H. R. FORD.

MACHINE EFFICIENCY RECORDER.

APPLICATION FILED NOV. 27, 1914.

1,154,983.

Patented Sept. 28, 1915.

4 SHEETS—SHEET 1.

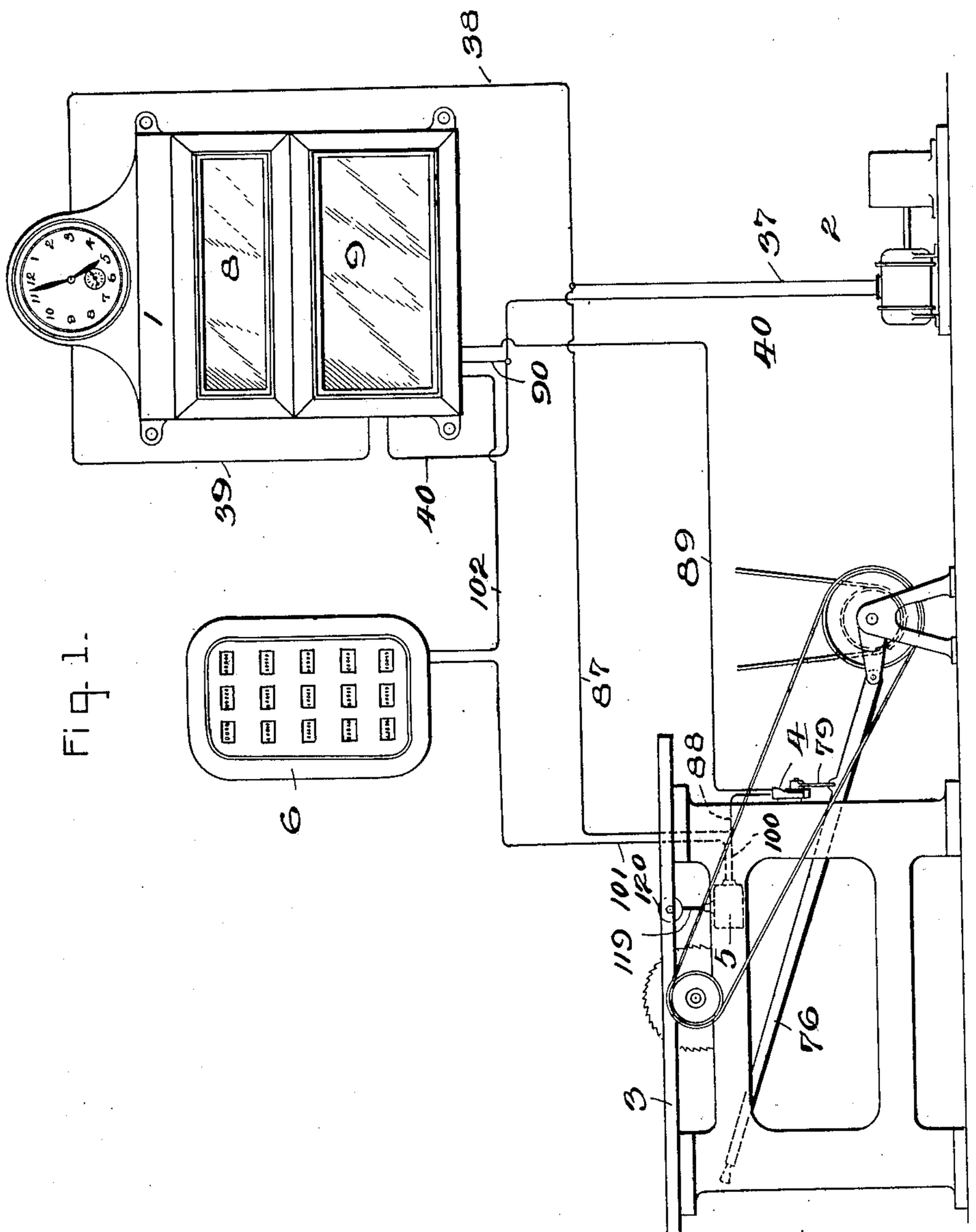

Fig. 1.

WITNESSES

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4 SHEETS—SHEET 2.

Fig. 3.

