

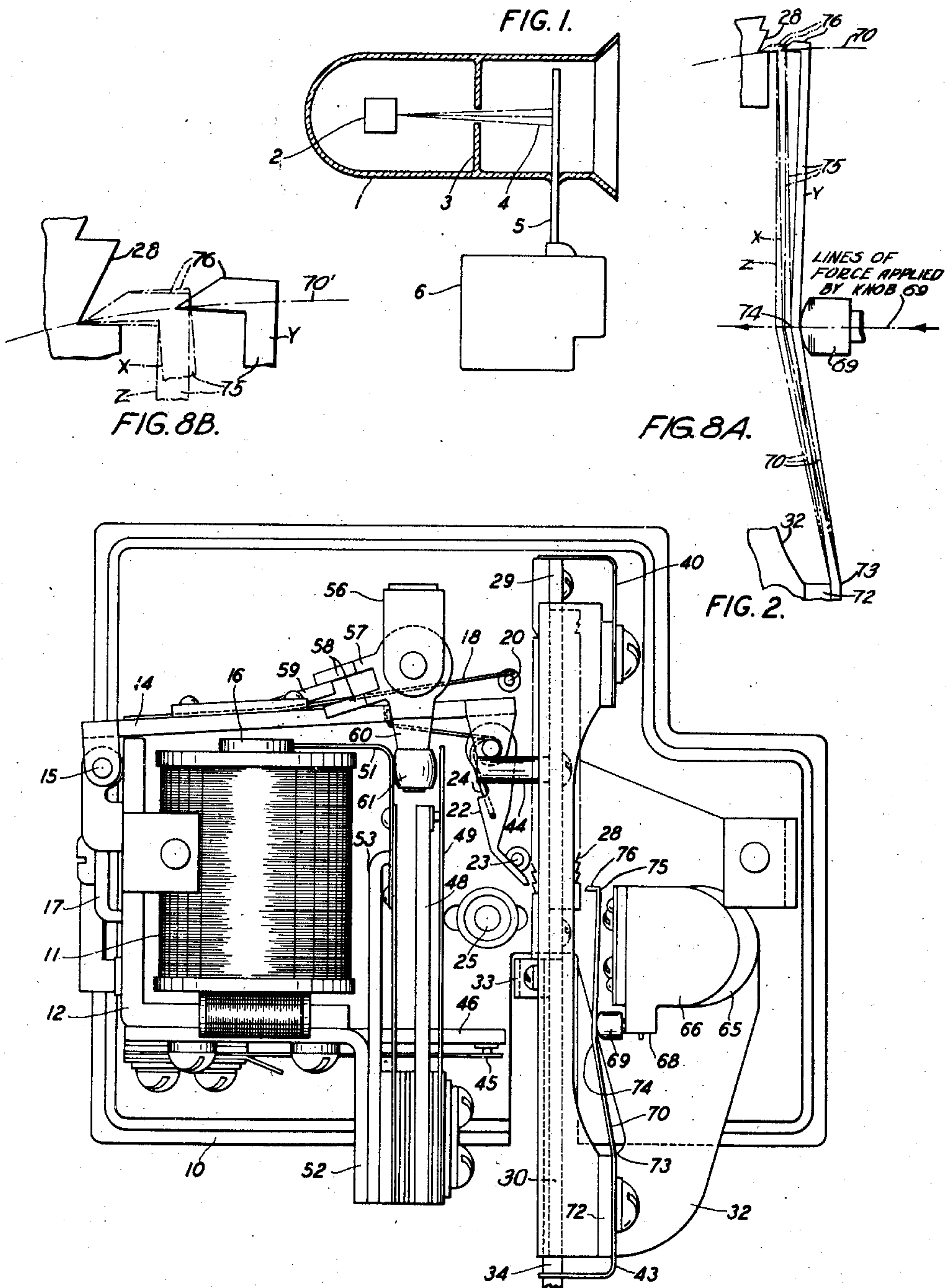
July 29, 1947.

