June 7, 1955

W. J. WEINFURT

CIRCUIT BREAKERS

2,710,320

Filed Aug. 16, 1952

4 Sheets-Sheet 1

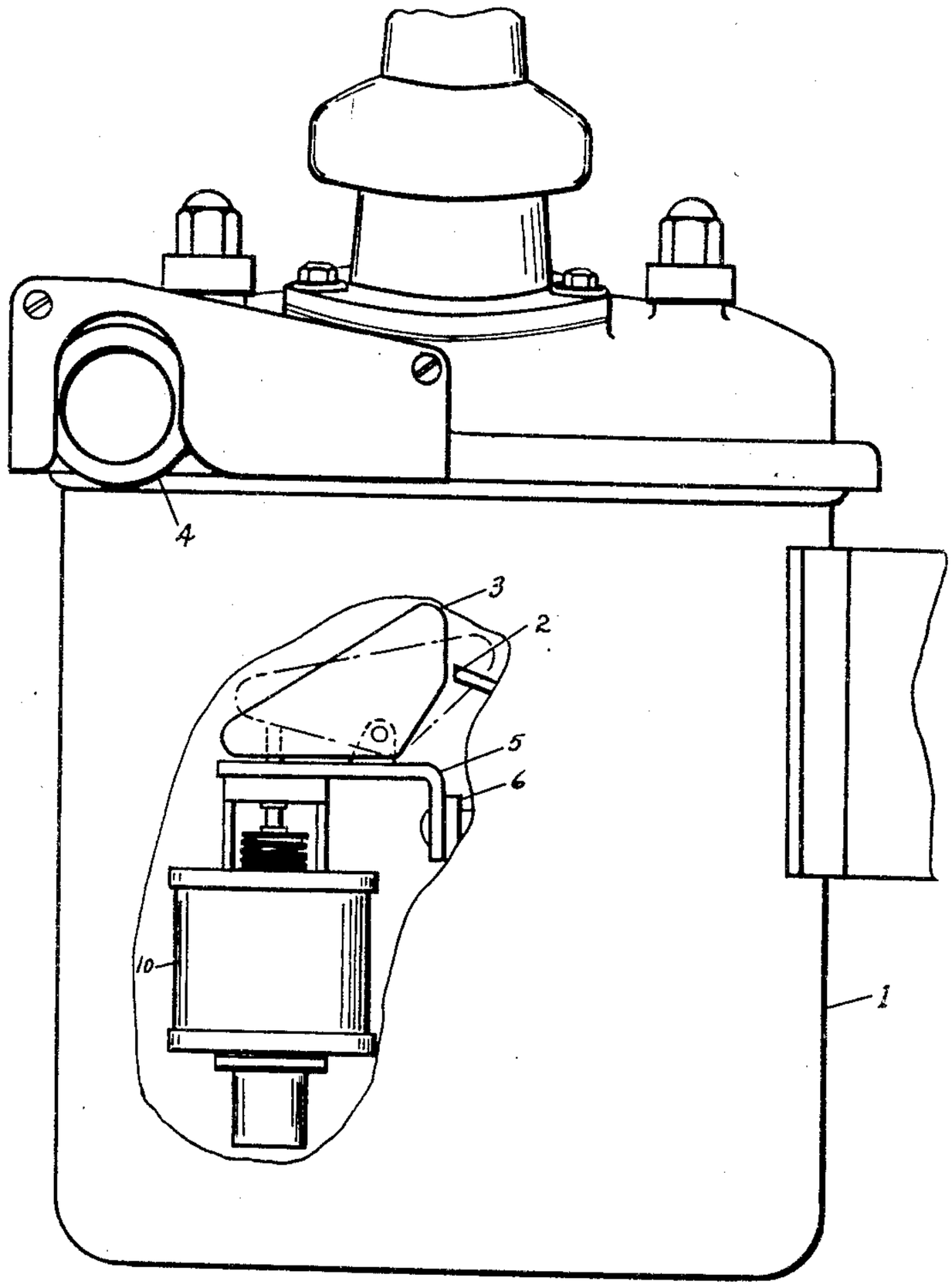

Fig. 1

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4 Sheets-Sheet 2

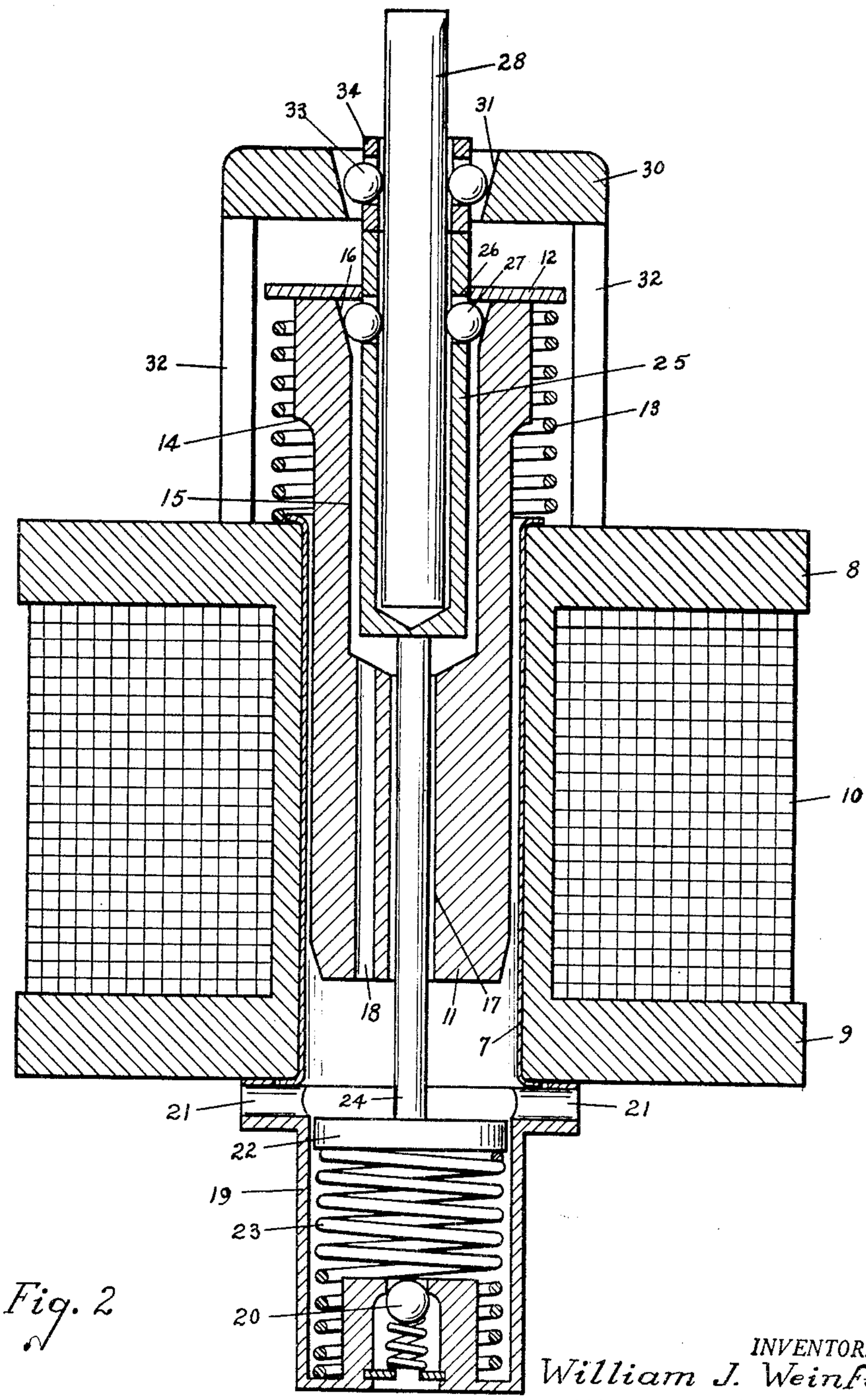

Fig. 2

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4 Sheets-Sheet 3

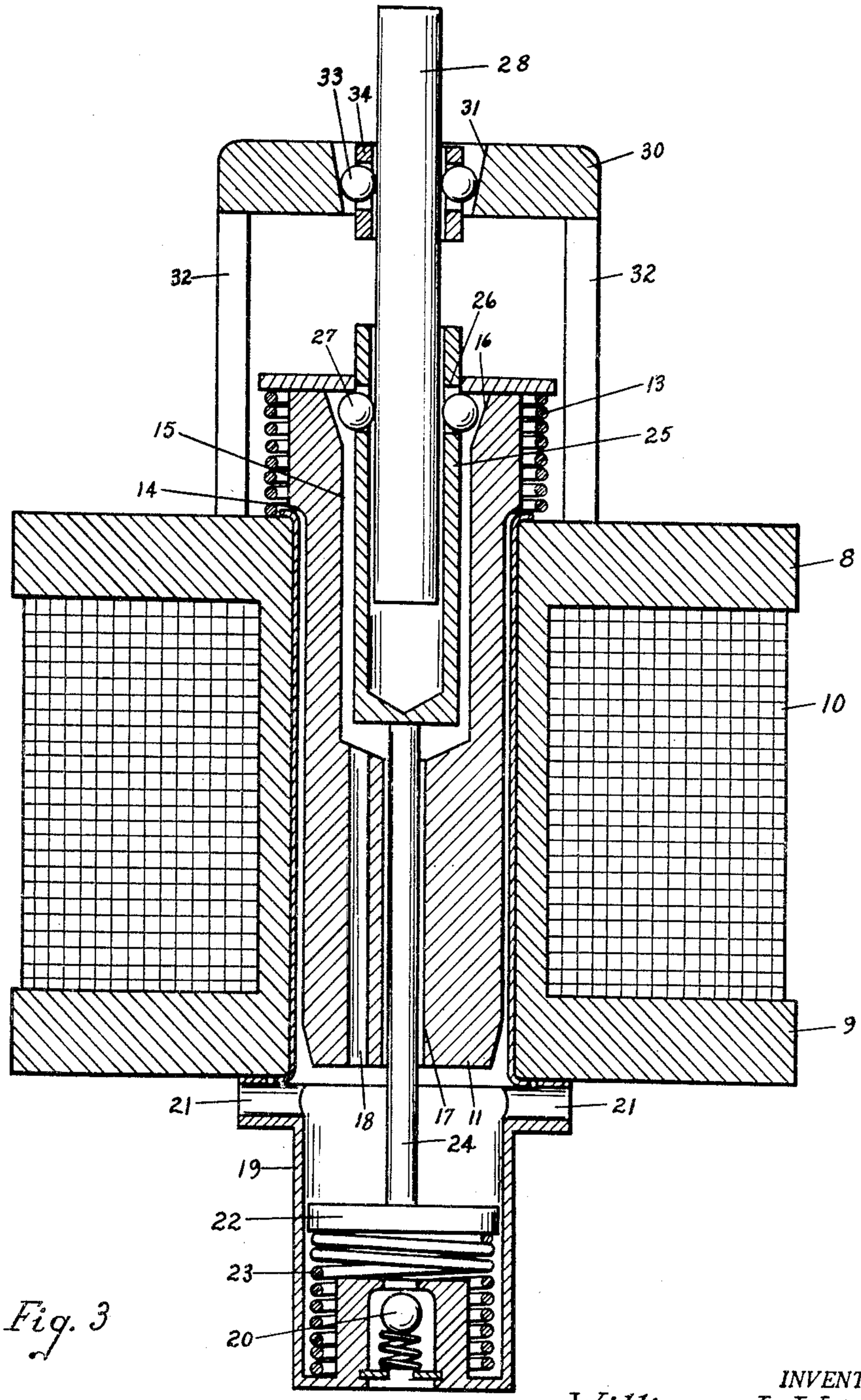

Fig. 3

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4 Sheets-Sheet 4

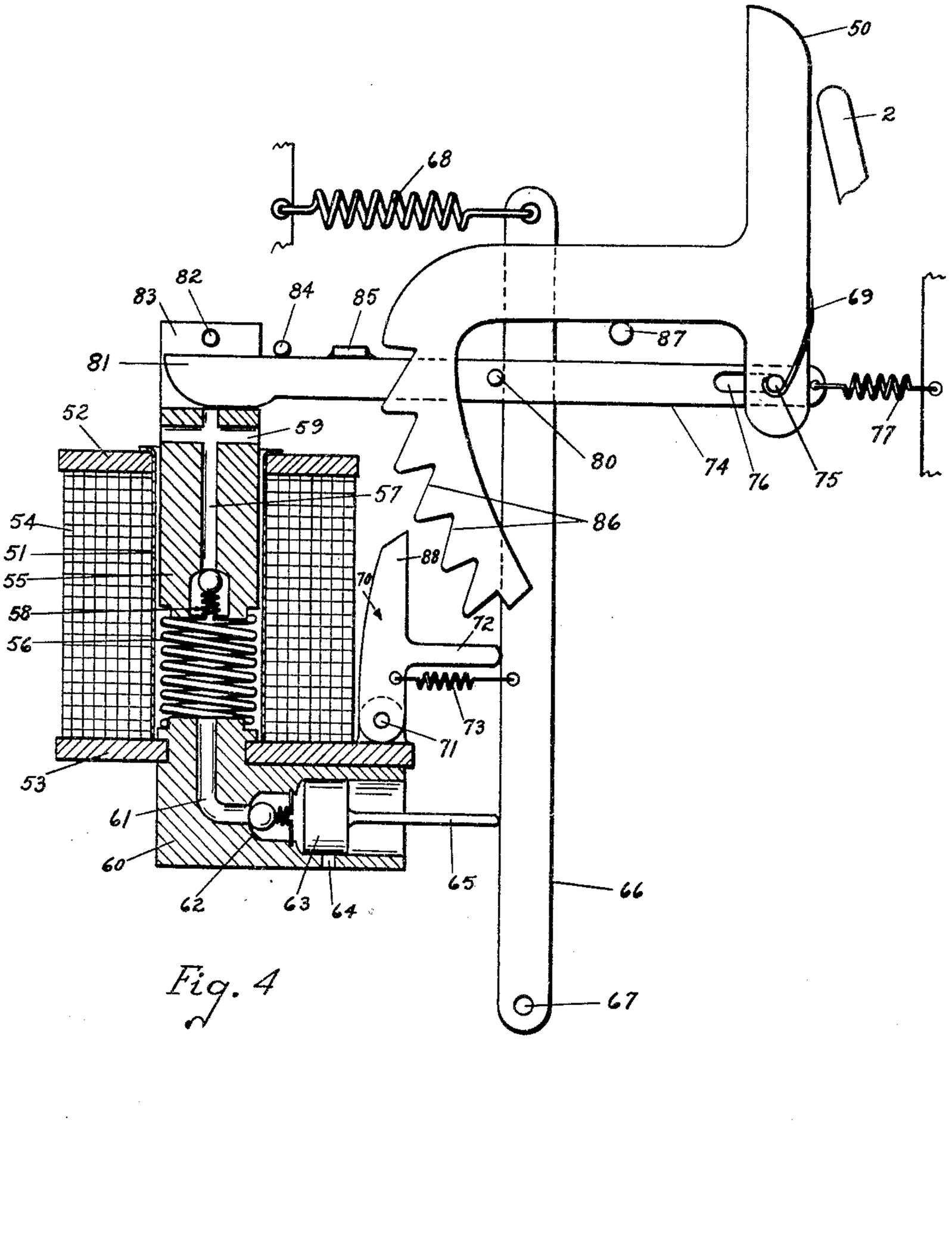

Fig. 4

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CIRCUIT BREAKERS

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Application August 16, 1952, Serial No. 304,669

8 Claims. (Cl. 200—108)

This invention relates to circuit breakers, and particularly pertains to circuit breakers having counting means responsive to a predetermined number of overload occurrences and which is arranged to have its contacts opened under no-load conditions after occurrence of this predetermined number of overloads.

