M. W. HOGLE.

CONTINUOUS ENGINE INDICATOR.

APPLICATION FILED FEB. 8, 1906.

898,474.

Patented Sept. 15, 1908.

3 SHEETS—SHEET 1.

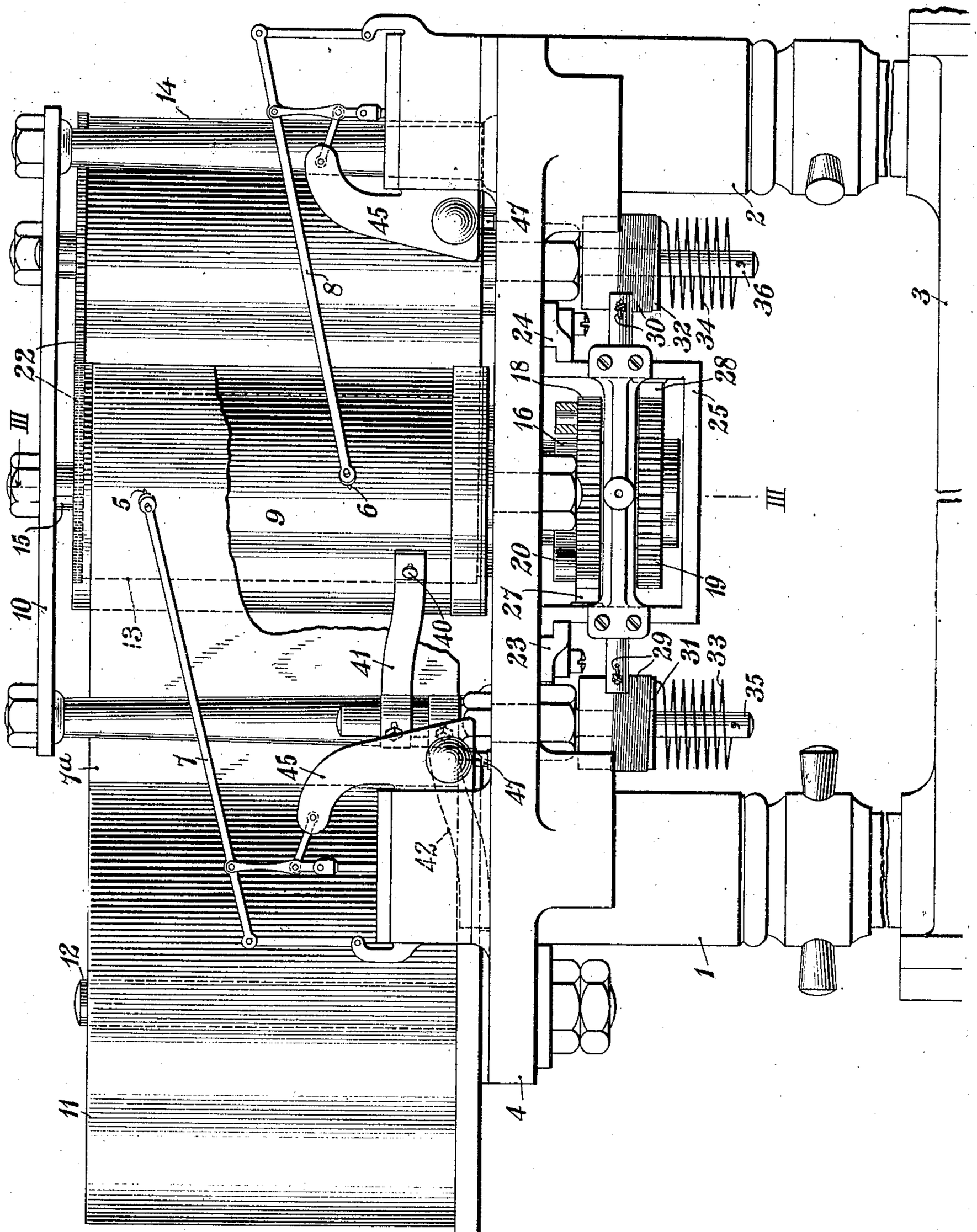

Fig. 1.

