

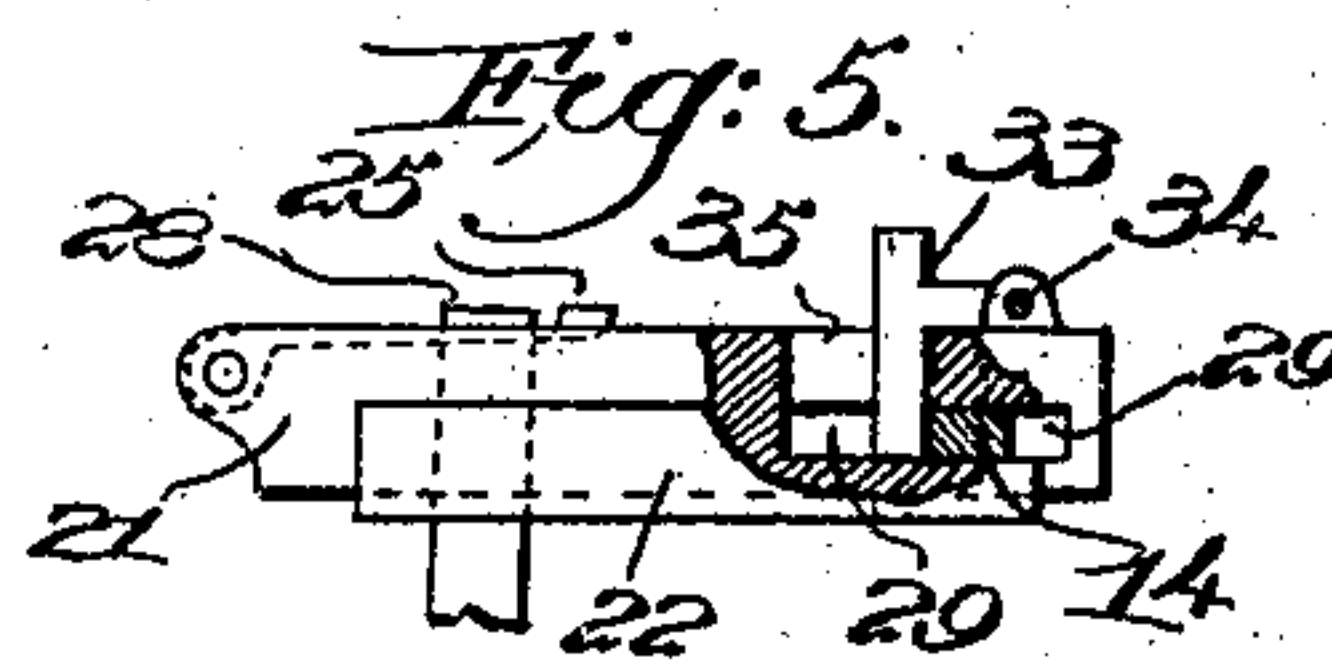
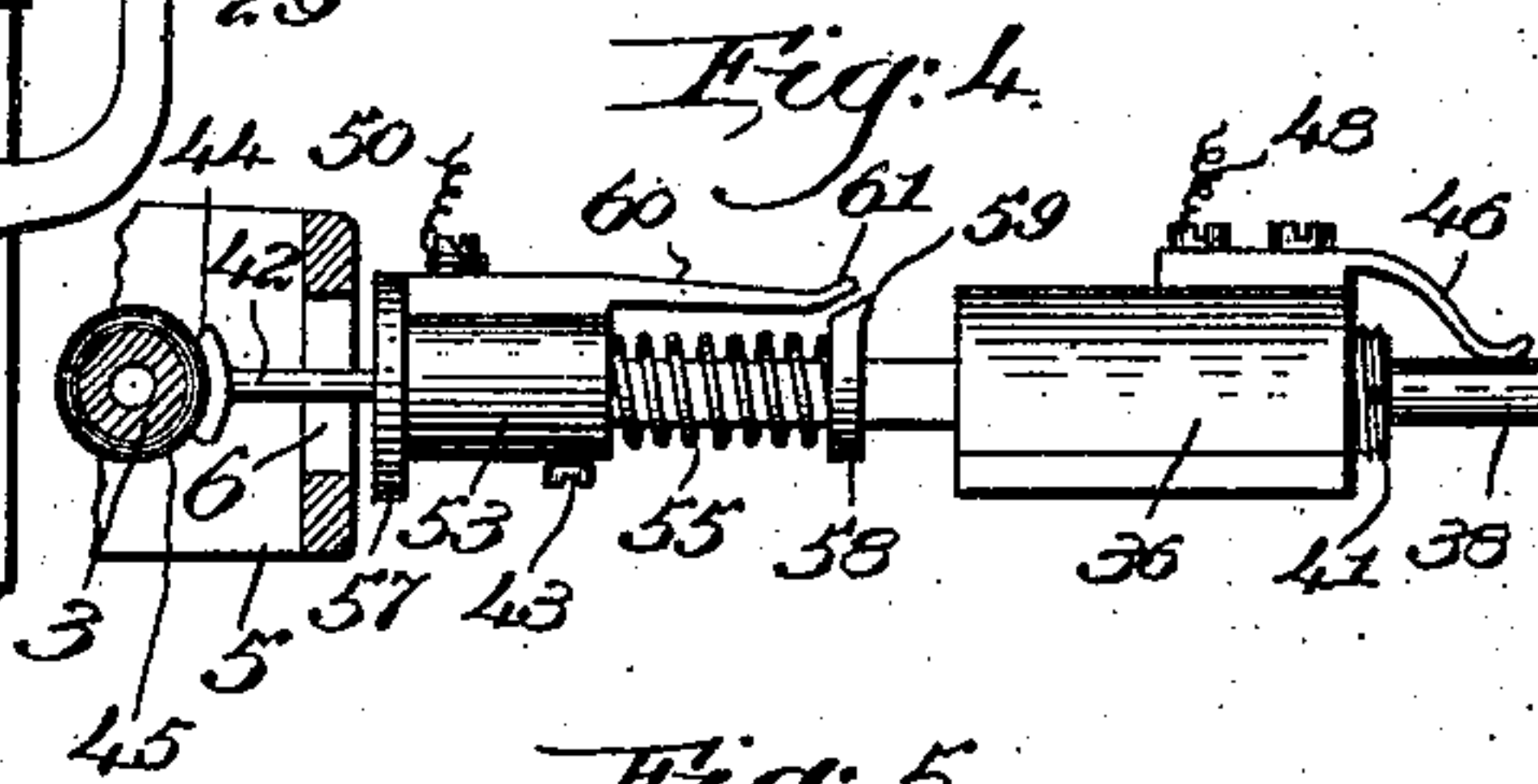