H. B. BROWN
CONTROLLING MECHANISM

2,424,551

Filed Oct. 7, 1943

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

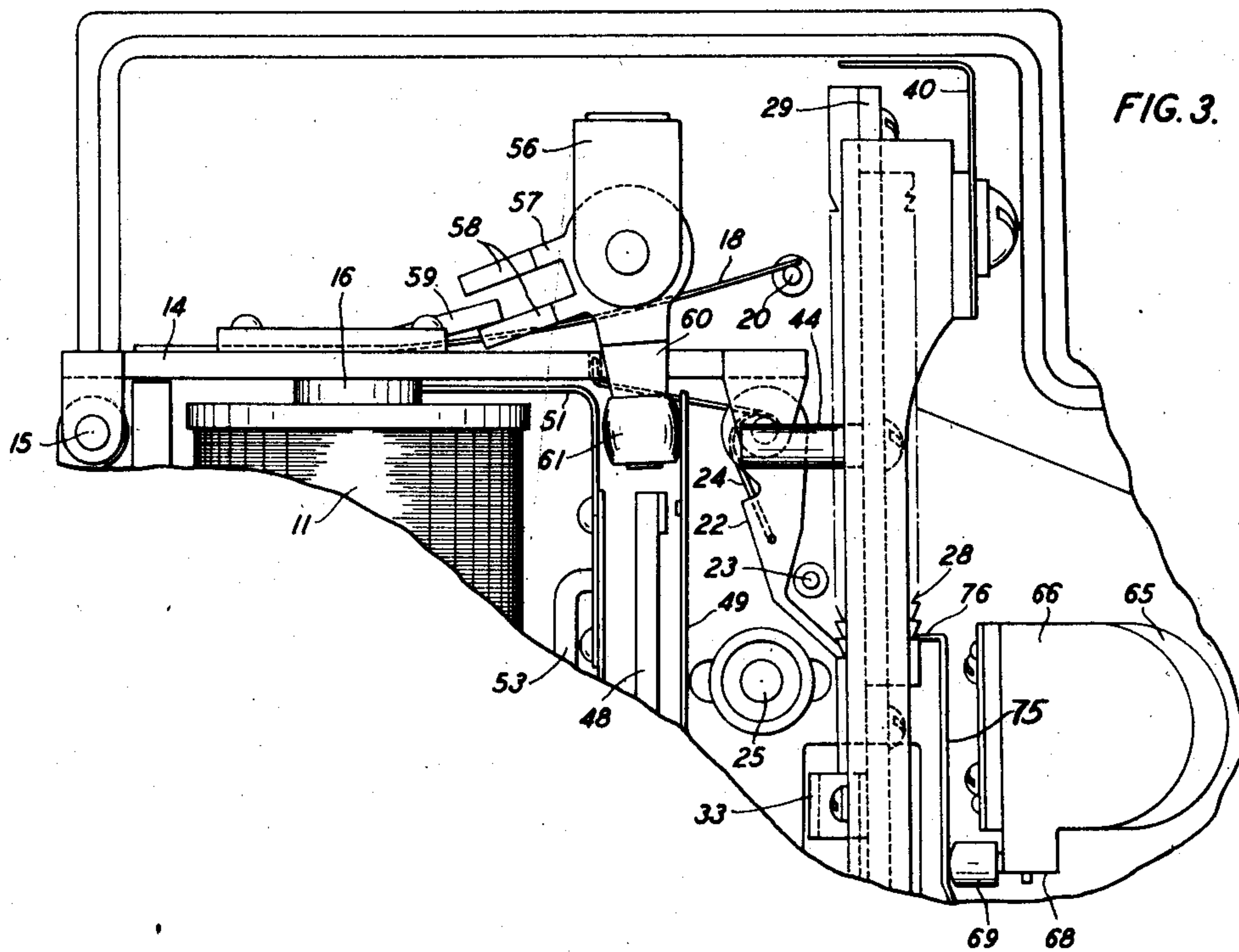


FIG. 3.

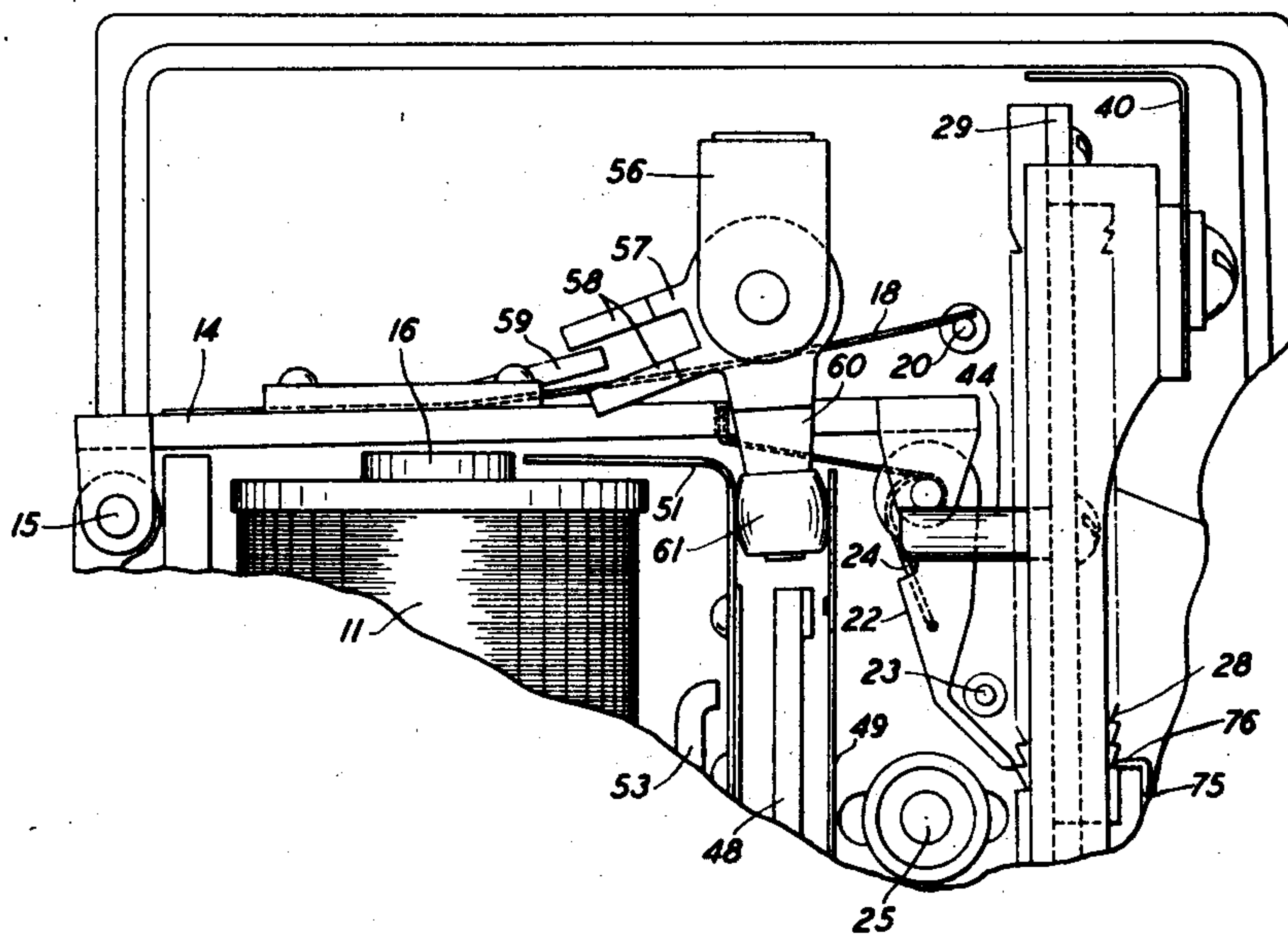


FIG. 4.