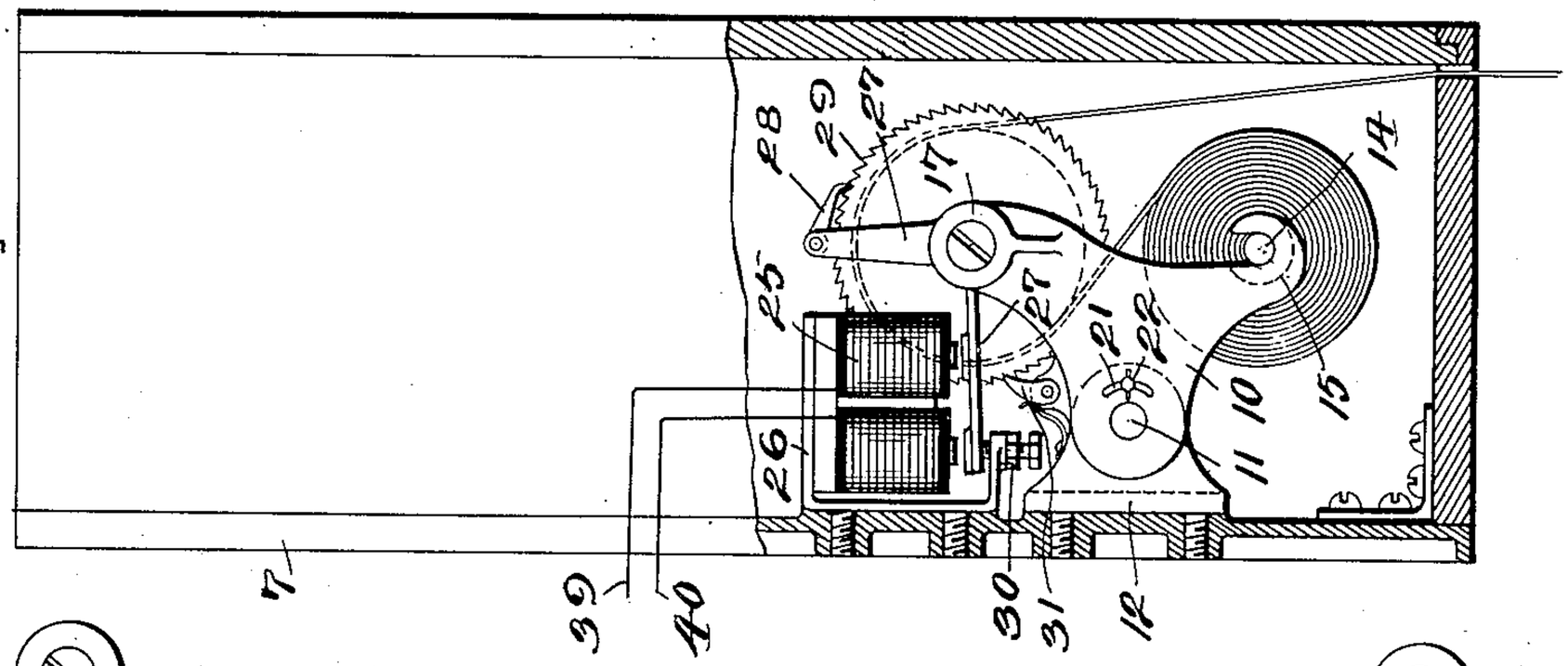
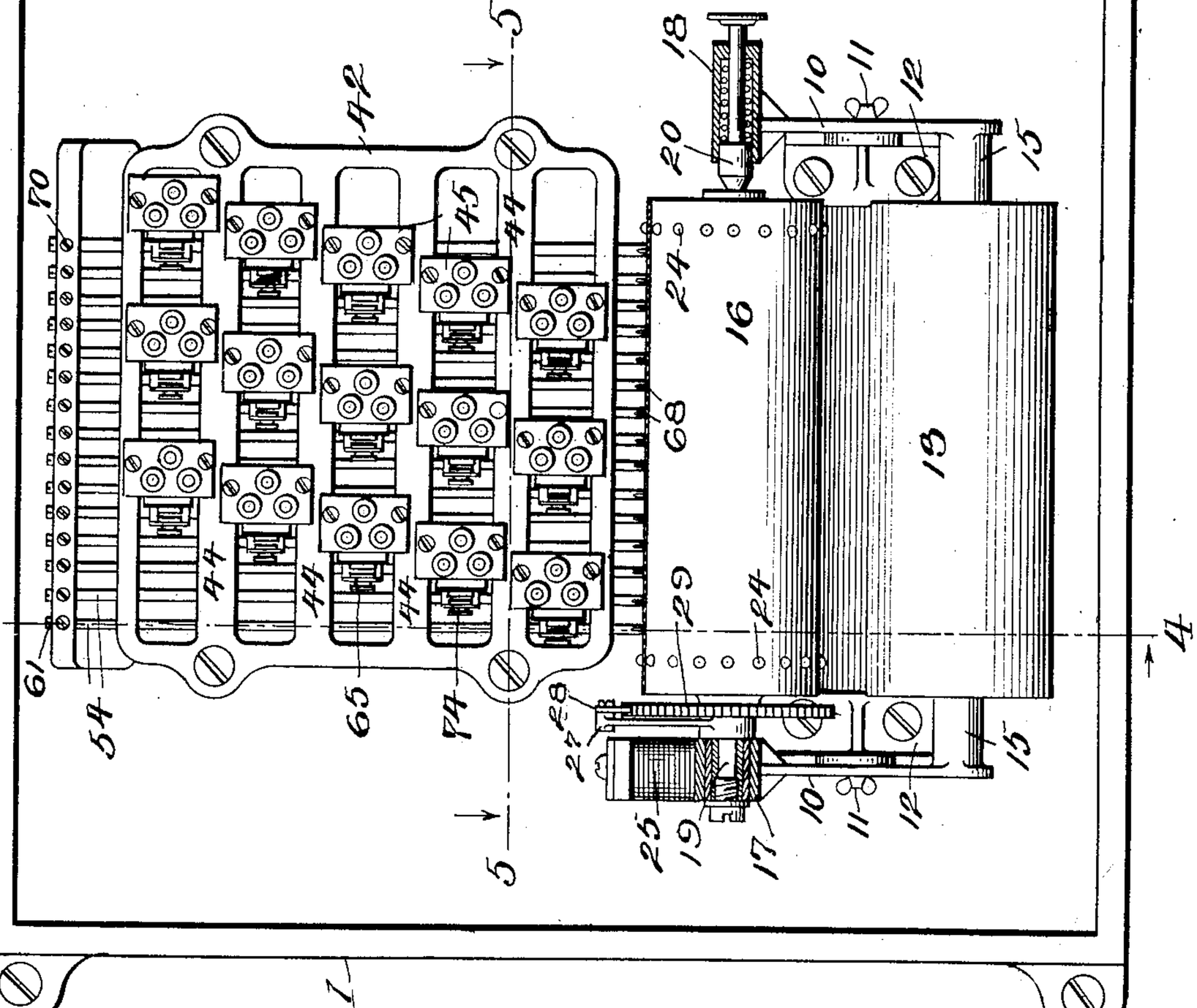


Fig. 2.



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4 SHEETS—SHEET 3.

Fig. 5.