The modern trend towards impulse counting, mechanical circuit breakers has brought forth a multitude of structures, all of which lend themselves to accomplishing a common objective—the eventual substitution of these structures for conventional single-shot fuse cutouts. It has been found that a substantial portion of the fault currents occurring on electrical lines are of a momentary nature. Even though the fault may be momentary, for the most part, a fuse link must be replaced each time this momentary overcurrent condition exists. This becomes a most troublesome and expensive item to add to operating and maintenance procedures and costs, and one that may be greatly minimized by the use of mechanical circuit breakers having overcurrent impulse counting means responsive to a predetermined number of impulses before final lock-out condition which ultimately requires operating attention to the breaker.

It will be apparent that overcurrent impulse actuated or counting devices for circuit breakers require means for permitting re-cycling of the operating characteristics when the overcurrent fault is of a temporary or momentary nature. The counting means must not accumulate past a predetermined number of impulses, but must be ready to start counting the predetermined number of impulses after a particular temporary fault condition has subsided, preparing itself as rapidly as possible to give full protection under a future set of fault conditions.

One major disadvantage to using hydraulically actuated integrating mechanisms has been that the various cooperating parts must be manufactured under very close tolerances. This is especially true when the resettling characteristics of the hydraulic counting device, such as a piston, depend upon leakage of the hydraulic fluid between the piston and its cooperating bore. Obviously, these tolerances require very expensive machining operations. In addition, leakage characteristics are often difficult to maintain when the hydraulic medium is not free from accumulations of dirt or other particles which may obstruct the free motion of the piston.

It is a general object of this invention to provide a circuit interrupter which may be called a counting single shot circuit interrupter which has a counting means for tripping the circuit interrupter, in which the counting means is advanced towards tripping position in a step-by-step manner upon cessation of current following overloads, and in which the counting means is finally moved to a position to trip the circuit interrupter when there is no current flowing following the occurrence of the last overload of the series for which the device is adjusted.

Another object of the present invention is to provide a circuit breaker structure including an overcurrent impulse counting trip mechanism which may take advantage

of hydraulic operation, and in addition, includes a positively operated integration and recycling means which are not directly dependent upon the exact volumetric displacement of an hydraulic pumping fluid.