WITNESSES:

C. L. Belcher

Birney Hines

INVENTOR

Milton W. Hogle

BY

Otto J. Schairer

ATTORNEY

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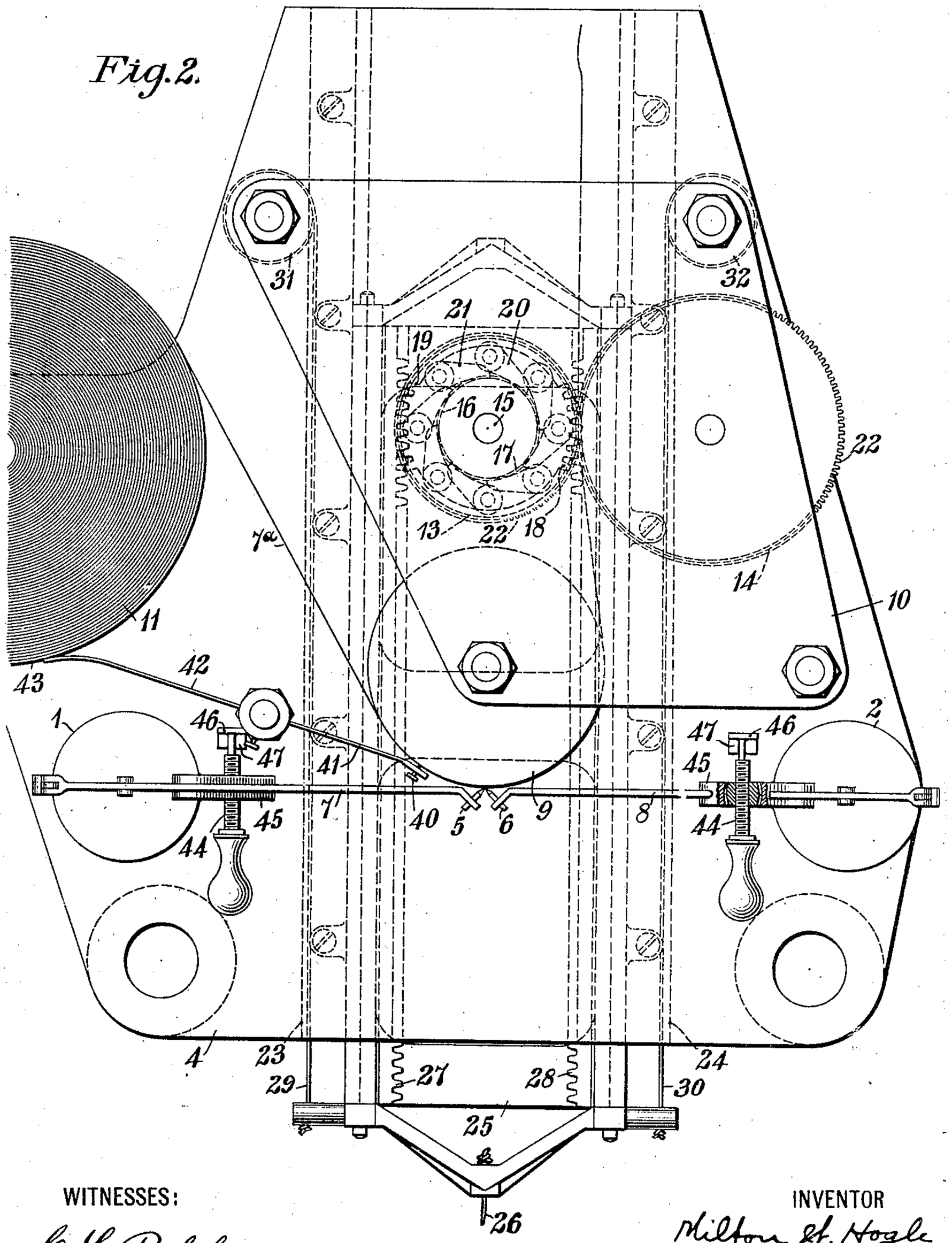
3 SHEETS—SHEET 2.

Fig. 2.



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3 SHEETS—SHEET 3.