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3 Sheets-Sheet 3

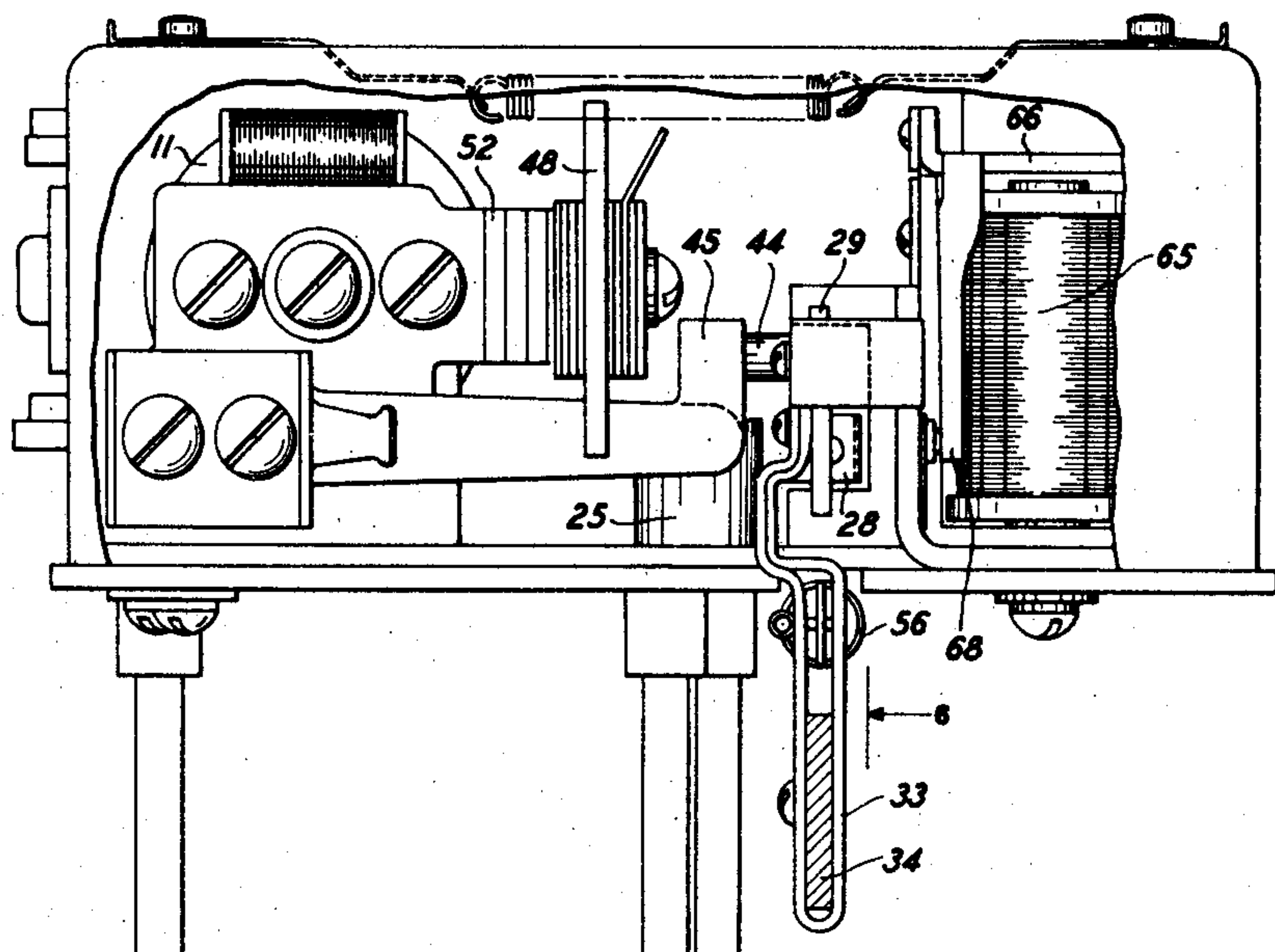


FIG. 5.