It is a further object of this invention to provide a circuit breaker having an overcurrent impulse counting trip mechanism, which may be actuated by a hydraulic medium responsive to pumping action of an electro-magnetic means, which action is reflected in a positive holding device associated therewith.

It is still another object of the present invention to provide a circuit breaker having an overcurrent impulse counting tripping mechanism, which mechanism is energized by a combined electro-magnetic hydraulic means, and further which incorporates a time delayed positive-action holding means independently operable from the main energizing portion.

Specifically, it is an object of the present invention, in its preferred embodiment, to provide a circuit breaker having an overcurrent impulse counting tripping mechanism utilizing a self-aligning rod-like counter or integrator axially slidable responsive to overcurrent impulses and which is held in positive integrating position by wedge-like clutching means and further, which is arranged to be released from said clutching means by an independently actuated time-delayed resetting means when a momentary overcurrent condition subsides after a predetermined number of counting operations.

Embodiments of the invention are shown in the accompanying drawings, in which:

Fig. 1 is an elevation partly broken away of a circuit breaker showing one form of the tripping mechanism.

Fig. 2 is a fragmentary view showing the tripping mechanism with its various parts in normal operating position.

Fig. 3 is a fragmentary view showing the mechanism in overcurrent operating position.

Fig. 4 is a fragmentary view showing a further form of the tripping mechanism.

Referring to Fig. 1 it will be seen that a sectionalizing circuit breaker has been indicated generally and may be of the usual type and is mounted within a casing **1** filled with oil. The circuit breaker is arranged to be tripped by operation of the contact releasing lever or movable member **2**. This movable member **2** is actuated by means of a member **3** which, in turn, is actuated by the impulse counting tripping means hereinafter described in detail. The circuit interrupter is of any usual type and may be manually operated and manually reset by means of an eyeleted externally located lever **4** in accordance with the usual practice. The novel tripping means is supported by a suitable bracket **5** preferably formed of insulating material and secured to a portion **6** of the circuit interrupter.

The tripping mechanism, in the embodiment shown in Figs. 1, 2 and 3 comprises a cylindrical member **7** which may be formed as a spool and spun at each end over opposed flanges **8** and **9**. A solenoid winding is indicated by the reference character **10** and surrounds the cylindrical member **7**. A magnetic plunger or piston **11** is normally seated within the bore of the cylindrical member **7** as shown in Fig. 2. The upper end of the plunger is formed with an integral flange **12** providing a stop for one end of a spring **13**. The spring is normally in relaxed position as shown in Fig. 2 with the plunger seated thereon. The plunger **11** is preferably undercut to provide a shoulder portion **14** which acts as a stop for limiting downward motion as will hereinafter be described. The magnetic plunger is provided with a bore **15** which is countersunk at its upper end to provide a flared portion **16**. The lower end of the bore connects with the longitudinal passage **17** which extends to the lower extremity of the plunger **11**. A passage **18** provides an oil-escape means for permit-

ting unobstructed longitudinal motion of the plunger 11 in the bore of the cylindrical member 7.

The effective length of the cylindrical member 7 is increased downwardly by means of the thimble-like cylindrical member 19 which is normally closed at its lower end by a ball-and-spring check valve 20 to provide a time-delay resetting means. The upper end of the member 19 is provided with transverse passages 21 which permit a free discharge of oil as will hereinafter be described. The extending cylindrical member 19 is adapted to retain a resetting piston or plunger 22, which is normally biased upwardly by a spring member 23 to the position shown in Fig. 2. The passage 17 of the plunger 11 is arranged to loosely receive a plunger rod 24 extending upwardly from the piston 22.

The bore 15 of the plunger 11 is adapted to loosely receive a cylindrical member 25, which is preferably of a non-magnetic material, and closed at the lower end. The member 25 contains a plurality of circumferentially spaced openings 26 which are adapted to receive non-magnetic spheroidal wedging members, or balls 27. A counting or integrating pin 28 is seated within the bore of the cylindrical member 25, and is normally seated to rest on the lower closed end as shown in Fig. 1. It is to be noted, that the pin 28 is freely slidable within the bore of the member 25, and is self-aligning as will hereinafter be described.

An auxiliary holding or latching means is provided for the integrating or counting pin 28, and comprises a plate 30 having an upwardly flared opening 31. The plate may be supported in any suitable manner from the upper flange 8, for instance by the use of radially spaced members 32.

As shown, the opening 31 of the plate 30 is adapted to receive a series of spheroidal wedging members or balls 33. The wedging members 33 are arranged to be received by openings radially disposed in a sleeve 34, which is adapted to surround the counting pin 28.