Fig. 3

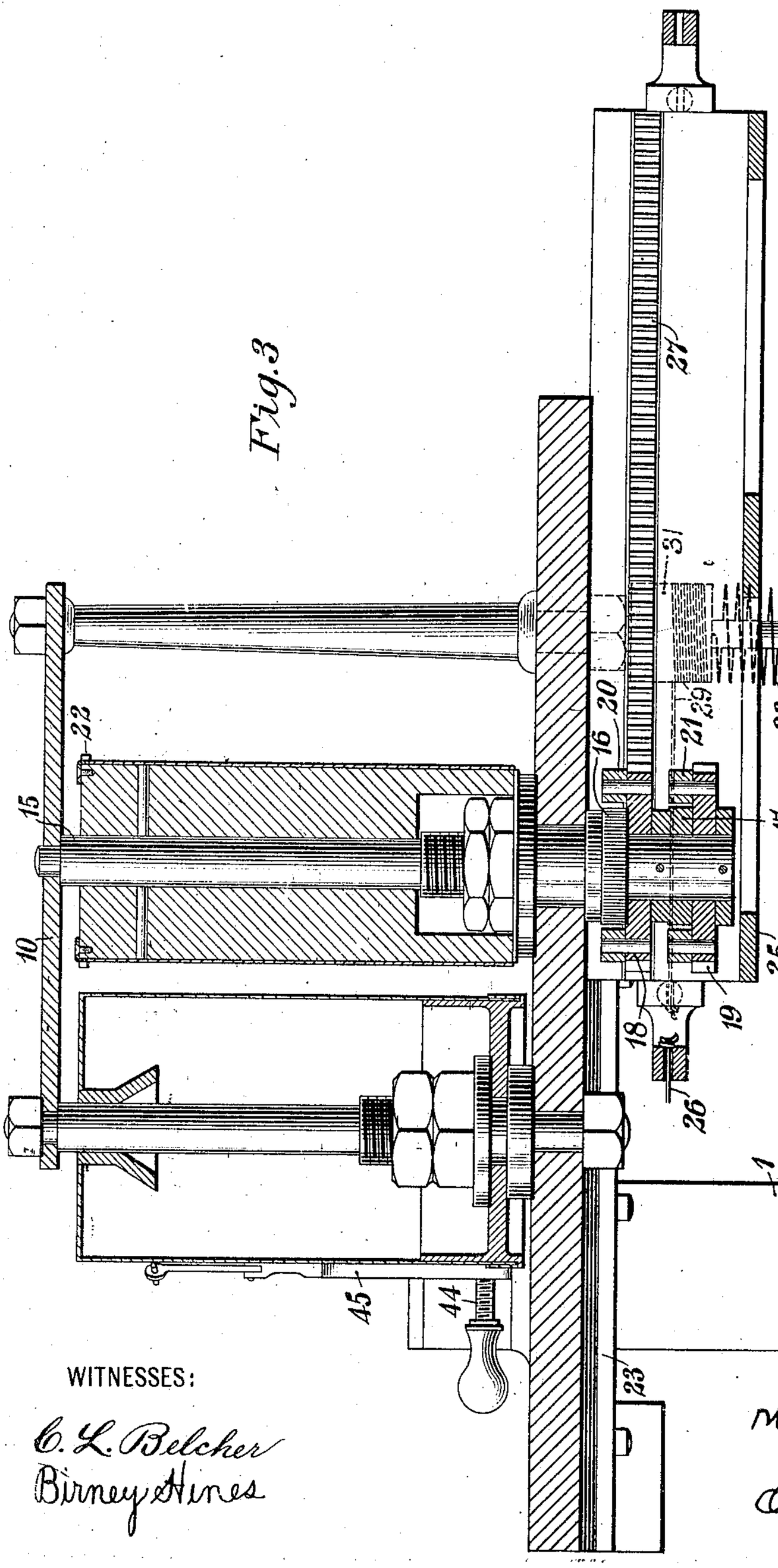
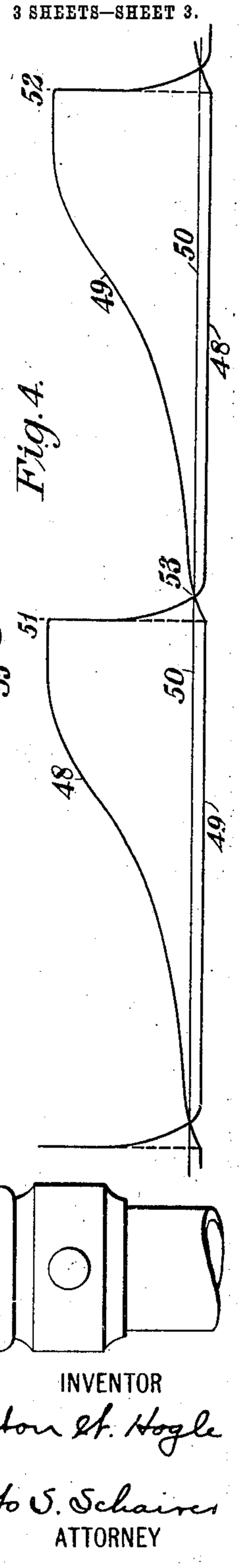


Fig. 4.



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ATTORNEY

UNITED STATES PATENT OFFICE.

MILTON W. HOGLE, OF PITTSBURG, PENNSYLVANIA.

CONTINUOUS ENGINE-INDICATOR.