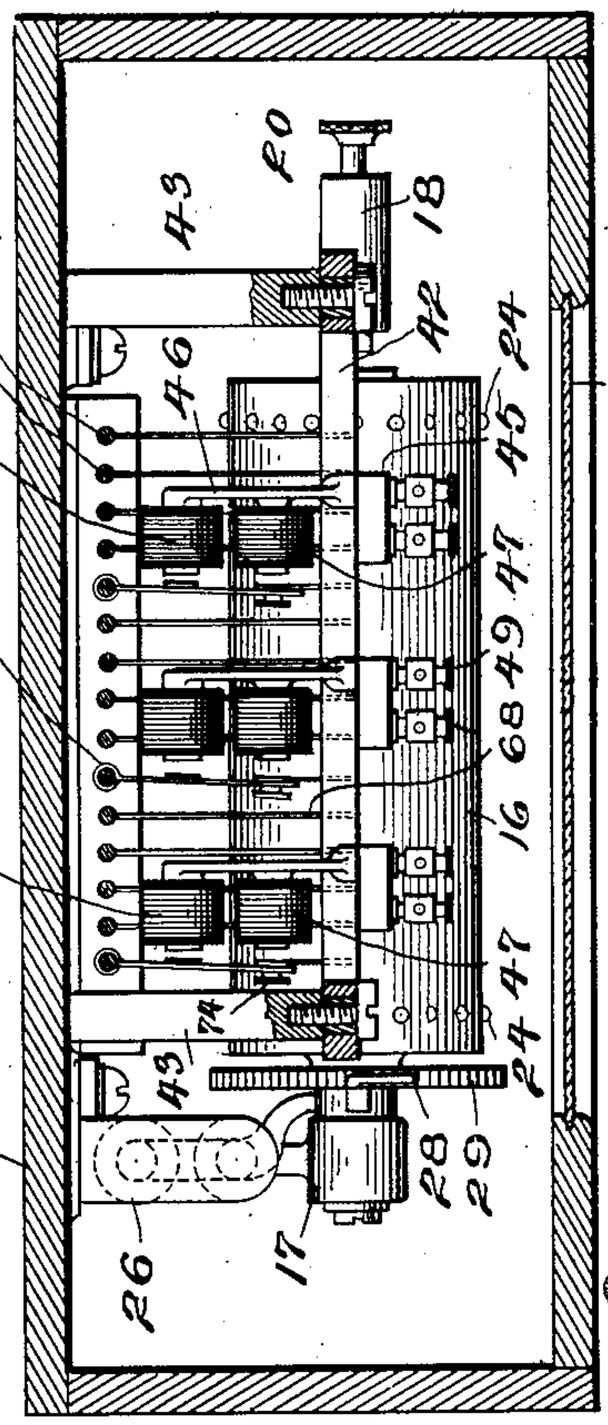


Fig. 6.

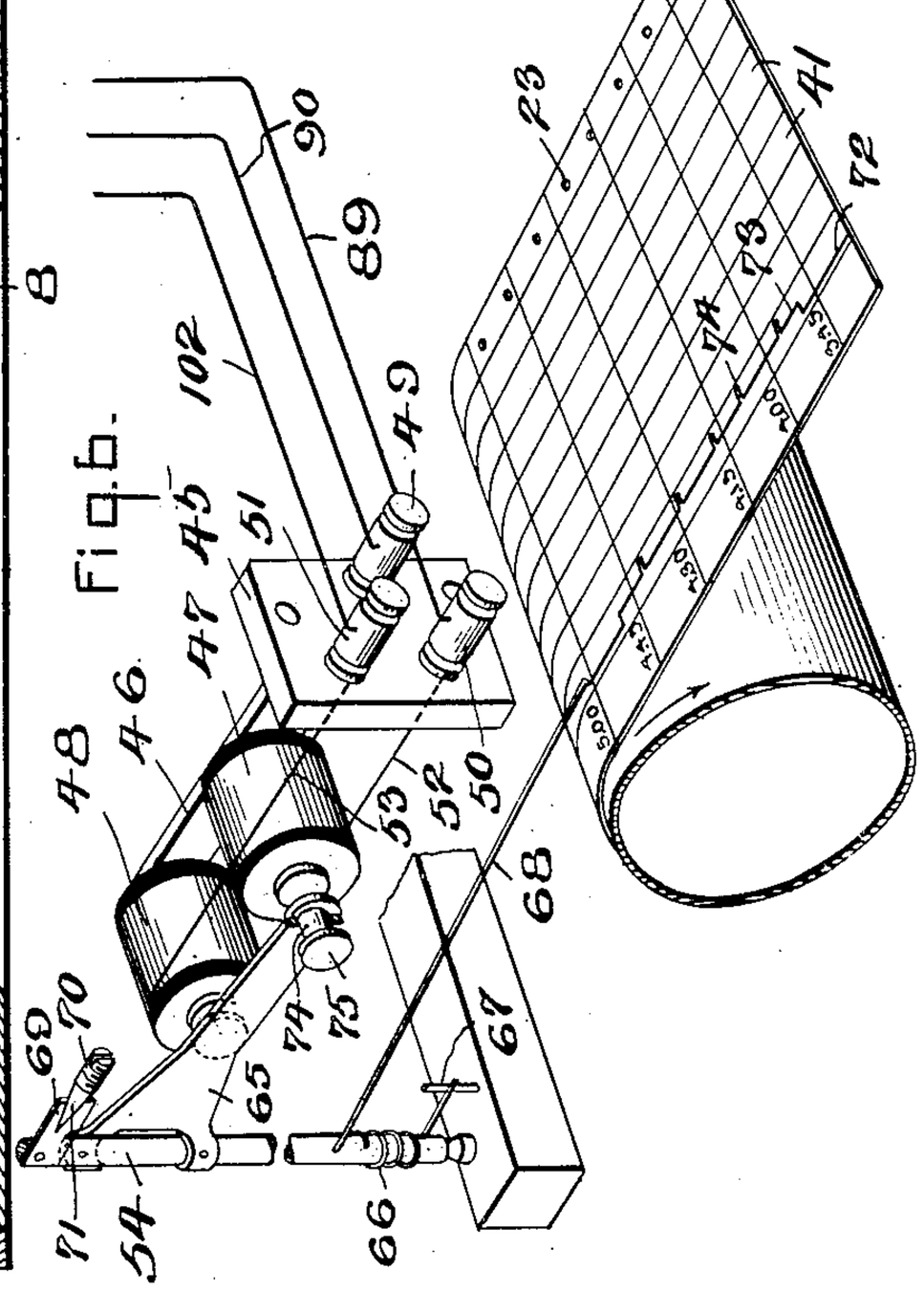
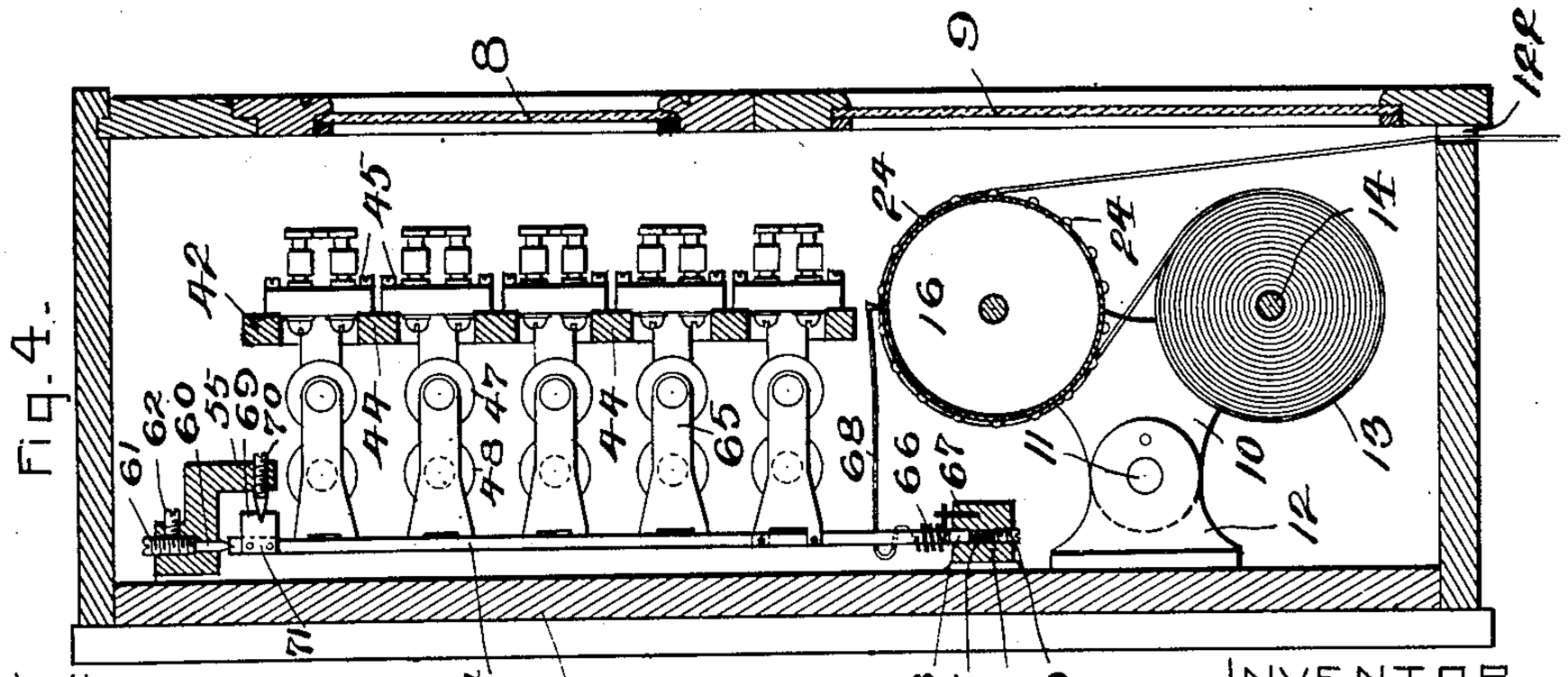