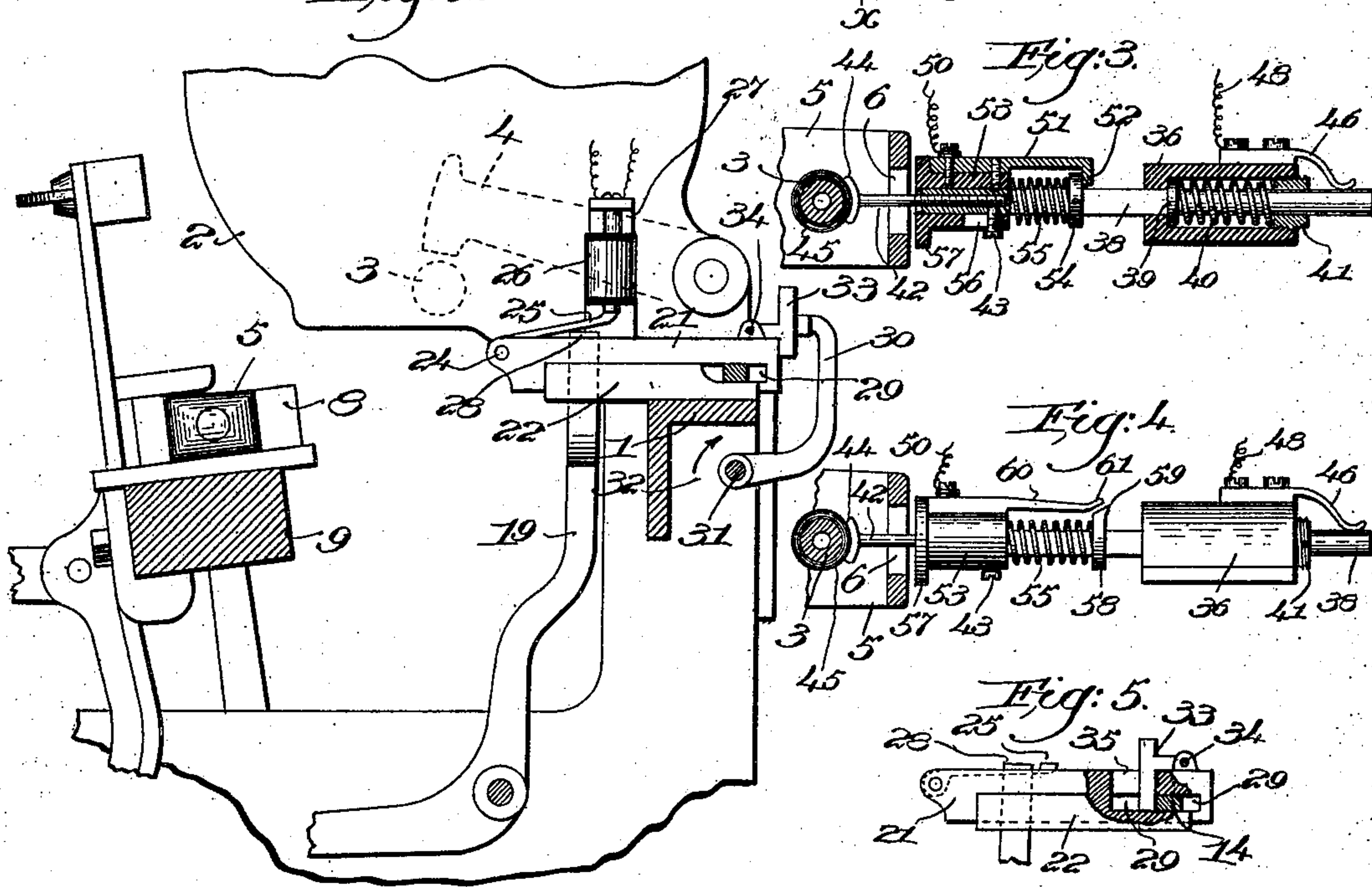
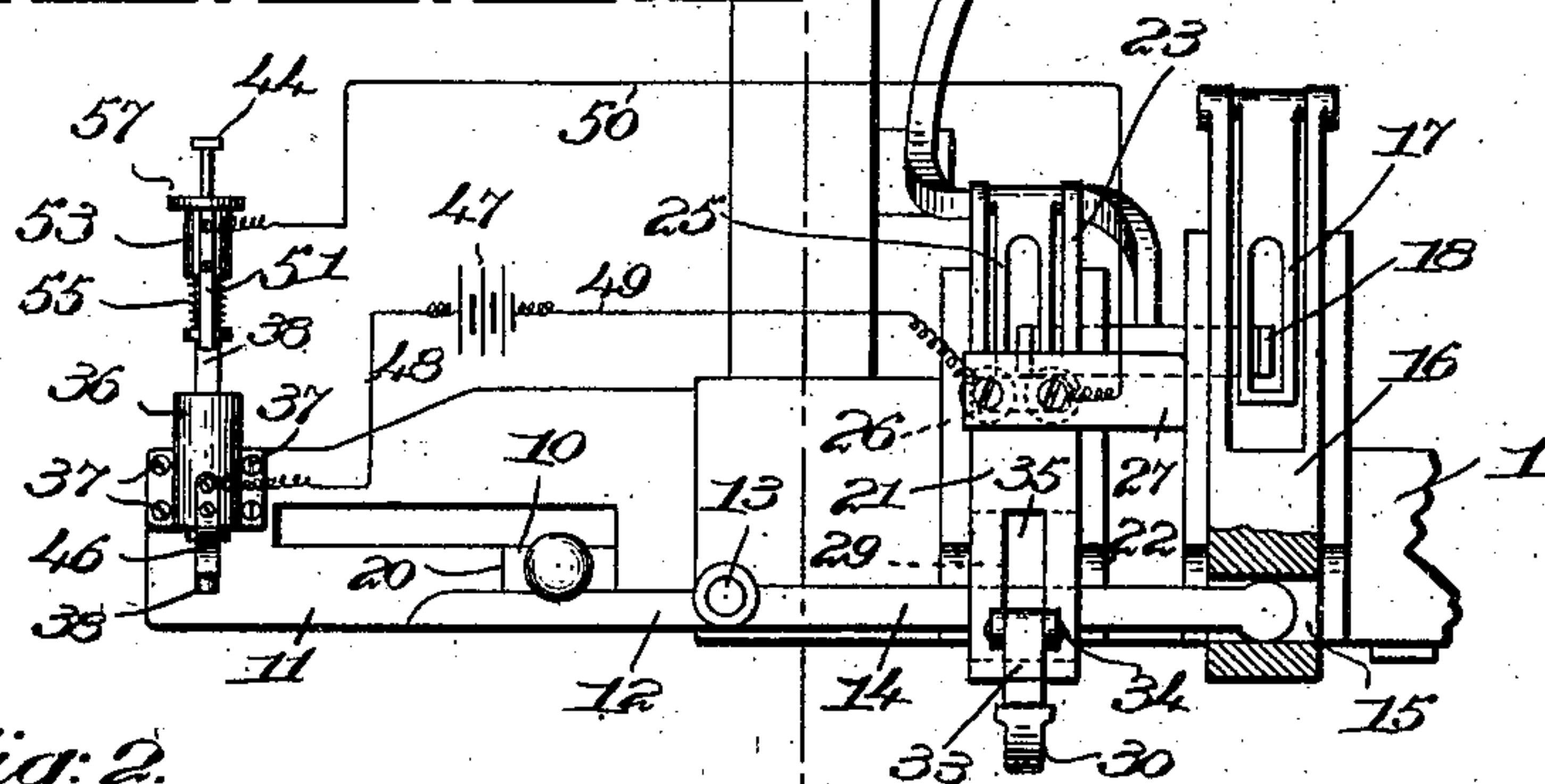