No. 898,474. Specification of Letters Patent. Patented Sept. 15, 1908.

Application filed February 8, 1906. Serial No. 300,178.

To all whom it may concern:

Be it known that I, MILTON W. HOGLE, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Continuous Engine-Indicators, of which the following is a specification.

My invention relates to indicators for steam engines and particularly to those which make continuous records of the variations in the steam pressure in an engine cylinder.

The object of my invention is to provide an inproved continuous engine indicator which shall record simultaneously the variations in steam pressure in both ends of an engine cylinder.

Figure 1 of the accompanying drawings is a view, in elevation, of a device that embodies my invention. Fig. 2 is a plan view of the device shown in Fig. 1. Fig. 3 is a view in vertical cross-section of the device on line III—III of Fig. 1, and Fig. 4 is a diagram or record such as is traced by the device.

Two pressure indicators 1 and 2 of the ordinary type, that are adapted to be connected respectively with opposite ends of an engine cylinder 3, are suitably supported in a base-plate 4 and are arranged so that recording pencils 5 and 6 that are carried at the ends of opppositely directed lever arms 7 and 8 may move in closely adjacent parallel lines without interference. It is essential in order that the coördinates of the curves traced by the two pencils may be substantially identical that the ends of the lever arms of the indicators be bent so that the points of the pencils may be as close together in passing as is possible without interference. The pencils 5 and 6 engage a record strip 7^a upon an idle platen roll 9 that is rotatably mounted between the base-plate 4 and a top-plate 10, the recording strip being drawn over the platen from a roll 11 that is carried by a spindle 12, by means of feed rolls 13 and 14. The feed roll 13 is mounted upon a spindle 15 that projects through the base-plate 4 and to the lower ends of which two ratchets 16 and 17, respectively, are rigidly secured, the pitch of the teeth on the ratchets being very small. Loosely mounted upon the lower end of the spindle 15, adjacent to the ratchets 16 and 17, are two pinions 18 and 19, that are provided, respectively, upon their upper faces, with sets of pawls 20 and 21 that are adapted to engage the corresponding adjacent ratchets 16 and 17. The pitch of the pawls is preferably a multiple of the pitch of the teeth on the ratchets plus or minus a fraction thereof in order that there may be but a small or negligible amount of lost motion during operation. In practice this arrangement has successfully obviated difficulties that might arise from lost motion. The roll 14 is preferably driven from the roll 13 by means of gearing 22, though, if desired, it may be run idle, and the rolls may be provided with rubber or other resilient coverings in order to prevent slipping of the record strip.

Mounted in parallel guides 23 and 24 upon the lower face of the base-plate 4, is a frame 25 that is adapted to be connected with the piston or connecting rod of an engine or to any other reciprocating part the motion of which is proportional to that of the piston, by means of a cord 26 that may be attached to either end of the frame. The frame 25 is provided upon opposite inner faces and in different planes with racks 27 and 28 that are adapted to engage the pinions 18 and 19, respectively. The frame 25 is normally maintained in the position shown by means of cords 29 and 30 that are adapted to be wound upon loosely mounted rolls 31 and 32 and that are maintained taut by means of helical springs 33 and 34, the opposite ends of which are attached to the rolls and to posts 35 and 36 upon which the rolls are mounted. Another pencil 40 that is carried at the outer end of a vertically adjustable arm 41 traces the line of atmospheric pressure upon the record strip 7^a. The position of the pencil 40 is determined before steam pressure is admitted to the cylinder by placing it in alinement with the pencils 5 and 6, which, under the conditions indicated, should be disposed horizontally opposite each other at the lower end of the platen roll 9.

The outer end of a spring 42 exerts pressure upon a disk 43 that is rigidly secured to the spindle 12 and serves to maintain the record strip taut, the record roll being mounted upon the spindle 12 in such a manner as to prevent relative rotation between those parts.

Any suitable means may be employed for holding the pencils in engagement with the record strip during operation of the device, a convenient means comprising screws 44

that thread in rotatably mounted posts 45 and the outer ends of which are provided with heads 46 and forked posts 47 with which the headed ends of the screws are adapted to engage.

In the operation of the device, a reciprocating motion is imparted to the frame 25 proportional to the motion of the engine piston and this motion is converted into a harmonic unidirectional motion which is applied to the feed roll 13 as will be explained presently. If the frame 25 is first moved to the left (Figs. 2 and 3) the rack 27 will cause the pinion 18 to rotate in such a direction that the pawls 20 engage the ratchet 16 and cause the feed roll 13 to rotate in a clockwise direction. When the frame is returned to the position shown, by means of the tension exerted upon cords 29 and 30 by the springs 34 and 35, the pinion 19 is rotated, by means of the rack 28, in a direction such that the pawls 21 engage the ratchet 17 and cause the feed roll 13 to be again rotated in a clockwise direction. As the indicator cylinders are connected with the opposite ends of the engine cylinder, the pencils 5 and 6 move vertically in opposite directions and trace the variations in pressure upon the record strip.

