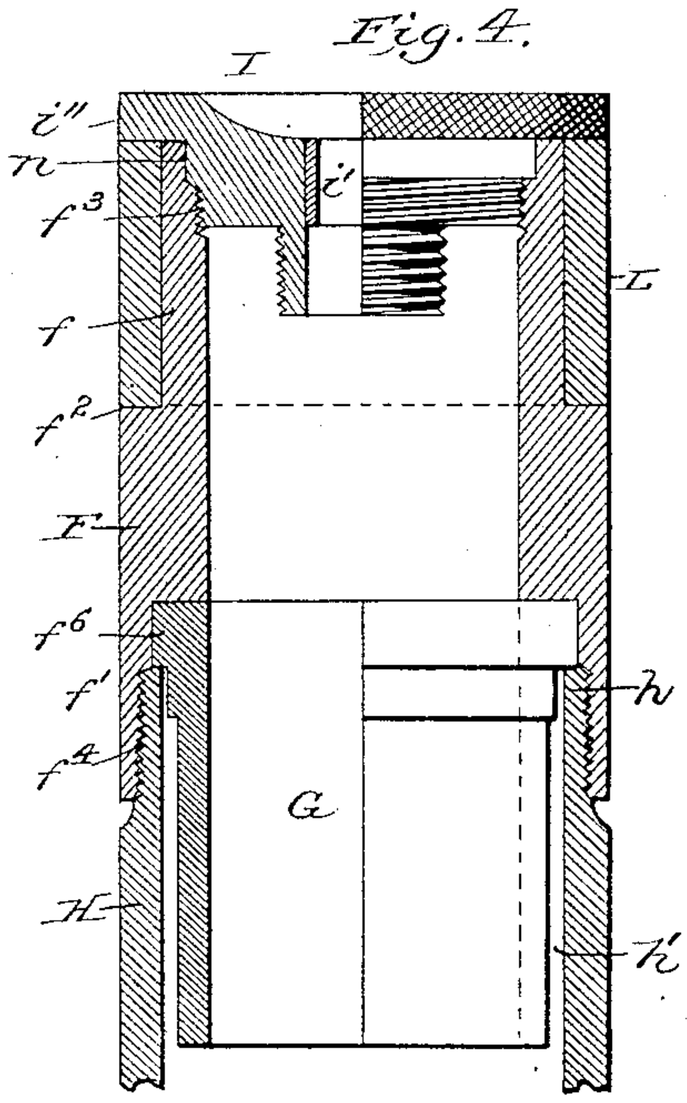


Fig. 4.



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UNITED STATES PATENT OFFICE.

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STEAM-ENGINE INDICATOR.

SPECIFICATION forming part of Letters Patent No. 538,515, dated April 30, 1895.

Application filed May 25, 1894. Serial No. 512,435. (No model.)

To all whom it may concern:

Be it known that I, ALBERT FRANCIS HALL, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Steam-Engine Indicators; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in steam engine indicators which will be hereinafter more particularly described and pointed out in the claims.

In the drawings, Figure 1 is an end view, and Fig. 2 a view partly in section and partly in elevation, of the indicator. Fig. 3 is a diagram representing the correlation of the moving parts; and Fig. 4 is an enlarged view, partly in section, of the cylinder.

In the drawings: the letter A indicates a steam engine indicator of any approved type in which there is the usual recording barrel or cylinder, B, pencil lever, C, and a steam cylinder and piston for moving the pencil lever, C.

The cylinder, B, is secured at one end of the supporting bracket, D. At the other end is formed a hollow cylindrical projection, F, which has an extension, f, above and an extension, f', below the bracket, D. The extension, f', has an exterior annular seat, f^2, and is interiorly threaded at f^3 at the top. The extension, f', is of greater diameter inside and outside than the extension, f, and is interiorly threaded at f^4 at the bottom. A small passage, f^5, runs from the interior of the projection, F, to the outside.

A cylinder, G, having an enlarged smooth end, f^6, is placed within the projection, f, and against a shoulder, f^7. This cylinder is secured in place by a cylindrical shell, H, the upper end, h, of which bears against the enlarged end, f^6, of the cylinder, G, and is screw threaded and engages the threads, f^4, of the projection, f'. The enlarged smooth end f^6 of the cylinder G forms a guide for centering this cylinder in place.

Between the cylinder, G, and cylindrical shell, H, there is an annular space, h'. At its lower end, h'', the shell, H, has means as usual for securing it to the engine, there being the usual steam way from the steam space of the engine to the interior of the shell, H.

Fitting into the top of the projection, f, and secured to the threads, f^3, is the cap, I, having the central hole, i'. Immediately above the screw threads, f^3, there is a guide surface, n, on the cap, I, which is accurately fitted to the corresponding interior recess in the cylinder, F. The purpose of this construction is to cause the cap, I, to fit precisely into the cylinder, F, and compel the concentricity of all the moving parts which are so essential to the accuracy in the pencil movement.