The embodiment of Figs. 1, 2, and 3 operates in the following manner:

As disclosed, the novel tripping mechanism is arranged to operate in a single shot circuit breaker known as a sectionalizer, which is ordinarily supplied for a branch line and backed up or preceded by a reclosing circuit breaker, and which is arranged to operate two or more times without opening the branch line while allowing the main reclosing circuit breaker to open, but which nevertheless opens the branch line if the fault persists in such branch line with the main reclosing circuit breaker re-establishing service for all of the remaining branch lines, the faulty branch line remaining open. An example of such single-shot circuit breakers, which are popularly known as sectionalizers, particularly described and claimed in the Patent No. 2,515,530, issued on July 18, 1950 to Carl Schindler, and assigned to the same assignee as the present invention.

As has been previously stated, Fig. 2 illustrates the tripping mechanism with all of its cooperating parts shown in normal operating position relative to one another. Assume that the main current passes through the tripping winding coil or solenoid 10. Under predetermined overload or fault condition, the magnetic plunger 11 will be pulled downwardly under the magnetic influence of the solenoid to the position shown in Fig. 3. This downward motion will compress the spring 13, and will be stopped from further travel on contact of the shoulder 14 with the upper end of the cylindrical member 7. The flange 12 of the plunger 11 will contact the balls 27, radially disposed about the surface of the cylindrical member 25, and will cause the sleeve to move downwardly along the plunger 11. As the cylindrical member 25 moves downwardly it will contact the upper extremity of the rod 24 extending from the resetting plunger 22 to move downwardly against the biasing force of the spring member 23. This downward motion of

the plunger 22 will force out any oil contained within the cylindrical member 19 through the check valve 20. This will create a partial vacuum which will act to hold the plunger in downward position. It is to be noted that a slow oil leakage is provided around the outer periphery of the plunger 22, or by other conventional means, such as an orifice (not shown). Eventually, the oil leakage will permit the plunger to be urged upwardly by the biasing influence of the spring 23.

It is to be noted, that the downward motion of the plunger 11 is free from obstruction in any manner with the mechanism including oil discharge passages 18 in the plunger and 21 in the cylindrical member 19, both acting to alleviate any hindering influence by surrounding oil. A close observation of both Figs. 2 and 3 will reveal that the counting pin 28 has not changed in position as the plunger 11 is moved downwardly. This has been accomplished by the influence of the upper holding means comprising the spheroidal members 33, acting as a wedge between the flared surface of the opening 31 and the pin 28.

As was stated previously, a back-up reclosing circuit breaker is used with the single-shot breaker shown and is designed to open its contacts under the same minimum current requirements as the branch line circuit breaker or sectionalizer. Therefore, as the plunger 11 is drawn downwardly under the influence of fault or overload conditions to the position shown in Fig. 3, the main circuit will be opened by the backup recloser momentarily thereafter. With the main circuit open, the solenoid 10 will be de-energized and the plunger 11 will be urged upwardly under the influence of the spring 13 to the position shown in Fig. 2. It is again to be noted that no particular tolerances are required between the plunger 11 and the bore of the cylindrical member 7, and that, in fact, an oil discharge passage 18 has been provided. The upward motion of the plunger 11 will cause the flared wall surface 16 at the upper end of the plunger to contact the balls 27 and thereby wedge them against the counting pin 28, causing the pin to rise with the plunger 11. It will be apparent, that this upward motion of the pin 28 will simultaneously release the wedging action of the spheroidal members 33 of the holding means, and the pin will rise substantially the stroke length of the plunger.

A unique feature of the present invention is that the resetting plunger 22 is entirely separate from the influence of the plunger 11, except during overcurrent or fault conditions, when it is forced downwardly by lower surface of the cylindrical member 25, as was described hereinabove.

If the fault has cleared by the time the delayed action, self-closing, back-up circuit breaker has again closed the circuit, nothing further will occur as far as the plunger 11 is concerned. However, the resetting plunger 22 will be caused to rise under the influence of the spring 23, but in a time-delayed manner responsive to the leakage characteristics between the periphery of the plunger 22 and the bore of the cylindrical member 19. It is to be noted that oil that may have collected above the plunger 22 will be freely discharged from the openings 21. As the plunger rises, the plunger rod 24 will eventually contact the lower portion of the cylindrical member 25, and force it upwardly until its upper surface contacts the holding sleeve 34, as shown in Fig. 2. The upward force of the member 25 acting on the sleeve 34 will release the wedging action of the spheroidal members 33 on the pin 28. The pin will thus be free to resettle to the position shown in Fig. 2, and will accordingly be in position to operate under a new set of fault conditions.