The form of the record that is produced is well illustrated in Fig. 4. Considering this figure, it may be supposed that the line 48 is traced by the pencil 5 and the line 49 by the pencil 6, the one being for the head end of the cylinder and the other for the crank end. The line 50 is traced by the pencil 40 and indicates the line of atmospheric pressure. In order to determine the mean effective pressure for any stroke, such as that between the ordinates 51 and 52, the area of the diagram traced by the pencils between the ordinates must be first measured or calculated. It will be observed that the lines 48 and 49 cross each other at 53 and that there are two areas inclosed by the lines, the larger to the right of the point 53 and the smaller to the left. The explanation is that the fluid-pressure moves the piston from the right to the point 53, and the inertia of the fly wheel and other moving parts of the engine moves the piston from the point 53 to the end of the stroke. It will, of course, be understood that the area between the lines to the left of 53 should be subtracted from that to the right in determining the mean effective pressure. The area to the left of 53 will vary according to the characteristics of an engine; that is, for high speed engines with high compression this area will be greater than is here shown. Means may also be provided for recording intervals of time upon the strip, a convenient record comprising a dot or other mark 54 made by means of a pencil 55 carried by an arm 56 that is actuated by an electromagnet 57 the circuit of which may be governed by a clock (not shown) and completed periodically, as for instance, every second. In this manner the speed of the engine under any given conditions of operation may be determined.

Since the present device records continuously the pressure variations in both ends of an engine cylinder, and since the simultaneous pressure values appear upon substantially the same ordinates, its use permits of obtaining much new information, as well as of some more accurate information than has heretofore been obtainable, with the result that it has been found particularly adapted to the investigation of the operation of reversing engines, and such as are subjected to wide fluctuations of load, as, for example, rolling mill engines. The device renders it possible to determine the amount of steam consumed in reversing an engine, and to compare the cost of operation of a reversing engine with that of a non-reversing engine. The amount of work done during each and every stroke of an engine may be accurately determined, because the difference of the pressures in the two ends of the cylinder is definitely known at all times, and because the record strip is moved at a rate proportional to the rate of movement of the engine piston. The total amount of steam consumed by an engine during any given period of time may also be accurately determined from the record.

The structural details of the device may obviously be varied within considerable limits without modifying the mode of operation thereof or departing materially from the spirit of the invention.

I claim as my invention:

1. The combination with an engine cylinder, of means for effecting unsuperposed continuous records of the pressure variations in both ends of the cylinder, the simultaneous pressure values being recorded upon substantially the same ordinates.

2. In an engine indicator, the combination with means for moving a record strip continuously and harmonically in one direction only at a rate proportional to the rate of movement of the engine piston, of means for simultaneously and continuously effecting records of the pressure variations in both ends of an engine cylinder, the simultaneous pressure values being recorded upon substantially the same ordinates.

3. In a continuous indicator, the combination with two pressure recording devices, of a reciprocating part, racks carried thereby, a feed roll, a spindle therefor, ratchets rigidly secured to the spindle, pinions loosely mounted upon the spindle that mesh respectively with the racks carried by the reciprocating part, and sets of pawls that are carried by the pinions and that engage the adjacent ratchets.

4. In a continuous indicator, the com-

bination with two pressure recording devices, of a reciprocating part, racks carried thereby, means for normally maintaining the reciprocating part at one end of its stroke, a feed roll, a spindle therefor, ratchets rigidly secured to the spindle, pinions loosely mounted upon the spindle that mesh respectively with the racks carried by the reciprocating part, and sets of pawls that are carried by the pinions and that engage with the adjacent ratchets.

5. In an engine indicator, the combination with means for moving a record strip continuously and harmonically in one direction only at a rate proportional to the rate of movement of the engine piston, of means for simultaneously and continuously effecting records of the pressure variations in both ends of an engine cylinder, the simultaneous pressure values being recorded upon substantially the same ordinates and the records for successive strokes of the engine being unsuperposed.

In testimony whereof, I have hereunto subscribed my name this 26th day of January, 1906.

MILTON W. HOGLE.

Witnesses:

OTTO S. SCHAIRER.

BIRNEY HINES.