Fig. 4.



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4 SHEETS—SHEET 4.

Fig. 7.

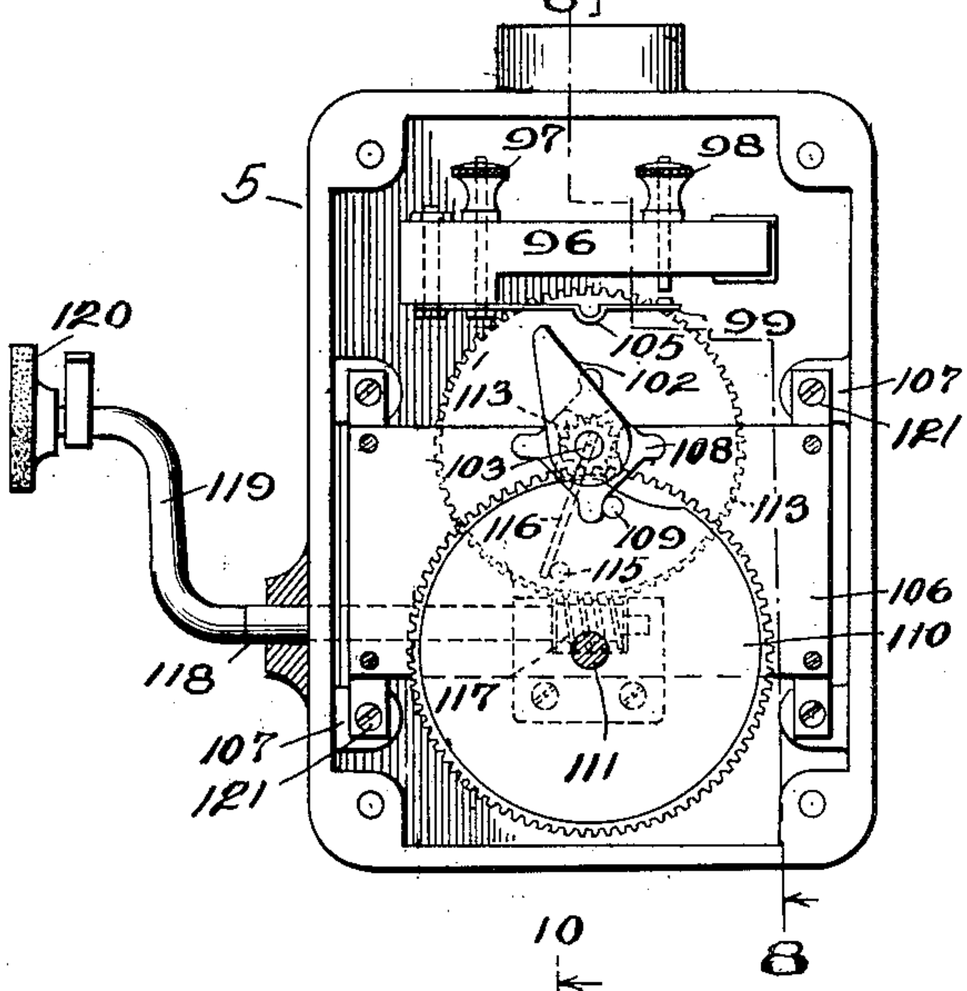

Fig. 8.