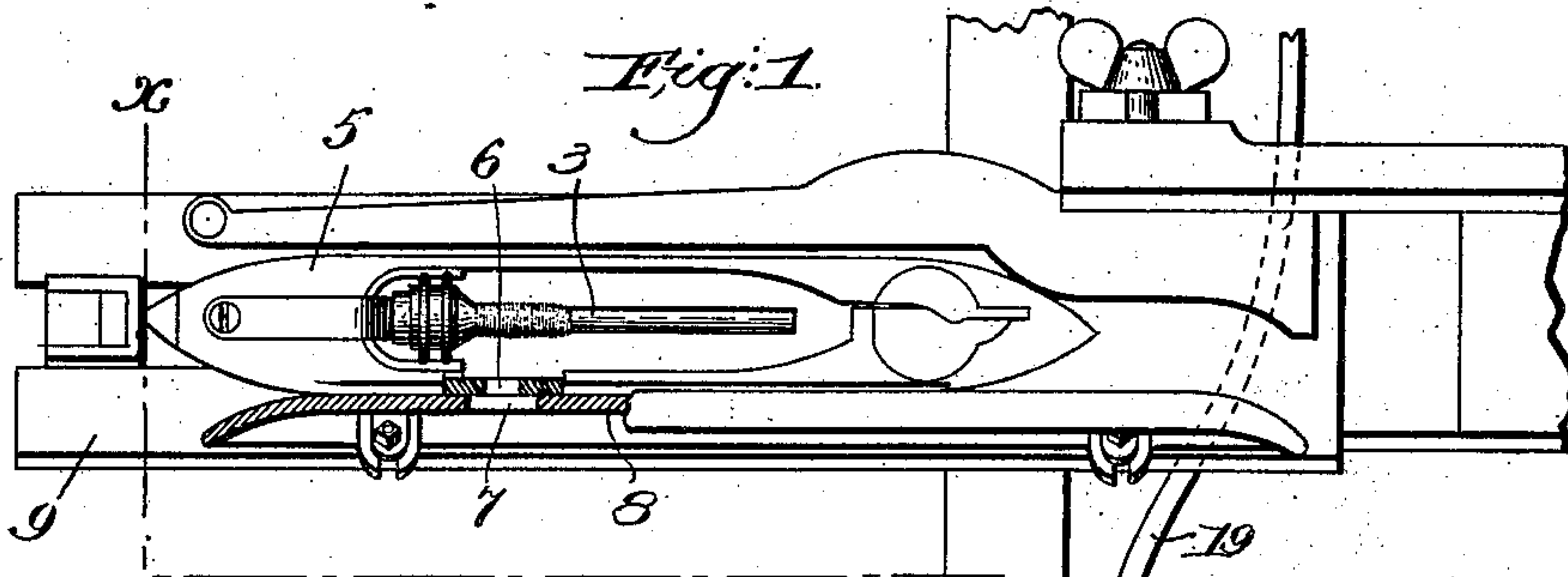
No. 690,644.