It will be apparent that should a fault condition creating an overload occur at least twice in succession or should continue to exist beyond a predetermined length of time, the device will eventually act to trip the releasing lever or movable member 2 by means of the member

3, shown in Fig. 1. Under such conditions the device acts as follows:

After a first opening operation of the backup recloser contacts, the plunger **11** will move upwardly under the influence of the spring **13** as above described. However, due to its inherent leakage characteristics, the resetting plunger **22** will not have moved upwardly far enough to unlock the wedging balls and release the counting pin **28**. Instead, on continued fault conditions, the plunger **11** will again be drawn downwardly into the bore of the cylindrical member **7** as described hereinabove. The counting pin **28** will be held in the first of successive operating positions (not shown) by the holding means. The member **25** will be drawn downwardly with the piston and again contact the plunger rod **24** and again push it downwardly to its biased operating position, shown in Fig. 3. When the main circuit is again opened by the backup recloser contacts, the plunger **11** will be released to rise to the position shown in Fig. 2. It will be obvious, that the rising plunger **11** will carry the counting pin **28** upwardly with it (not shown). This integrating movement of the pin **28** is continued for a predetermined number of shots, until the pin eventually actuates the member **3** to contact the releasing lever **2** and lock out the sectionalizer.

It is to be particularly noted that the self-aligning pin **28** is moved upwardly under no-load conditions and will thereby cause lock-out of the sectionalizer contacts under no-load. This will permit a less expensive unit which requires lower insulation levels for normal operation.

Fig. 4 shows a further form of the invention in which an integrating ratchet is appended to the trip mechanism for obtaining a positive holding action of the tripping integrator means until a predetermined time delay period has passed. This embodiment may be used, with slight modification, in the same manner as the preferred embodiment. It is to be noted that the counting or integrating means has been directly incorporated as an integral part of the member **3** of Figs. 2 and 3 to provide a member **50** for actuating the releasing or movable member **2** towards lockout position.

In the form of the invention shown in Fig. 4 the main cylindrical member is indicated at **51**. It is provided with end flanges **52** and **53** and carries the tripping coil or energizing coil **54**. The main mangetic plunger **55** is seated within the bore of the cylindrical member **51** and is biased upwardly by spring member **56**. The plunger contains a longitudinal passage **57** coextensive therewith. The lower end of the passage is adapted to be closed by a check valve **58**. A transverse passage **59** at the upper end of the plunger **55** connects with the longitudinal passage **57**.

The lower portion of the cylindrical member **51** terminates in an L-shaped reset cylinder **60** containing an oil passage **61** which is normally closed by a check valve **62**. The reset cylinder **60** is adapted to receive a reset piston **63**, and is provided with a venting port **64** which is uncovered by the piston **63** after the piston has traveled a predetermined distance, as will hereinafter be described. A connecting rod **65** extends from the piston **63** and is adapted to releasably engage the lever **66** which is pivoted on a fixed pivot pin **67**. The lever **66** is urged in a counterclockwise direction by a spring **68**, which may be located at its upper end, or may be in any of the usual forms such as a torsional spring (not shown). A torsional spring **69** normally urges the counting member **50** in a counterclockwise direction.

A holding or latching pawl **70** is pivotally mounted on a projecting portion of the flange **53**, and is adapted to rotate about a pivot pin **71**. A projecting portion **72** of the pawl **70** is adapted to releasably contact the lever **66**, and is urged towards the lever by a spring member **73**. A slidable member **74** is pivotably and slidably positioned on a fixed pivot **75** through the slotted opening **76**. The member **74** is normally urged towards the

right as shown in Fig. 4 by a spring member **77**. The member **74** carries an extending pin **80** which abuts lever **11**. The opposite end of the member **74** is formed as a shoe-like portion **81**, which is loosely received between the upper surface of the plunger **55** and the stop **82** mounted an extending portion **838** integral with the plunger **55**.

A stop **84** is provided to limit the upward travel of the member **74** as will hereinafter be described. A driving pawl **85** is affixed to the member **74** and is adapted to engage the ratchet teeth **86** integral with the member **50**. The member **50** is adapted to rotate about the pivot pin **75** and normally rests on the stationary stop **87**. It is to be noted that the member **74** is normally held to the left, resisting the biasing influence of the spring **77**, by the lever **66** which is urged in a counterclockwise direction by the spring **68**. The projecting portion **88** of the holding pawl **70** is also adapted to engage the ratchet teeth **86** of the member **50** as will hereinafter be described.