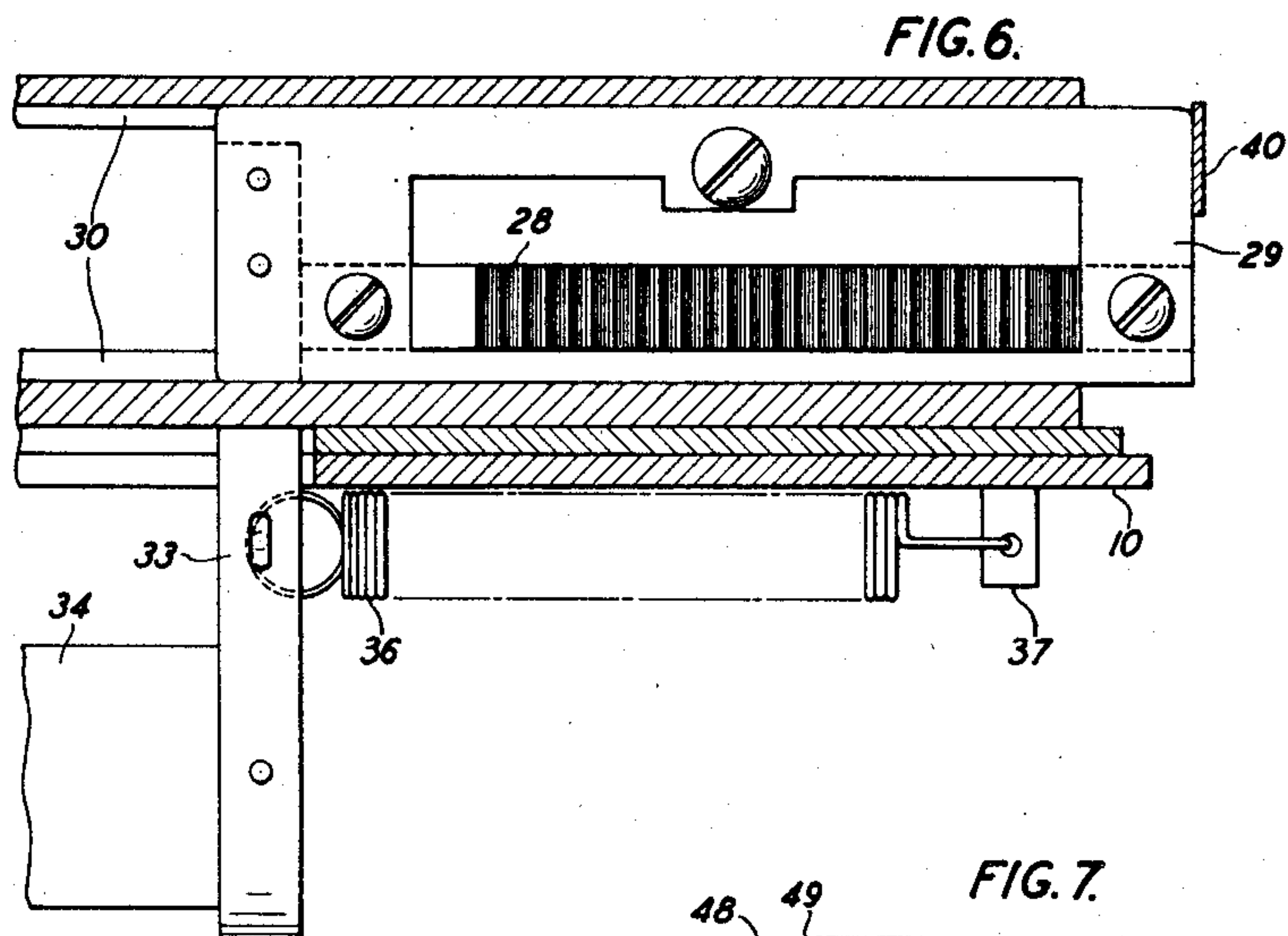


FIG. 6.