Patented Jan. 7, 1902.

J. C. EDWARDS.  
ELECTROMECHANICAL CONTROLLING MECHANISM FOR LOOMS.

(Application filed Sept. 26, 1901.)

(No Model.)



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# UNITED STATES PATENT OFFICE.

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## ELECTROMECHANICAL CONTROLLING MECHANISM FOR LOOMS.

SPECIFICATION forming part of Letters Patent No. 690,644, dated January 7, 1902.

Application filed September 26, 1901. Serial No. 76,588. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN C. EDWARDS, a citizen of the United States, and a resident of Brookline, county of Norfolk, State of Massachusetts, have invented an Improvement in Electromechanical Controlling Mechanism for Looms, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention has for its object the production of novel electromechanical controlling mechanism for looms, whereby upon a predetermined or substantial exhaustion of the filling in the active shuttle the loom may be stopped or a fresh supply of filling provided automatically, the term "filling-replenishing" as hereinafter employed covering either the automatic substitution of a fresh shuttle with a full supply of filling in the place of the substantially exhausted shuttle or the insertion of a fresh supply of filling in the running shuttle when its filling has become substantially exhausted.

Looms provided with filling-exhaustion-indicating means are technically termed "feeler" looms, and numerous devices have been constructed for controlling the operation of such looms; but, so far as I am aware, a special shuttle or filling-carrier, or both, forms a necessary part of the structure, so that the application of the same to looms, whether new or already in use, involves a very considerable outlay for coöperating shuttles and filling-carriers, either or both.

The electromechanical controlling mechanism embodying my present invention is wholly independent of the structure of the shuttle or the filling-carrier, any usual form of either being operative in connection with such controlling mechanism, and in the practical embodiment of the invention herein shown and described a well-known form of shuttle is used having an opening or aperture in one side wall.

So far as I am aware I am the first to devise and produce an electromechanical controlling mechanism for looms which in its application and operation involves no additions to or special forms of filling-carriers and shuttles, either or both, and the consequent wide field of application and general utility of my invention will be manifest.

I have herein illustrated my invention in connection with an automatic filling-replenishing loom on account of the widely extended use of such looms and for convenience; but I wish it to be understood that the application or use of my invention is in no wise restricted to such type of loom.

Various novel features of my invention will be hereinafter described, and particularly pointed out in the following claims.

Figure 1 is a top or plan view, partly in section, of the left-hand side of a loom with one embodiment of my invention applied thereto, the electric circuit being shown diagrammatically. Fig. 2 is a transverse section thereof on the line  $x x$ , Fig. 1, looking toward the right, a portion of the filling-replenishing mechanism being shown. Fig. 3 is an enlarged longitudinal sectional view of the means for changing the condition of the controlling-circuit upon a predetermined exhaustion of the filling in the shuttle, a portion of the latter and the filling-carrier being shown in section. Fig. 4 is a side elevation, also enlarged, of a modified form of the circuit-changing means, with the shuttle and filling-carrier in section; and Fig. 5 is a detail in side elevation and section of the actuating means governed by the controlling mechanism to be described.

In the apparatus herein shown the controlling mechanism includes an electric circuit and a controller governed thereby, exhaustion of the filling in the shuttle to a predetermined extent effecting by means exterior to the shuttle and the filling therein a change in the condition of the circuit to render the controller operative.

The breast-beam 1 of the loom is herein shown as provided at the right-hand side (see Fig. 2) with a filling-feeder supported by a stand 2, the feeder sustaining a plurality of filling-carriers 3 of any suitable character and which are transferred one by one by a transferer 4 to the shuttle 5, open at top and bottom and provided with suitable means for holding the filling-carrier in position therein, the shuttle being of the automatical self-threading type, the filling-replenishing mechanism being substantially such as is shown in United States Patent No. 529,940. The shuttle has in its front side wall (see Fig. 1) an opening or aperture 6, which is adapted



to register with an opening 7 in the front wall 8 of the shuttle-box at the left-hand end of the lay 9 when the shuttle is boxed, the openings permitting entrance of the filling-exhaustion-indicating device to be described.