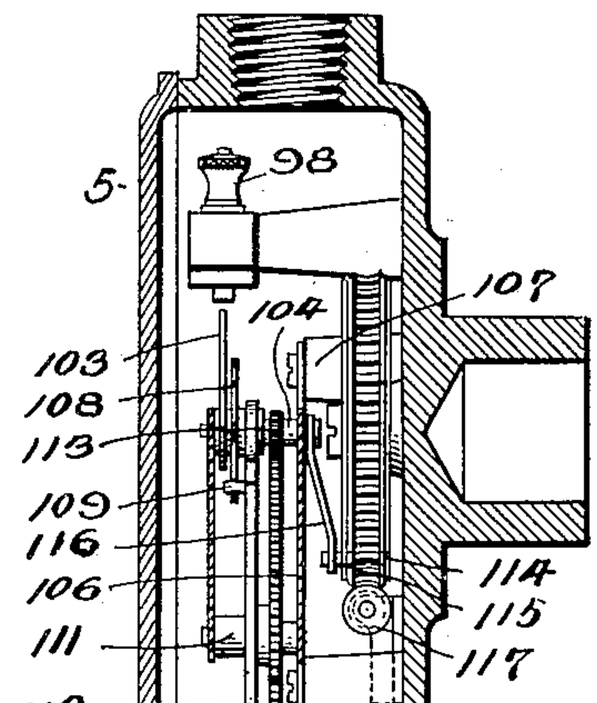

Fig. 9.

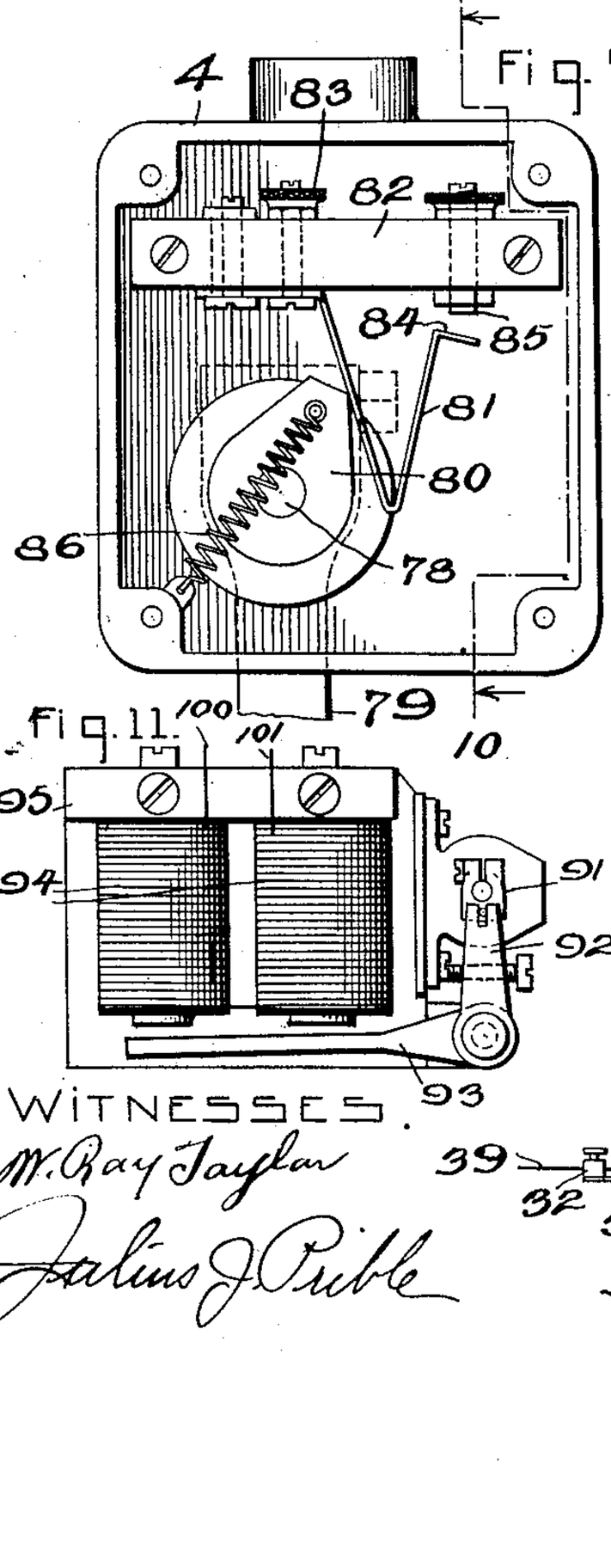

Fig. 10.

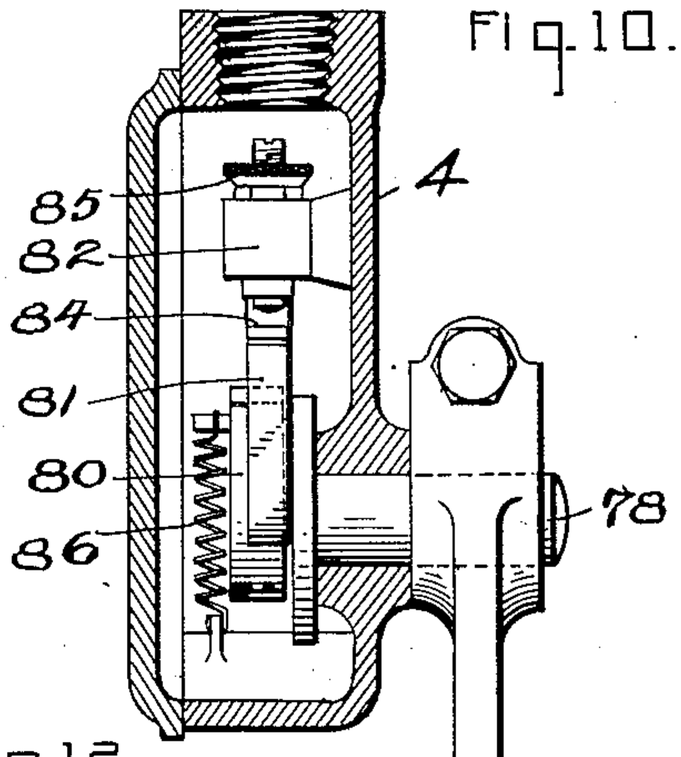

Fig. 11.

Fig. 12.

Fig. 13.

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UNITED STATES PATENT OFFICE.

HENRY R. FORD, OF BUFFALO, NEW YORK.

MACHINE-EFFICIENCY RECORDER.

1,154,983. Specification of Letters Patent. Patented Sept. 28, 1915.

Application filed November 27, 1914. Serial No. 874,176.

To all whom it may concern:

Be it known that I, HENRY R. FORD, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Machine-Efficiency Recorders, of which the following is a specification.

This invention relates more particularly to the class of recorders employed in factories for recording the efficiency of the various machines operated therein, such devices being usually placed in the office of the factory manager or superintendent.