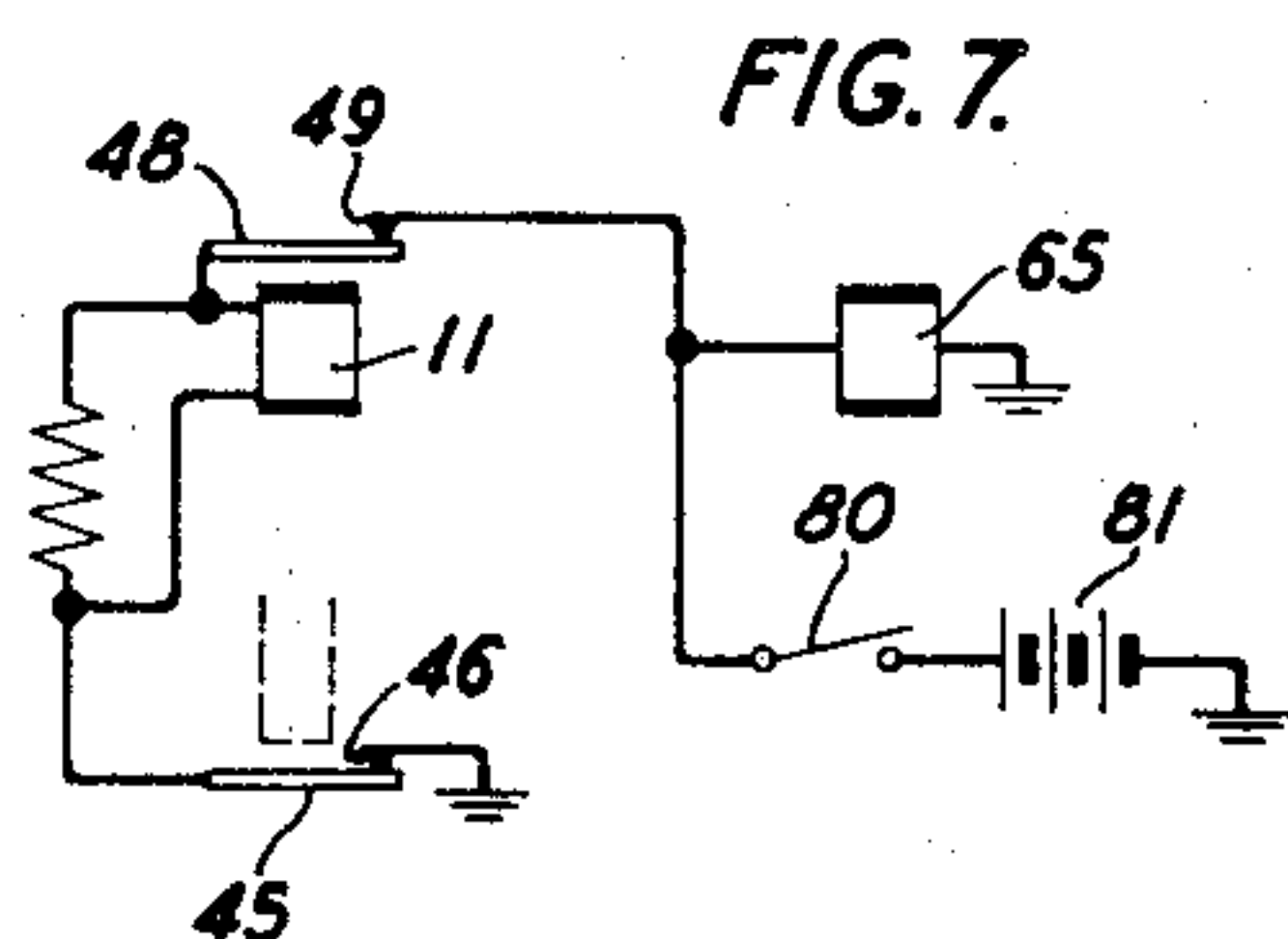


FIG. 7.

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CONTROLLING MECHANISM

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8 Claims. (Cl. 172—126)

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This invention relates to controlling mechanisms and particularly to such mechanisms in which members are advanced in steps and released in a single movement by electrically operated means.

An object is to simplify and improve such mechanisms and to increase their reliability and accuracy of performance.

Heretofore switching mechanisms have been used in which a rack or shaft for controlling switch wipers or the like to engage terminals to establish electrical connections were controlled in steps by a stepping magnet having an armature and a pawl operating on a rack each time the magnet was energized. The electrical operating circuit for this magnet was often controlled by self-interrupting contacts which maintained the circuits closed until the armature had completed its operating stroke when said contacts opened and maintained the circuit opened until the armature completed its release stroke. A release magnet was usually provided in which a holding pawl operating on the rack to maintain it in advanced position was actuated by the magnet to release the rack for its return to normal. In some cases as shown for example in Patent 1,567,053 of December 29, 1925, to F. H. Hibbard, an auxiliary armature and a fork member on the main armature for the stepping magnet were employed for maintaining the self-interrupting contacts closed normally by holding the auxiliary armature in position to be magnetically held by the energization of the magnet until the main armature was fully attracted when the fork member moved the auxiliary armature to open said contacts which were then maintained open until the main armature was fully released when the fork member again closed the contacts by operating on the auxiliary armature. In other cases as for example in the Patent 2,320,258 of May 25, 1943, to V. F. Bohman an auxiliary reed armature was first attracted to close a locking circuit through special contacts for the stepping magnet circuit which were opened by the main armature at the end of its operating stroke and when the magnet was deenergized the reed armature was first released to maintain the locking circuit open.

The present invention relates to mechanisms of these general types where a rack is advanced in steps and released in one movement. This mechanism may be employed for the purpose of opening a shutter in steps by having it attached to said rack for allowing the gradual passage of beams of radiant energy, for example, and for

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closing said shutter by a single movement for the shutting off of said beams quickly.

It is a feature of this mechanism to provide a step-by-step magnet with self-interrupting contact springs and circuits therefor in which an armature and pawl mechanism under control of said magnet advances said rack in steps and in which a hold magnet and circuit therefor controls a holding pawl spring to engage the rack and hold it in advanced position when the hold magnet is energized and to permit the release of said rack under tension of said pawl spring when the hold magnet is deenergized.

This mechanism includes means whereby the self-interrupting contacts are maintained closed until the end of the forward stroke of a main armature of the step-by-step magnet to advance the rack one step and to maintain them open until said main armature is fully returned to normal. This means consists of a forked lever controlled by the main armature and an auxiliary reed armature for controlling the self-interrupting contacts. When the stepping magnet is energized the reed armature is first fully attracted and then the main armature, the latter armature rotates said lever at the end of its forward stroke to open the self-interrupting contacts, then when the magnet is deenergized the reed armature releases first and operates by its own spring tension through the lever to hold the self-interrupting contacts open until the lever is actuated by the main armature at the completion of the return stroke of this armature to close said self-interrupting contacts against the tension of said reed armature.

This mechanism also includes a holding pawl spring for controlling the holding of the rack in advanced position by the hold magnet when energized and to release it when desired on the deenergization of this magnet. It consists of a flat pawl spring bent at a right angle at its free end and also bent approximately halfway down its length at a slightly oblique angle and anchored at its opposite end. This spring is engaged slightly above the oblique angle bend by an extension on the armature of the hold magnet when operated and is so located when so engaged that the upper part of the spring lies parallel with the teeth on the rack and the right angle extension engages a tooth on the rack surface thus holding the rack with a force exerted in a direction parallel to the rack and parallel with the upper portion of the spring. As the rack is advanced and this spring engages succeeding teeth the spring will yieldably slide from one tooth to another with

the point where the armature extension engages the spring as a fulcrum. The lower portion of the spring extends outwardly away from the rack in such a position that when the armature releases the spring it will return to its normal position with the anchoring point as its fulcrum and thus disengage the angle extension from the tooth with which it is engaged in a movement in a slightly upward direction away from the tooth and thus glides or slides from the tooth with the least possible friction. By this arrangement of the holding pawl spring and hold magnet the spring when engaging the rack is holding it with a firm grip and when it is released it will release in an easy and practically frictionless manner.