The only member of the stopping mechanism for the loom herein shown is the shipper 10, held in the notched holding-plate 11 when the loom is running, (see Fig. 1,) a knock-off lever 12, fulcrumed on the breast-beam at 13, having an inward extension 14, which enters an opening 15 in the usual weft-fork slide 16, on which is mounted the weft or filling fork, having a tail 17 to cooperate with a branch 18 of the weft-hammer 19 when the filling breaks and operating in usual manner to rock the knock-off lever and release the shipper from its holding-notch 20. A second slide 21 is mounted in a guideway 22 on the breast-beam adjacent the slide 16, the inner end of the slide being bifurcated, as at 23, Fig. 1, and having fulcrumed thereon at 24 a loop-like armature 25, cooperating with a controller or electromagnet 26, supported above the armature and slide 21 by a stand 27 on the breast-beam. An upturned branch 28 of the weft-hammer moves back and forth in the bifurcated inner end of the slide 21 and normally beneath the armature 25, which in the present embodiment of my invention is attracted by the electromagnet and maintained elevated, as shown in Fig. 2, while the loom is running properly. The outer end of the slide has a longitudinal slot 29 therein, Figs. 1, 2, and 5, through which the extension 14 of the knock-off lever passes, and in front of the outer end of the slide I have shown an upturned arm 30, fast on a rock-shaft 31, which operates the filling-replenishing mechanism when it is turned in the direction of arrow 32, Fig. 2. The length of the slot 29 is such compared with the width of the extension 14 that forward movement of the slide 21 will not necessarily move said extension to operate the knock-off lever, and by reference to Fig. 2 it will be seen that the upper end of the arm 30 is beyond and above the outer end of the slide, so that outward movement of the slide will not of necessity move the arm to rock the shaft 31.

In order that the outward movement of the slide may actuate either the stopping mechanism or the filling-replenishing mechanism, as desired, I have provided a manually-operated selecting device, shown as a substantially T-shaped block 33, pivotally mounted at 34 on the slide 21. This selecting device may be swung out, as in Figs. 1 and 2, so that one of its arms will be interposed between the end of the arm 30 and the slide, so that outward movement of the slide will swing the arm and turn the rock-shaft 31 to effect the operation of the filling-replenishing mechanism, and when so positioned the extension 14 will not be moved by the slide 21. On the other hand, if it is desired to operate the stopping mechanism by outward movement of the

slide 21 the selecting device 33 is swung into the position shown in Fig. 5, so that one of its arms passes through an opening 35 in the slide and into the slot 29 behind the extension 14. When the selecting device is thus positioned, outward movement of the slide will operate the extension and the stopping mechanism will be actuated to stop the loom, the arm 30 remaining stationary. The weft-hammer and slide 21 thus constitute common actuating means for the filling replenishing and stopping mechanisms, the operation of either mechanism being determined by the position of the selecting device.

The electromechanical controlling mechanism and the filling-exhaustion-indicating means will now be described in detail, reference being had more particularly to Figs. 1 and 3. A hollow stand 36, preferably of insulating material, is secured by suitable screws 37 to the holding-plate 11, the inner end of the stand being provided with an aperture for a metallic rod 38, which may be polygonal in cross-section, to prevent rotation and which is the main member of a filling-feeler. A collar or annular flange 39 on the rod within the stand supports one end of a spiral spring 40, Fig. 3, the other end bearing against a plug 41, screwed into the outer end of the stand and forming a second bearing for the outer end of the rod 38, the stand being so located that the rod will be at right angles to the breast-beam and opposite the opening 7 in the shuttle-box. I have shown the inner end of the rod as having screwed into it a contact member 42, held in adjusted position by a set-screw 43 and at its inner end enlarged to form a crutch-head 44, the concave face of which is adapted to intermittently engage the filling 45 on the filling-carrier 3 as the lay beats up. By making the feeler in two parts, one of which is longitudinally adjustable relatively to the other, the extent to which filling exhaustion is to be carried may be regulated with great accuracy, as will appear more fully hereinafter, the feeler being yieldingly sustained by the means described, and filling-induced movement of the feeler moves it outward against the action of the spring 40, the annular enlargement 39 limiting its inward movement. A light metallic spring-contact 46 bears on the outer projecting end of the feeler member or rod 38, said contact member being mounted on the stand 36, and herein it is shown in electrical connection by a wire 48 with one pole of a battery 47 or other suitable generator of electricity, (see Fig. 1,) a wire 49 leading from the other pole including the controller or electromagnet 26 in the electric circuit, the latter being continued from the electromagnet by wire 50 to a terminal 51. This terminal is best shown in Fig. 3 as extended longitudinally above the feeler toward the front of the loom and downturned at its outer end, as at 52, said terminal being secured to and supported on a sleeve-like car-



rier 53, of insulating or non-conducting material, slidably mounted on the inner end of the feeler member or rod 38. The downturned end 52 of the terminal 51 overhangs a metallic collar 54, fast on the feeler, said collar constituting the other terminal proper of the circuit and also serving as a stop for one end of a spiral spring 55, interposed between the collar and the outer end of the carrier 53. The spring serves to yieldingly maintain the carrier in normal position on the feeler and also to maintain the terminals of the circuit in engagement, so that the said circuit is normally closed and the electromagnet is thereby normally energized, attracting its loop-like armature 25 and holding it inoperative in the position shown in Fig. 2. A slot 56 is made in the carrier for the set-screw 43, and I have shown the inner end of the carrier enlarged, as at 57, to present an area greater than that of the aperture 6 in the side wall of the shuttle.