The object of my invention is the provision of a reliable apparatus of this character which will accurately record not only the periods of rest and action of each machine of the plant, but also its output in quantity of product or rate of production for every hour or other given interval of its running time, thus enabling the factory manager or superintendent to readily determine whether or not each machine is being operated at its maximum efficiency.

In the accompanying drawings: Figure 1 is a diagrammatic view showing the connections of the electrical indicating devices when applied to a machine or other producing unit. Fig. 2 is an enlarged front elevation of the recorder, with the cover removed. Fig. 3 is a side elevation of the same, partly in section. Fig. 4 is a transverse vertical section on line 4—4, Fig. 2. Fig. 5 is a horizontal section on line 5—5, Fig. 2. Fig. 6 is an enlarged perspective view of one of the recording units. Fig. 7 is a front elevation of the output switch with the cover removed. Fig. 8 is a transverse vertical section on line 8—8, Fig. 7. Fig. 9 is a front elevation of the shipper switch with the cover removed. Fig. 10 is a transverse vertical section thereof on line 10—10, Fig. 9. Fig. 11 is a side elevation of the adding attachment, and Fig. 12 is a front elevation of the same. Fig. 13 is a side elevation of the switch which controls the movement of the record-chart.

Similar characters of reference indicate corresponding parts throughout the several views.

Referring to Fig. 1, 1 indicates the recording instrument and 2 a motor-generator set or other source of electricity adapted to supply current thereto.

3 indicates the machine or producing unit, 4 a switch which is actuated by the shipper bar or lever of the machine when the same is started and which controls a circuit for recording the running periods of the machine. For distinction this switch will hereafter be referred to as the "shipper-switch."

5 indicates a switch which is actuated by the material passing through the machine and which controls another circuit for recording the production or output of the machine. This switch will hereafter be called the "output switch."

6 represents a case containing suitable counters or adding attachments for registering the total output of each machine.

Referring to the construction of the recording machine, its inclosing casing or frame 1 has windows 8 and 9 through which the markings on the chart and the operation of the machine may be observed.

10 indicates supporting plates pivotally mounted at 11 in brackets 12 projecting from the rear wall of the casing. 13 indicates a web or roll of paper or other suitable material mounted upon a mandrel 14 journaled in bearings 15 formed in the lower portions of the supporting plates 10 and open on their upper sides to allow the mandrel to be removed when it is desired to renew the web.

16 indicates a drum arranged above the web 13 and journaled in bearings 17 and 18 carried by the supporting plates 10. In passing the web around the drum it is desirable to remove the latter from its bearings, for which purpose the drum is provided at one end with a journal 19 removably seated in the bearing 17. The opposite bearing 18 is chambered to receive a spring pressed journal or plunger 20 having a conical front end which fits into a socket in the adjacent end of the drum-shaft. Upon withdrawing this plunger, the drum can be readily removed from its bearings. To permit the web and the drum to be lowered out of engagement with other mechanism hereinafter described, the plates 10 are pivoted to swing vertically on the brackets 12 and suitable means are provided for clamping these plates to the brackets to support the drum and web in their operative position. In the construction shown, the plates 10 are provided with segmental slots 21 adapted to receive threaded studs

projecting laterally from the brackets 12, said studs being provided at their outer ends with thumb nuts 22 for clamping the plates to said brackets.

As shown in Fig. 6, the web is preferably in the form of a chart ruled and printed to represent intervals of time, each horizontal line representing say a 15-minute period. Apertures 23 equally spaced along the margins of the web, receive projections 24 similarly spaced around the periphery of the drum at each end thereof, compelling the web to travel positively with the drum. The drum is rotated at a predetermined speed, sufficient to cause the web to travel a certain distance every fifteen minutes. The mechanism for rotating this drum preferably consists of an electromagnet 25 secured to the rear wall of the casing by a bracket 26. The armature 27 of this magnet is in the form of a bell crank fulcrumed on the journal 17 of the drum 16, its horizontal arm forming the armature while its vertical arm 27 carries a feed pawl 28 which engages a ratchet wheel 29 secured to the shaft of the drum. A rocking movement is imparted to the bell crank by the vibrations of its armature-member, the return stroke of the bell crank being properly regulated by an adjusting screw 30 carried by the bracket 26. A detent pawl 31 mounted on the supporting plate 10 also engages the ratchet wheel 29.

Current is supplied to the magnet from the generator 2 and the magnet is regularly and intermittently energized to actuate the drum 16 preferably by the action of a clock-controlled switch of any suitable construction. In the example shown in the drawings, Figs. 1 and 13, one terminal 32 of this magnet-circuit is connected with a switch spring 33 adapted to contact with the other terminal 34 of said circuit. This spring is periodically closed by a trip wheel 35 mounted to turn with the clock-spindle carrying the second hand, said wheel having a single tooth 36 which presses the blade against the terminal 34 once during each rotation of the wheel, closing said magnet-circuit accordingly and causing the chart to be advanced a step every minute. When this magnet circuit is closed the current flows from the generator through wires 37 and 38, switch blade 33, wire 39, magnet 25 and wire 40 back to the generator.

As shown in Fig. 6, the chart is divided into vertical or longitudinal columns 41 each representing a machine or working unit in the factory. In each column a line is produced by a marker or stylus preferably actuated by electro-magnets included in circuits which are controlled by the switches 4 and 5, Fig. 1. Referring to the actuating mechanism of these markers, 42 indicates a substantially rectangular upright frame supported by arms or brackets 43 projecting horizontally from the rear wall of the casing 7 and having cross bars 44. Mounted on these bars are a plurality of insulating blocks 45 which carry a plurality of rearwardly-extending brackets 46 each of which in turn carries two magnets which may be distinguished as the shipper magnet 47 and the output magnet 48. The end of the winding of the coil of each of these magnets is connected with a terminal 49 secured to the insulated block 45. 50 and 51 indicate terminals mounted on the block 45 from which wires 52, 53 lead to the shipper and output magnets, respectively. 54 indicates a series of vertical rock shafts supported by upper and lower bearing rails 55 and 56. The lower rail has a row of vertical openings 57 in which are seated pointed bearing pins or studs 58 which receive the countersunk lower ends of the shafts 54. These pins are yieldingly supported by spiral springs resting upon adjusting screws 59 which engage the screw threaded lower portion of said openings. The upper ends of the shafts receive similar bearing pins 60 arranged in openings in the upper rail—and each abutting against an adjusting screw 61 which is locked by a set screw 62. An armature 65 is secured to each rock shaft 54 and projects forwardly therefrom in front of the cores of the two magnets 47 and 48, so as to be attracted when either of the same is energized. When they are deënergized, the armature is withdrawn by a suitable spring 66 which in the construction shown is coiled around the rock shaft 54 and secured at one end thereto, while its other end abuts against a fixed pin 67.