In practice it is well known that, owing to the inaccuracy of screw thread cutting, the male and female threads do not always fit with perfect accuracy, but by the guide surface, n, and corresponding recess in the cylinder the parts are forced into their proper concentricity. This is a very important improvement in fitting the cap, I, to its place, and which I consider to be new and has proved in practice to accomplish the purpose effectually.

Within the cylinder, G, is the usual piston, K, having the stem, k, which projects up through the hole, i', the piston and its concomitant parts being constructed and arranged in the usual way. The cap, I, has a projecting flange, i'', and in the space between this flange, i'', and the seat, f^2, is placed the annular sleeve, L, carrying the arm, l, on the side toward the cylinder, B.

To the opposite side of the sleeve, L, is pivoted in the usual way the link, O, to which is pivoted the pencil lever, C. This pencil lever, C, is connected to the top of the piston stem, k, by a link, o, which is loosely pivoted to both the pencil lever and piston stem. From this link, o, a steadying link, o', extends to the arm, l, this steadying link being loosely pivoted to the link, o, and the arm, l.

Without a correct movement of the pencil, or recording mechanism, an indicator would be of little value. The fundamental kine-

matic principle of the new device is that found in the pantograph; the fulcrum of the mechanism, as a whole; the point attached to the piston rod; and the pencil, or recording point, always lie in a straight line, whatever be the position of the pencil.

The principle enunciated above is easily shown by reference to the diagrammatic drawing, Fig. 3. In this illustration the parallel lines N and M represent, respectively, the paths of movement of the piston and pencil. *d* is the fulcrum of the mechanism; *ac*, the pencil arm, and *ad* and *be* links, the lower end of the latter, *e*, being joined to the head of the piston rod. If the various members of this mechanism are properly constructed relatively to one another, and the point, *e*, is constrained to move in a straight line, then the pencil point, *c*, will not only move in a line M parallel to the line N of motion of point *e*, but the distance traveled by point *c* will be an exact and constant multiple of the distance traveled by point *e*. For example, let *a'*, *b'* and *e'* be new positions of the points, then point *c'* will be found on the line M, and the distance, *cc'*, will be an exact multiple of distance *ee'*. To attain this result, the length of the pencil arm, *ac*, divided by that of the link, *ad*, must be exactly equal to the distance, *cb*, divided by the length of the link, *be*. The links, *ad* and *be*, will also be always parallel. Further; the ratios: *ac* divided by *ab*, *gd* divided by *df*, and *cd* divided by *de*, will be always equal.

The above represent the fundamental and essential conditions in the construction of the recording mechanism.

In the actual construction it has been found advisable to introduce a steadying link to prevent undue swaying of the mechanism, and thus obtain a clear and well defined movement of the pencil under all variations of speed. This line, *hi*, must be so designed, both as to length and position, that the points, *e* and *c*, will still be free to move in parallel lines as illustrated.

In order that the axis of the piston and of its rod shall always coincide with the axis of the cylinder, the cap, I, Fig. 4, should be so constructed that the central hole, *i'*, which serves as a guide for the piston rod, will be always coincident with the axial line of the cylinder. To obtain this result a plain cylindrical portion or guide, *n*, is turned on the cap exactly concentric with its center and this guide is carefully and closely fitted to a recess turned in the cylinder exactly concentric with its axis, so that, when the cap is screwed down upon the top of the cylinder, the axial lines of cap and cylinder shall be exactly coincident.

The sleeve, L, shown in Fig. 2, bored to accurately fit the outside of the projection, *f*, and concentric therewith, just fills the space between the under side of the cap, I, and the seat, f^2. The circular parts being all, therefore, truly concentric with the axis of the cylinder, the axis of the piston and of its rod will always coincide with that of the cylinder, thereby insuring a movement of the pencil point in a line strictly parallel with that of the piston's.

The annular space, *h'*, between the cylinder, G, and cylindrical shell, H, allows steam to surround the cylinder, G, and keep it at an even temperature, allowing free movement of the piston, K.

Having thus described my invention, what I claim is—

1. The combination of the cylinder, F, having the seat, f^2, the sleeve, L, fitted to the same; the link, O, pivoted to the sleeve, L, the pencil lever, C, with the pencil; the link, *o*, pivoted to the stem, *k*; and the steadying link, *o'*, pivoted to the arm, *l*, and to the link, *o*; the cap, I, having the flange, *i''*, and hole, *i'*, and provided with the guide surface, *n*, fitted to the corresponding interior surface of the cylinder, F; all substantially as set forth.

2. The combination of the cylinder, F, having the seat, f^2, the removable cylinders, G and H, between which is the narrow steam space, *h'*; the cylinder, G, being held in place by the recess in the projecting part, f^6, bearing on the end of the cylinder, H, substantially as set forth.

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

ALBERT FRANCIS HALL.

Witnesses:
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ROBERT PRICE.