It will be manifest from the foregoing description and the drawings that the terminals are movable in unison with the feeler and also that they are relatively movable, as an outward sliding movement of the carrier 53 on the feeler will separate the terminals and change the condition of the circuit by opening it.

The carrier and the cooperating terminals constitute one form of circuit-changing means to change the condition of the electric circuit and by such change to so act upon the electromagnet or controller, which is normally quiescent, as to render it operative.

In the construction just described the change in the circuit deenergizes the electromagnet, so that it releases its armature 25, which drops into position (see Fig. 5) to be engaged by the branch 28 of the weft-hammer, the outward movement of the latter thereupon moving the slide 21 outward.

In the operation of the apparatus the contacting member of the feeler enters the shuttle through the opening 6 on alternate picks as the lay beats up and engages the filling on the filling-carrier 3, and as the lay completes its forward beat the feeler is moved outward in its support or stand 36, and such intermittent or periodical filling-induced movement of the feeler will prevent engagement of the rear end of the carrier 53 until the filling is substantially exhausted. At such time the contacting member 42 of the feeler having been properly adjusted, the shuttle side will engage the carrier as the lay beats up and will move said carrier outward on the feeler to separate the terminals and open the circuit, with the result hereinbefore described.

The adjustment of the feeler will be such that when the shuttle operates the circuit-changing means there will still be sufficient filling left upon the filling-carrier to extend one or more times across the lay. The adjustment can be made exceedingly fine or accurate, so that waste will be reduced to a

minimum, it being manifest that an exceedingly-slight movement of the carrier 53 by the shuttle is sufficient to change the condition of the circuit and render the controller or electromagnet operative. The fineness and accuracy of the adjustment are materially increased by the fact that the filling-carrier and shuttle are a unit for all practical purposes, and the external surface of the barrel of the filling-carrier is at a constant distance from the outer face of the side wall of the shuttle. Consequently the filling-engaging end of the feeler is gradually approaching the surface of the filling-carrier as the yarn mass decreases, such surface being at a fixed distance from the part of the shuttle which at the proper time will engage and operate the circuit-changing means.

Any vibration affecting the filling-carrier will equally affect the shuttle, and vice versa, without changing their relatively fixed position, so that variations in the running speed of the loom will not interfere with the proper operation or effectiveness of my invention.

It will be manifest that no change is made in the filling-carrier or in the shuttle, any usual form of either being operative, provided the shuttle has a suitable aperture or opening in its side wall.

Inasmuch as the controlling mechanism can be used to stop the loom upon a predetermined exhaustion of filling, my invention is as well adapted to non-automatic looms as to those wherein the filling is replenished or supplied automatically, and in the latter type of loom the filling may be replenished or the loom stopped, as desired, when substantial filling exhaustion is reached.

I have shown in detail a normally closed electric controlling-circuit; but by slight changes well known to those skilled in the art a normally open circuit may be employed, and in Fig. 4 I have shown the circuit-changing means slightly modified to cooperate therewith. In said modification the terminal 58, fast on the feeler, is provided with a beveled portion 59, and the terminal 60 on the carrier 53 is at its extremity or tip slightly bent upward or beveled, as at 61, the spring 55 normally separating the terminals, and in such modification the set-screw 43 acts as a stop to limit spring-impelled movement of the carrier. Impact of the shuttle moves the carrier outward, as before; but in this case closes the circuit by bringing the terminals into engagement with each other. To adapt this modification to the loom, it is only necessary to so change the arrangement of the armature that when the electromagnet is energized the armature will be moved into operative position, and such an arrangement is shown in United States Patent No. 681,164, dated August 20, 1901, wherein the armature is fulcrumed between its ends and counterbalanced, so that normally the loop-like end will be retained in its inoperative position. Closure of the circuit causes the electromagnet



to attract the weighted end of the armature, thereby depressing the loop-like end into operative position.

In my invention the circuit-changing means is yieldingly sustained exterior to the shuttle and the filling therein and operated by engagement with the shuttle, presence of filling preventing and absence or exhaustion of the filling to a predetermined extent permitting the operation of the circuit-changing means.

The various mechanical details of my invention may be modified or varied according to circumstances without departing from the spirit and scope of my invention, one practical embodiment thereof being herein shown and described without attempting to illustrate modifications or variations which could be made by those skilled in the art without the exercise of invention.

By "predetermined exhaustion" or "substantial absence of filling" and similar terms employed as indicating the condition of the filling in the running shuttle I mean such a degree or extent of exhaustion of the filling as will permit operation of the controlling mechanism while sufficient filling remains in the shuttle to prevent imperfection in the cloth being woven.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a loom provided with filling-replenishing mechanism, means to control the operation thereof, including an electric circuit and a circuit-changer exterior to the shuttle and the filling therein, a shuttle, and means to permit actuation of the circuit-changer by the shuttle upon predetermined exhaustion of the filling in the latter.

2. In a loom, an electric controlling-circuit, a circuit-changer forming a part thereof and mounted independently of the shuttle, a shuttle, and means to permit actuation of the circuit-changer by the shuttle upon predetermined exhaustion of the filling in the latter.