68 indicates markers respectively secured to the vertical shafts 54 and projecting forwardly therefrom with their front ends resting upon the web or chart, as best shown in Fig. 6, there being such a marker for each column 41 of the chart. The pressure with which the markers bear upon the chart may be regulated by the adjusting screw 61 arranged in the upper shaft-bearings.

In order to permit each marker to be adjusted laterally with accuracy to make a record within the corresponding column 41 of the chart, each rock shaft 54 is provided with a stop arm 69 adapted to engage an adjustable stop screw 70 carried by the upper bearing rail 55. This screw has a conical or wedge-shaped front end 71 which bears against the rear side of said stop-arm 69, the spring of the rock shaft tending to hold the arm against the screw. It will thus be understood that by turning the screw forward or backward, the marker is adjusted to the right or left accordingly.

Each marker has three working positions in which it produces lines or marks upon the chart indicating; first, the periods during

which the machine is idle or at rest; second, the period during which it is running and not producing, and third, the output or production of the machine during given or regular intervals of its operation. In the particular example shown in the drawings, these three positions of the marker are, first, its normal position in which it makes a line or mark 72 indicating that the machine is idle; second, a position to the right of the first, in which it makes a line 73, indicating that the machine is running but not producing and third, a position still farther to the right in which it makes loop-like marks 74, indicating the output of the machine, the last-named marks when read in connection with the horizontal or transverse lines of the chart indicating the rate of production or periods during which the machine produced given amounts of work.

Normally, the marker occupies the first-described position. It is shifted to the second position by a partial or initial inward movement of the armature 65 when the shipper magnet 47 is energized, and the marker is shifted to the third position by the continued or final inward movement of said armature when the output magnet 48 is energized. This initial action of the armature is preferably effected by a supplemental armature or double-headed button 74 mounted on the free end of the armature opposite the core of the shipper magnet and slidable transversely in the armature to a limited extent. When the button is attracted by the shipper magnet, it slides idly over the armature until its rear head 75 comes in contact with the back of the armature when the latter is drawn toward said magnet, but for a distance less than its full forward stroke, owing to the initial dead movement of the button. When thereafter, the output magnet is energized, it attracts the partly shifted armature and completes its forward stroke, shifting the corresponding marker to the third or output position above described. During this final stroke of the armature, the same slides on the neck 74 of the button 75 which latter abuts against the core of the shipper magnet for the time being. When the shipper and output magnets are de-energized, the released armature is withdrawn by the shift-spring 66. The neck or shank of the button is of the proper length to effect the partial forward stroke of the armature above described.

As an example of the use and operation of the recorder, the same is shown in Fig. 1 in connection with a sawing table; 76 indicates the starting or shipper lever which is thrown to the right or left to start or stop the saw in a manner well known. In moving this lever to the starting position, a circuit including the shipper magnet 47 is closed, preferably by the following means: As best shown in Figs. 1, 9 and 10, the box or casing of the switch 4 is secured to the frame of the machine above the shipper lever 76. 78 indicates a rock shaft transversely journaled in the rear wall of said box and having an external rock arm 79 which is suitably connected to the shipper lever 76 for rocking said shaft when the lever is shifted. Secured to the inner end of this rock shaft is a cam 80, and extending into the path of travel of the cam is a substantially V-shaped switch blade 81 one end of which is securely fastened to an insulated switch block 82 and provided with a terminal 83 while its other end is bent outwardly to form a contact lip 84 which is normally out of contact with a terminal 85 also mounted on said block. When the arm 79 is rocked by the shifting of the shipper lever, the cam 80 taking part in this movement, deflects the switch blade 81 in the proper direction to press its lip 84 against the terminal 85, the cam remaining in this position while the machine is running. A spiral spring 86 fastened at one end to the outer end of the cam and at its other end to the casing serves to quickly withdraw the cam and allow the switch spring to leave the contact terminal 85 when the shipper lever is shifted to stop the machine. The closing of said switch blade completes a circuit leading from the generator 2 or other source of power, through wires 37, 87 and 88, terminal 83, switch blade 81, terminal 85, wire 89, terminal 50, wire 52, shipper magnet 47, bracket 46, terminal 49, wires 90 and 40 to the generator 2, this circuit remaining closed so long as the machine continues to run. As hereinbefore described, the closing of said circuit causes the marker to inscribe the line 73 on the chart, indicating that the machine is running.

It is desirable to register the total quantity of material sawed, or otherwise produced during a working day or other given period, and I therefore combine with the recording mechanism counters or adding attachments which show at a glance, without the necessity of referring to the chart, the number of thousands of feet or other quantities produced during a given period, the chart being referred to only to ascertain the rate at which the work is done. These counters may be of any suitable construction and are inclosed in the casing 6 having sight apertures through which the tumblers of the counters are exposed, as shown in Fig. 1. In the example shown in the drawings, Figs. 11 and 12, the tumbler shaft of each counter has a rock arm 91 which is actuated by the upper arm 92 of a bell crank, the lower arm 93 of which forms the armature of an electromagnet 94. The latter and the counter are mounted on a suitable support 95. Every time this magnet is energized, the

units tumbler of the counter is advanced one step, indicating for example an output of a thousand feet or other quantities of lumber for each stroke of the counter-actuating arm 91. At the same time a corresponding record 74 is made on the chart by the companion marker.

The electro-magnet of the counter is included in a normally-open circuit which also contains the output magnet 48, so that whenever this circuit is closed the companion counter and marker are simultaneously actuated. This circuit is controlled by the switch or circuit-closer 5 which in turn is controlled by the material passing through the sawing table or other machine. This controlling mechanism is shown in its preferred form in Figs. 7 and 8, and comprises a switch box containing in its upper portion a fixed insulating block 96 carrying a pair of terminals 97, 98. Electrically connected with one of these terminals is a switch member or blade 99, the free end of which is adapted to make contact with the other terminal 98. The circuit controlled by this switch includes the generator 2, wires 37, 87 and 100, terminal 97, switch blade 99, terminal 98, wire 101, counter magnets 94, wire 102, terminal 51, output magnet 48, support 46, terminal 49 and wires 90 and 40.