Referring now to the drawings:

Fig. 1 shows in a diagrammatic form a radiant energy producing device with the mechanism in accordance with the applicant's invention for controlling the passage of beams from this source;

Fig. 2 shows a top view of a mechanism in accordance with the applicant's invention;

Figs. 3 and 4 show various positions of the main armature and auxiliary armature and self-interrupting contacts of the mechanism shown in Fig. 2 during the operation of this mechanism;

Fig. 5 is a front view of the mechanism shown in Fig. 2 with part of the cover broken away;

Fig. 6 is a partial view of the rack and its operating spring and other parts of the mechanism shown in Fig. 2;

Fig. 7 is a circuit diagram of the circuit for controlling the mechanism shown in the preceding figures.

Figs. 8A and 8B show magnified pictures of the steps through which the holding spring pawl goes in relation to the rack during its movement by the holding magnet.

Referring now to the drawings and particularly to Fig. 1 which shows an application of the applicant's invention to a device for controlling the passage of radiant energy. For example, a device such as shown in Fig. 1, marked 1, may have a light source 2 from which light beams are projected through an opening 3 to a distant point. The passage of these light beams to the distant point may be controlled by a shutter 5 which may be gradually removed in steps to permit the passage of these light beams by the applicant's mechanism which has been indicated merely by a box 6 in this figure and further controlled by being rapidly shut off by the shutter 5 by means of this mechanism 6. It is, of course, understood that the shutter control mechanism and the applicant's mechanism may be employed for other purposes without departing from the spirit of the invention.

Applicant's invention has been illustrated in detail in the succeeding figures in the drawings. It may consist essentially of a base 10 on which is mounted an operating magnet 11 on the yoke piece 12 secured to the base 10. On this yoke piece 12 is mounted an armature 14 at a pivotal point 15 for attraction by the core 16 of the magnet 11. The armature is provided with a back stop extension 17 engaging normally the yoke piece 12 and is held in this position by a flat spring 13 connected to the armature 14 at one end and resting at its opposite end on a stud or post 20 secured to the base 10. At the free end of this armature 14 is mounted an operating pawl 22 which is held against the back stop 23 mounted on the frame 10 by means of a spring 24 and

when the armature is operated the pawl is controlled by a front stop 25 also secured to the base 10. The pawl 22 operates on a toothed bar or rack member 28 which is secured at its opposite ends by means of screws to a frame member 29 which is slidably movable in a runway 30. This runway is secured to a bracket 32 mounted on base 10. The rack 28 and its frame 29 are held in a normal released position by means of a spring 36, which at one end is secured to a post 37 connected to base 10 and located under the base. The opposite end is secured to an extension 33 connected at one end to the frame 29. The opposite end of the extension 33 is connected to an arm 34 to which may be secured the shutter 5 shown in Fig. 1. The normal position of the rack in the frame 29 is controlled by a buffer spring 40 secured with the runway on the bracket 32. Each time the armature 14 is attracted the pawl 22 engages a tooth in the rack 28 and moves it with its frame in the runway 30 one step. On the last step of the rack 28 it will engage an opposite buffer spring 43 and a pin 44 on the rack will then engage a spring 45 which is normally in contact with a spring 46 to open a connection between these two springs, which are mounted on the yoke piece 12.

To control the energization and deenergization of the magnet 11, self-interrupting contact springs 48 and 49 are provided and a mechanism for opening these springs at the end of the operating stroke of the armature 14 and for closing them at the end of the release stroke of this armature is provided as follows. This mechanism consists of an auxiliary reed armature 51 which is mounted on the bracket 52 with a stop member 53. On this bracket 52 is also mounted the springs 48 and 49 while the bracket itself is secured to the yoke piece 12. Attached to a bracket 56 extending from the base 10 is a lever 57 which may be engaged at its forked arm 58 by an extension 59 secured to armature 14. This lever 57 is also provided with an arm 60 having an insulating knob 61 which may engage the spring 49 to open the connection between it and the spring 48 and also may be controlled by the reed armature 51 as will presently be described. When the magnet 11 is first energized the reed armature 51 is immediately attracted by the core 16 and when the armature 14 completes its operating stroke the forked arm 58 is engaged by extension 59 causing the lever 57 to be rotated so that the knob 61 on arm 60 will engage spring 49 and open the connection with the spring 48 thus causing the deenergization of the magnet 11. This permits the reed armature 51 to be immediately released to engage knob 61 and hold the member 57 in the position where the springs 48 and 49 are maintained separated, until the armature 14 is completely released when the extension 59 again engages the forked arm 58 to rotate lever member 57 in the opposite direction and thus permit the closure of the connection between springs 48 and 49 against the tension of the reed armature 51. Thus it will be seen that by means of this auxiliary armature and the lever 57 the self-interrupting contacts 48 and 49 are controlled so that they will remain closed until the operative stroke of the armature 14 is completed and remain open until the completion of the return stroke of the armature 14.

Fig. 3 shows the armature 14 completely attracted by the magnet 11 with the lever 57 and the knob 61 in position so that this knob holds the springs 48 and 49 separated. Fig. 4 shows the

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position of the armature 14 almost at its released position and with the auxiliary armature 51 holding through the knob 61 the springs 48 and 49 separated, while in Fig. 2 the armature 14 is shown completely restored to normal in which position the knob 61 engages the reed armature 51 and permits the connection between springs 48 and 49 to become closed.