3. In a loom, an electric controlling-circuit, a circuit-changer forming a part thereof and mounted independently of the shuttle, a shuttle, and means to intermittently engage the filling in the shuttle and prevent actuation of the circuit-changer by the shuttle until predetermined exhaustion of the filling in the latter.

4. In a loom, filling-replenishing mechanism, means to determine the time of its operation, including an electric circuit and a controller governed thereby, a shuttle adapted to contain a supply of filling, and means mounted exterior to the shuttle and actuated by impact thereof to change the condition of the circuit and render the controller operative when the filling in the shuttle is exhausted to a predetermined extent.

5. In a loom, a shuttle to contain filling, an electric circuit and a controller governed

thereby, and means exterior to the shuttle and actuated by mechanical engagement therewith upon predetermined exhaustion of the filling in said shuttle to change the condition of the circuit and render the controller operative.

6. In a loom, an electric circuit including an electromagnet and having circuit-changing means exterior to the shuttle and the filling therein, a shuttle, and a device to render said means inoperative by the presence of filling in the shuttle and operative by or through the shuttle upon substantial absence of the filling therein.

7. In a loom, means to control its operation, including an electric circuit and a controller governed thereby, a shuttle to contain a supply of filling, and means exterior to the shuttle and the filling therein to change the condition of the circuit and render the controller operative upon substantial exhaustion of the filling in the shuttle.

8. In a loom, filling-replenishing and stopping mechanisms, means, including an electric circuit, to determine the time of operation thereof, a shuttle to contain filling, and a circuit-changer exterior to the shuttle and its contained filling, to govern the condition of the circuit, said circuit-changer being operated by or through the shuttle to change the condition of the circuit upon predetermined exhaustion of the filling and thereby render said determining means effective.

9. In a loom, a shuttle adapted to contain a supply of filling, filling-replenishing mechanism, means, including an electric circuit and a controller governed thereby, to effect the operation of said mechanism, and means exterior to the shuttle and operated by impact thereof upon predetermined exhaustion of the filling, to change the condition of the circuit and render the controller operative, through the first-mentioned means, to effect actuation of the filling-replenishing mechanism.

10. In a loom, filling-replenishing and stopping mechanisms, means, including an electric circuit, to determine the time of operation thereof, a shuttle to contain filling, a circuit-changer exterior to the shuttle and its contained filling, to govern the condition of the circuit, said circuit-changer being operated by or through the shuttle to change the condition of the circuit upon predetermined exhaustion of the filling and thereby render said determining means effective, and a selecting device to render one of said mechanisms responsive to the operation of the said determining means.

11. In a loom, a shuttle to contain filling, a feeler to intermittently engage and be moved by the filling until predetermined exhaustion of the latter in the shuttle, mechanism to automatically supply filling, controlling means therefor including an electric circuit and a normally quiescent controller operative by a



change in the condition of the circuit, and means exterior to and operated by the shuttle to change the condition of the circuit upon failure of filling-induced movement of the feeler.

12. In a loom, a shuttle-box and shuttle each having an opening in its side for the entrance of a feeler when the shuttle is boxed, the feeler, an electric circuit including an electromagnet and having coöperating and relatively movable terminals, and means exterior to and operated by the shuttle to effect relative movement of the terminals and change the condition of the circuit, the feeler, in the operation of the loom, periodically passing through the openings in the shuttle and box to engage the filling and thereby prevent the operation of said means by the shuttle until exhaustion of the filling in the latter to a predetermined extent.

13. In a loom, the combination with an electric circuit including a generator and an electromagnet, a yieldingly-sustained feeler independent of the shuttle and having a terminal of said circuit thereon, a second circuit-terminal mounted on and movable upon the feeler into and out of contact with the first terminal, to thereby change the condition of the circuit, and a shuttle having an aperture for the periodical entry of the feeler to contact with the filling therein and be moved thereby until predetermined exhaustion of the filling, the second terminal being thereupon moved, by impact of the shuttle, relatively to the feeler, to change the condition of the circuit and render the electromagnet operative.

14. In a loom, an electric circuit including a generator and an electromagnet and having two coöperating, yieldingly-sustained and relatively movable terminals, a shuttle to contain filling, and means to periodically move the terminals in unison by the presence of filling in the shuttle, and to effect their relative movement by the substantial absence of the filling to thereby change the condition of the electric circuit and operate the electromagnet.

15. In a loom, an electric circuit including a generator and an electromagnet and having two coöperating, yieldingly-sustained and relatively movable terminals, a shuttle to contain filling, means to periodically engage the filling in the shuttle and move said terminals in unison, and means to contact with the shuttle and effect relative movement of the terminals upon predetermined exhaustion of the filling, to thereby change the condition of the circuit and operate the electromagnet.

16. In a loom, an electric circuit including an electromagnet responsive to a change in the condition of the circuit, a shuttle to contain filling, means to indicate filling exhaustion to a predetermined extent, circuit-changing means exterior to the shuttle and the fill-

ing therein and operated by the former upon predetermined filling exhaustion, to change the condition of the circuit, and means to vary the extent to which filling exhaustion shall be carried before the operation of said circuit-changing means.