The switch blade is intermittently closed by a rotary trip arm or device 103 mounted loosely on a transverse shaft 104 arranged in the switch box below the switch blade, the latter having a projection 105 adapted to be engaged by said arm. This shaft is preferably supported on an upright plate 106 carried by studs 107 projecting from the rear wall of the box. Secured to the hub of the trip arm is a trip wheel 108 preferably having four equidistant teeth, as shown, which are successively engaged by a pin 109 projecting from the side of a rotary disk 110, thereby causing the trip arm to close the switch blade once during every revolution of said trip wheel 108. The disk is mounted on an arbor 111 also preferably carried by the plate 106, and is secured to a gear wheel 112 also mounted on said arbor. This wheel is rotated from the shaft 104 by a pinion 113, and said shaft in turn is rotated by a worm wheel 114 having a pin 115 which engages an arm 116 secured to said shaft.

117 indicates a worm meshing with the worm wheel and mounted on a shaft 118 which is connected by a flexible shaft 119 with the journal of a friction wheel or roller 120 placed on the same table in a position to be rotated by contact with the material passing over the table. This worm and gear train is thus actuated whenever any material passes through the machine and the trip arm is intermittently rotated until it trips over the projection 105 of the switch blade 99 when it momentarily closes the latter and the circuit controlled by it. By this construction and arrangement of the parts, the circuit is quickly made and broken, causing the markers to inscribe the short looplike indications 74 on the chart which can be easily distinguished from the lines 73 indicating the running periods of the machines.

The worm wheel 114 and worm 117 may be permanently mounted in the switch box behind the supporting plate, being of a standard character, but the trip arm and other parts of the switch box which are carried by the plate 106 may require changes in dimensions and speed to suit the character of material operated on by various machines. To permit such changes to be readily made without disturbing said worm drive, the support plate 106 is removably secured to its support by screws 121 or other suitable means.

The web or chart after passing over the drum emerges through a slot 122 in the bottom of the casing.

The operation of the apparatus is as follows: In the normal position of the parts, the shipper and output switches are open, each marker occupies its initial or extreme left-hand position, as best shown in Fig. 6, and the chart is constantly fed forward by the action of the pawl under the control of the magnet 25 and clock. The marker therefore produces the longitudinal line 72 on the chart, indicating that the machine or producing unit is idle. Upon moving the shipper lever 76 to start the machine, the shaft 78 of the shipper switch is rocked, causing the cam 80 to move the switch blade 81 against the contact terminal 85 and closing the circuit of the shipper magnet 47. This magnet thereby attracts the sliding button 74 and draws the armature inwardly far enough to shift the marker to its intermediate position hereinbefore described, inscribing the line 73 on the record chart and indicating that the machine is running. Upon feeding lumber or other material to the machine, the same passes over the friction wheel 120, which by its rotation actuates the output switch 99, thereby closing the circuit of the output magnet, the current flowing from one side of the generator through the wires 37, 87 and 100, terminal 97, switch blade 99, terminal 98, wire 101 to the magnet 94 of the counter, wire 102, terminal 51, wire 53, output magnet 48, bracket 46, terminal 49, wires 90 and 40 to the other side of the generator. This causes the output magnet 48 to complete the inward stroke of its armature, whereby the marker is shifted to its third or extreme right-hand position, indicated by the mark 74 on the chart. This output circuit is closed only for an instant, and as the chart moves step-by-step, the last-mentioned shift

of the marker results in the loop-like or U-shaped marks 74, which are readily distinguishable from the straight-line marks 72 and 73 which respectively indicate the resting and running periods of the machine. By the closing of the last-named circuit, the magnet of the corresponding counter is also energized, causing the same to register and totalize the output of the machine for the working day.

Referring to the example illustrated in Fig. 6, the lines 72 of the chart indicate that the machine was at rest from about three to three forty-five o'clock; the lines 73 indicate that the machine was running continuously from about three forty-five to four forty-five, while the U-shaped marks 74 indicate the rate of output of the machine at different intervals of such running time.

It will be understood from the foregoing that this apparatus in addition to recording the periods of time during which each machine represented by the chart is active and inactive, furnishes the additional important record of the rate of output of each machine during each hour or other division of the working day. By inspecting the chart from time to time, the factory superintendent or manager can thus see at a glance the amount of work done by each machine and the rate at which the work is being done throughout its running periods.

I do not wish to be limited to the particular construction of the apparatus herein shown and described, as many of its parts may obviously be modified within the scope of the appended claims.

I claim as my invention:

1. An apparatus for recording the efficiency of machines, comprising a support for a record-chart, a marker coöperating with said support, means for holding said marker in normal position to record the inactive periods of the machine, means for automatically moving the marker to another position to record the running periods of the machine, and means for automatically moving the marker to a third position to record the rate of output of the machine.

2. An efficiency recorder, comprising a support for a record-chart, a marker cooperating with said support, separate electric circuits, magnets included in said circuits, respectively, a main armature controlling said marker and coöperating with one of said magnets, a supplemental armature acting on said main armature and cooperating with the other magnet, said supplemental armature having a limited idle movement relative to the main armature to produce a partial stroke thereof, and means for controlling said circuits.

3. An efficiency recorder, comprising a support for a record-chart, a marker cooperating with said support, separate electric circuits, magnets included in said circuits, respectively, a main armature controlling said marker and coöperating with one of said magnets, a supplemental armature member carried by said main armature and coöperating with the other magnet, said member being idly movable on the main armature to a limited extent, and means for controlling said circuits.

4. An efficiency recorder, comprising a support for a record-chart, a marker cooperating with said support, separate electric circuits, magnets included in said circuits, respectively, a main armature controlling said marker and coöperating with one of said magnets, a button slidably mounted on said main armature opposite the core of the other magnet, and means for controlling said circuits.

5. In a machine-efficiency recorder, the combination of a chart-support, a coöperating marker, an electric circuit, an electromagnet in said circuit controlling said marker, and means for controlling said circuit comprising a switch member, a rotary trip-device constructed to intermittently engage said switch member, a worm shaft, gearing for transmitting motion from said worm-shaft to said trip-device, and a friction wheel operatively connected with said worm shaft and adapted to be actuated by the material passing through the machine.

Witness my hand this 21st day of November, 1914.

HENRY R. FORD.

Witnesses:
ROBERT N. CUNDALL,
C. F. GEYER.