To maintain the rack 28 in an advanced position after each step the hold magnet 65 is provided mounted on the bracket 32 and having an armature 66. This armature 66 is provided with a downward extension 68 to which is attached the insulated knob 69 which engages the holding pawl spring 70. This holding pawl spring 70 is secured on the bracket 32 at 72 and forms part of the previously mentioned buffer spring 43. It should be observed that this pawl 70 is bent at point 73 slightly towards the left as shown in Fig. 2 and at point 74 it is bent back towards the right so that the remainder of the free end 75 of this pawl lies practically parallel with the rack 28 when the spring is not engaged in a tooth of the rack. On the other hand when the armature 66 is attracted by the energization of magnet 65 the knob 69 will bend the pawl 70 with the point 73 thereof as a fulcrum and cause the right angle extension 76 to engage a tooth in the rack 28. In this position the upper end 75 of the pawl from the point 74 to the extension 76 will lie substantially parallel with the rack 28. In this position of the pawl the under-surface of the extension 76 forming a right angle to the end 75 will engage a corresponding tooth surface, surface to surface, and thus hold the rack with a force acting on the engaged tooth at a right line direction exactly opposite to the tension of spring 36 and thus hold the rack firmly in an advanced position. It is seen from an examination of Figs. 8A and 8B that in the intermediate position of the spring pawl 70, to be known as position X and designated as X on Figs. 8A and 8B, there has been no force external to the spring pawl 70 acting on the extension 76 in the opposite direction to that exerted by the knob 69 and that the surfaces of the extension 76 and the tooth of the rack 28 which are intended to contact each other have not met and that the spring pawl 70 has essentially the same configuration above the point 73 as in its unoperated position, designated as Y on Figs. 8A and 8B. During subsequent movement of the spring 70 under further force exerted by knob 69 in the same direction there will be a force acting by the rack 28 on the extension 76 opposite to that of knob 69 such that the spring pawl 70 will be deformed as in position Z, designated as Z in Figs. 8A and 8B, relative to its configuration in positions X and Y. It is further seen that this deformation of the pawl 70 will rotate the extension 76 such that the underneath surface thereof engages, surface to surface, with the face of the tooth of rack 28 as shown on Fig. 8B, and the section 75 of the pawl 70 is substantially parallel to the rack. As the rack 28 is advanced step by step by the pawl 22 the extension 76 will slide from tooth to tooth and bent from the point 74 as a fulcrum. On the other hand when the magnet 65 is deenergized releasing the armature 66, knob 69 will permit the pawl 70 to return to normal position. In this case the pawl 70 will swing outwardly under its own tension with the point 73 as its fulcrum and it will be observed that under these circumstances there will be a slight upward movement of the extension 76 as it disengages a tooth in the rack 28. Thus the release

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will be accomplished quickly without sticking as the under surface of the extension 76 will disengage itself from the surface of a tooth in this slightly upward and outward direction along the arc 70' away from the tooth. It is seen from Fig. 8B that the contact surface of the extension 76 will rotate under the tension in spring pawl 70 due to the deformation of same in position Z so as to separate substantially normally from the tooth surface prior to returning to its unoperated position under the tension in the spring pawl 70 along the arc 70'. By this arrangement of the pawl 70, that is, by having it bent at points 73 and 74, having the end parallel with the rack and having the lower surface of the extension 76 at a right angle to the holding surfaces on the teeth, a firm grip is established on the teeth when the pawl is holding the rack in an advanced position and when the pawl is released an easy release condition is established. Thus sliding friction is minimized at the contact surfaces of the extension 76 and the tooth on engagement and release.

A description will now be made of the circuit operations for the controlling of this mechanism to open the shutter 5 in steps and to close it in one movement. The circuit such as shown in Fig. 7 may be used for this purpose. A circuit may be closed to cause the mechanism to function by the operation of switch 80 from battery 81, switch 80, hold magnet 65 to ground. This operates the hold magnet 65 to cause the pawl 70 to engage a tooth in rack 28. A circuit is also closed from battery 81, switch 80, self-interrupting contacts 49 and 48, magnet 11, contacts 45 and 46 to ground. This causes the energization of magnet 11 which then operates to attract its armature and cause pawl 22 to engage a tooth in rack 28 to advance rack 28 one step. When the magnet is fully energized the connection between the self-interrupting contacts 48 and 49 is open as described and the magnet releases whereupon the circuit for the magnet 11 is again closed. These operations are repeated until the rack has been advanced to the position where the pin 44 engages the spring 45 to open this circuit permanently. The mechanism remains in this position as long as desired with the shutter 5 open to permit the rays 4 from source 2 to pass to a distant point. When it is desired to shut off these rays from passing to this distant point the switch 80 is open and the magnet 65 released causing the rack to be immediately released under the tension of spring 36 to normal position in a single movement and at a rapid rate.

What is claimed is:

1. In a controlling mechanism a motor magnet, an energizing circuit therefor, a rack, a spring for yieldingly holding said rack in normal position, a main armature and an auxiliary armature for said magnet, interrupter springs included in said circuit, means controlled by said main armature for opening said springs at the end of the attracted stroke of said main armature, for maintaining said springs open under control of said auxiliary armature while the main armature is releasing from its attracted position and for permitting the closing of said springs when the main armature has completed its release stroke, a hold magnet, an energizing circuit therefor, a spring pawl controlled by said hold magnet for maintaining said rack in advanced positions when said hold magnet is energized and for releasing said rack when said hold magnet is released, said hold magnet and spring pawl being so arranged that when the spring pawl is

holding said rack in an advanced position it exerts a holding force directly opposite to the force exerted by the rack spring on said rack and when the spring pawl is released from said rack it exerts a releasing force which is in a direction away from the rack and at an angle less than a right angle to the direction of the force exerted by the rack spring on said rack.