17. In a loom, an electric circuit including an electromagnet responsive to a change in the condition of the circuit, a shuttle to contain filling, means exterior to the shuttle and the filling therein and rendered inoperative by the presence of filling in the shuttle, and operative by the substantial exhaustion of the filling, to change the condition of the circuit, and a device to predetermine to what extent such substantial exhaustion of the filling shall be carried.

18. In a loom, an electric circuit including an electromagnet responsive to a change in the condition of the circuit, the latter having two coöperating terminals movable in unison, and also relatively to each other to change the condition of the circuit, a shuttle to contain filling, means to periodically move the terminals in unison by the presence of filling in the shuttle, and to effect their relative movement by substantial exhaustion of the filling, and means to predetermine to what extent such exhaustion shall be carried.

19. In a loom, filling-replenishing mechanism, controlling means therefor, comprising an electric circuit including an electromagnet responsive to a change in the normal condition of the circuit, a feeler to periodically engage and be moved by the filling in the shuttle until predetermined exhaustion of the filling therein, and circuit-changing means movable with the feeler and adapted to be operated by engagement with the shuttle, filling-induced movement of the feeler preventing operation of said circuit-changing means until the predetermined exhaustion of the filling is effected.

20. In a loom, the combination with an electrically-controlled filling-replenishing mechanism, and a yieldingly-sustained feeler upon which the terminals of the controlling-circuit are mounted, of a shuttle having an aperture for the entrance of the feeler, and means mounted on the feeler and in the path of the shuttle, to change the normal relative position of the terminals and thereby render the controlling-circuit operative, the filling in the shuttle acting through the feeler, until exhausted to a predetermined extent, to prevent movement of said means by engagement with the shuttle before such predetermined exhaustion of filling.

21. In a loom, filling-replenishing mechanism, an electric controlling-circuit therefor, a feeler to intermittently engage and be moved by the filling in the shuttle, a shuttle to contain filling, and circuit-changing means movable with and also relatively to the feeler, the said circuit-changing means being moved by the shuttle relatively to the feeler when the



filling is exhausted to a predetermined extent, to thereby change the condition of and render the controlling-circuit operative.

22. In a loom, filling-replenishing mechanism, an electric controlling-circuit therefor, including a generator and a normally quiescent electromagnet, a feeler having a terminal movable with it, a shuttle to contain filling and having an opening in its side for the periodical entrance of the feeler, and a yielding carrier slidably mounted on the feeler and supporting a second terminal, intermittent movement of the feeler by engagement with the filling preventing engagement of the carrier with the side of the shuttle until predetermined exhaustion of the filling, subsequent movement of the carrier by the shuttle effecting relative movement of the terminals to change the condition of the circuit and thereby render the electromagnet operative.

23. In a loom, an electric controlling-circuit including a generator and an electromagnet responsive to a change in the circuit, a shuttle to contain a supply of filling, circuit-changing means yieldingly sustained exterior to the shuttle and the filling therein and operated by engagement with the shuttle, and a feeler to periodically engage and be moved by the filling in the shuttle and thereby prevent operative engagement of the latter with said circuit-changing means until predetermined exhaustion of the filling.

24. In a loom, an electric controlling-circuit including a generator and an electromagnet responsive to a change in the circuit, a shuttle to contain a supply of filling, circuit-changing means yieldingly sustained exterior to the shuttle and the filling therein and operated by engagement with the shuttle, a feeler to periodically engage and be moved by the filling in the shuttle and thereby prevent operation of the circuit-changing means by the shuttle until predetermined exhaustion of the filling, and means to vary the extent to which such filling exhaustion shall be carried.

25. In a loom, an electric controlling-circuit including a generator and an electromagnet responsive to a change in the circuit, a shuttle to contain a supply of filling, circuit-changing means mounted exterior to the shuttle and the filling therein and operated by engagement with the shuttle, and a device to move said means away from the shuttle and

thereby render it inoperative until the filling in the shuttle is exhausted to a predetermined extent.

26. In a loom, filling-replenishing mechanism, stopping mechanism, common actuating means, a manually-operated selecting device to determine which of said mechanisms shall be actuated, a controlling-circuit for said means, including an electromagnet, a shuttle to contain filling, circuit-changing means exterior to the shuttle and its filling, and a device to render said circuit-changing means inoperative by the presence, and operative by the substantial absence, of filling in the shuttle, to thereby render said actuating means operative by or through the controlling-circuit.

27. In a loom provided with mechanism to effect a change of filling, electromechanical means wholly exterior to the shuttle and the filling therein, and operated by the shuttle upon substantial exhaustion of the filling to effect the actuation of the filling-changing mechanism, and a shuttle to contain filling.

28. In a loom provided with mechanism to effect a change of filling, means to determine the time of operation thereof, including an electrically-governed and normally quiescent controller, a shuttle adapted to contain filling, and means wholly exterior to the shuttle, and its contained filling and operated by the shuttle upon substantial exhaustion of the filling to render said controller operative and thereby effect actuation of the filling-changing mechanism.

29. In a loom, electromechanical controlling means wholly exterior to the shuttle and the filling therein and operative by the shuttle upon substantial exhaustion of the filling, and a shuttle to contain filling.

30. In a loom, a closed electric circuit containing an electromagnet, a shuttle to contain a supply of filling, and means wholly exterior to the shuttle and the filling therein and operated by the former upon substantial exhaustion of the filling to open the circuit.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN C. EDWARDS.

Witnesses:

GEO. W. GREGORY,

GEO. H. MAXWELL.