2. In a step-by-step mechanism, a motor magnet, an energizing circuit therefor, an armature for said magnet, a rack, a spring for yieldingly holding said rack in normal position, means controlled by said magnet and armature for advancing said rack in steps in response to the closing of said energizing circuit including self-interrupting contacts and means for opening said contacts when the armature is fully attracted and for permitting the closing of said contacts when said armature is fully released, a hold magnet, an energizing circuit therefor, a spring pawl controlled by said hold magnet for maintaining said rack in advanced positions when said hold magnet is energized and for releasing said rack when said hold magnet is released, said hold magnet and spring pawl being so arranged that when the spring pawl is holding said rack in an advanced position, it exerts a holding force directly opposite to the force exerted by the rack spring and when the spring pawl is released from said rack, it exerts a releasing force which is in a direction away from the rack at an angle less than a right angle to the direction of the force exerted by the rack spring on said rack, said releasing force being produced by tension in said spring pawl.

3. In a step-by-step mechanism, a motor magnet, an energizing circuit therefor, a rack, a rack spring for yieldingly holding said rack in normal position, a main armature, a pawl on said armature for engaging teeth in said rack, to advance said rack one step each time said motor magnet is energized, an auxiliary armature for said motor magnet, interrupter springs including said circuit, means for opening said interrupting springs operative by said main armature at the end of its attracted stroke, for maintaining said interrupted springs opened during the release stroke of said main armature operative by said auxiliary armature when released and for permitting the closing of said interrupter springs operative when said main armature is at the end of the release stroke, a hold magnet, a circuit therefor, a spring pawl operative by the hold magnet when energized to engage teeth in said rack to hold it in advanced positions with a force acting directly in opposition to the force exerted on said rack by said rack spring and operative by its own tension to disengage from a tooth in said rack to release it to normal with a force acting in a direction away from said tooth at an angle which is less than a right angle to the direction of the force exerted by the rack spring on said rack.

4. In a step-by-step mechanism, a motor magnet, a rack, a spring for yieldingly holding said rack in its normal position, means controlled by said motor magnet for advancing said rack in steps against the tension of said rack spring, a hold magnet, a spring pawl operative against its natural tension by said hold magnet when energized to engage teeth in said rack to hold the rack in the positions to which it is advanced by said motor magnet and operative under its own tension when the hold magnet is deenergized for releasing the rack, said pawl being so fixed, shaped and tensioned when it engages a tooth

in the rack that it exerts a holding force on a tooth in a direction coinciding with the axis of the rack and opposing the force exerted by said rack spring on said rack and when said spring pawl is released it is disengaged from said tooth in a direction away from the tooth and at an angle which is less than the right angle formed by the axis of said rack and the perpendicular to said axis.

5. In a step-by-step mechanism, a motor magnet, an energizing circuit therefor, a main armature, an auxiliary armature, interrupter springs included in said circuit, means controlled by said main armature for opening said interrupter springs at the end of the attracted movement of said main armature, for maintaining said interrupter springs opened under control of said auxiliary armature while the main armature is releasing from its attracted position, and for permitting the closing of said springs when the main armature is fully released.

6. In a step-by-step mechanism having a frame to which are attached a rack, a rack spring for yieldingly holding said rack in its normal position and means for advancing said rack in steps against the tension of said rack spring, a spring pawl having one end thereof fixed to said frame and the other end thereof free and adapted to engage said rack for holding same in advanced position, said pawl being biased normally out of engagement with said rack by reason of its own tension, and controlling means for said pawl adapted first to engage said pawl at a point between the ends thereof to force same into engagement with a tooth of said rack, said pawl rotating about its fixed end as a first fulcrum prior to said engagement, second to hold said pawl against its tension in engagement with said rack as the latter is stepped whereby said pawl engages and disengages succeeding teeth on said rack, said pawl rotating about the area of engagement of same with said controlling means as a second fulcrum during the stepping of said rack and third to disengage from said pawl to enable same to release from said rack by reason of its own tension, said pawl rotating about said first fulcrum after disengagement from said rack, and so on each time said pawl is forced into engagement with said rack, held engaged therewith and released therefrom.

7. In a step-by-step mechanism, a rack, a rack spring for yieldingly holding said rack in its normal position, means for advancing said rack in steps, against the tension of said rack spring, a hold magnet, an energizing circuit therefor, a spring pawl for holding said rack in its advanced position under control of said hold magnet when energized, said hold magnet and said spring pawl being so arranged in relation to the rack and to each other that when said spring pawl is holding said rack, said pawl exerts a holding force produced by its own tension, said force resulting from said hold magnet acting against the tension of said spring pawl, said force acting on said rack in a direction exactly opposite to the force exerted by the rack spring on said rack and when said spring pawl is releasing from its holding position with said rack, it exerts a releasing force produced by its own tension, said latter force initially causing separation of the contact surfaces of said pawl and a tooth of said rack in a direction substantially perpendicular to both surfaces without causing said pawl to release from its holding position with said rack and subsequently to remove the pawl from holding position with said

rack in a direction between that away from said rack perpendicular to the axis of same and the direction in the line of force of said rack spring.

8. In a step-by-step mechanism, a rack, a rack spring for yieldingly holding said rack in its normal position, means for advancing said rack in steps, against the tension of said rack spring, a hold magnet, an energizing circuit therefor, a spring pawl for holding said rack in its advanced position under control of said hold magnet when energized, said hold magnet and said spring pawl being so arranged in relation to the rack and to each other than when said spring pawl is holding said rack, said pawl exerts a holding force produced by its own tension, said force resulting from said hold magnet acting against the tension of said spring pawl, said force acting on said rack in a direction exactly opposite to the force exerted by the rack spring on said rack and when said spring pawl is releasing from its holding position with said rack, it exerts a releasing force produced by its own tension, said latter force initially causing separation of the contact surfaces of said pawl and a tooth of said rack without causing said pawl to release from its holding position with said rack

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and subsequently to remove the pawl from holding position with said rack.

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