The device shown in the reset position ready for a sequence of operations. Operation is as follows: An overload or fault current of a predetermined value flowing through the coil **54** will cause the plunger **55** to be moved downwardly against the action of the spring **56**. Inasmuch as the passage **57** of the plunger **55** will be closed by the check valve **58**, oil entrapped below the plunger will be forced into the reset cylinder **60** through the passageway **61**. The piston **63** will be forced to the right until the venting port **64** is uncovered. The connecting rod **65** extending from the piston **63** will contact the lever **66** and urge it in a clockwise direction about the pivot **67**. This clockwise motion of the lever **66** will simultaneously permit the members **74** to slide to the right under the influence of the spring **77** on the pivot **75** and also rotate the holding pawl **70** in a clockwise direction. The driving pawl **85** on the member **74** will simultaneously engage the uppermost tooth of the ratchet teeth **86** causing the member **50** to be slightly rotated in a clockwise direction about the pivot **75**. This upward motion of the ratchet teeth **86** will permit the portion **88** of the holding pawl **70** to slide under one of the lower teeth members. The member **50** will now be held in a positive position by the holding pawl **70** as the plunger **55** continues to descend downwardly. The pin **82** will engage the shoe-like portion **81** of the members **74** and urge it to rotate in a counterclockwise direction about the pivot **75**. Accordingly, the driving pawl **85** will engage the next tooth of the ratchet teeth **86** at the end of the first downward stroke of the plunger.

When the fault is interrupted, the coil **54** will be de-energized and the spring **56** will urge the plunger in an upward direction, carrying with it the shoe-like portion **81** of the member **74** and the member **50** which is engaged with the driving pawl **85** by its ratchet teeth **86**. At the end of the upward movement of the plunger **55**, the portion **88** of the holding pawl **70** drops into engagement with the next lower ratchet. It is to be noted that the upward motion of the plunger **55** is unimpeded as the passage **57**, operating in conjunction with the now open check valve **58**, provides a free discharge oil through its upper extremity and also the transverse opening **59**. It will be apparent that the lever **66** will continue to be held outwardly in a clockwise direction by the oil entrapped in the reset cylinder **60**.

When fault current again flows through the winding **54**, the plunger **55** will again be drawn down into the solenoid, but this time the oil it pumps will be vented out the port **64**. The driving pawl **85**, in the meantime, will slip around another tooth on the ratchet. When the fault is interrupted again, the plunger will return up as before, and carry the member **50** with it. Thus, by a number of operations, the member **50** will be rotated clockwise until it engages the member **2**, forcing it towards lockout position. However, if the number of

operations of the member 50 does not position it to cause tripping, oil will leak from the reset cylinder in the space provided by the periphery of the piston 63 and the bore of the cylinder, thereby permitting the lever 66 to be moved in a counterclockwise direction by the spring 68. Both of the pawls 70 and 85 will be disengaged from the ratchet teeth 86, and a member 50 will return to the position shown resting against the stop 87. In this position, another full sequence of operations is possible.

It will be seen that the embodiment of Fig. 4 is partly in diagram to conveniently illustrate the various levers and lever-actuating means, which obviously may be modified and re-positioned to obtain the same fundamental operating characteristics.

The term "sectionalizer" used throughout the specification and appended claims designates a circuit breaker structure having line contacts arranged to be opened only after occurrence of a predetermined number of integrating sequence of a counting member responsive to repeated or permanent fault conditions on the protected line.

It will be apparent that a novel impulse counting tripping mechanism has been provided by the present invention, which contains an integrating or counting member that is held in displaced position by a positive action-retaining means, and which further includes a time-delayed resetting portion that is independently operated from the main current responsive means.

I claim:

1. In a tripping device for actuating a contact releasing member and comprising a solenoid including a tubular member, an energizing winding surrounding said tubular member, and a magnetic plunger positioned in said tubular member; the combination of a counting member movable towards engagement with said contact releasing member, a driving member mechanically releasably engageable with said plunger and with said counting member to alternatively engage and disengage said counting member subsequent to successive energization of said winding in excess of a predetermined current value corresponding to an overload condition, latching means normally detachably associated with said counting member for releasably holding said counting member during progressive stepping positions, hydraulically actuated time delay resetting means normally urged towards reset position and releasably engageable with said latching means and arranged to detach said latching means from said counting member after the predetermined period during which said winding is not subjected to overload condition, said resetting means hydraulically communicating with said magnetic plunger whereby said resetting means is releasably actuated towards time delay position on each operation of said magnetic plunger responsive to overload energization of said winding.

2. In a tripping device for actuating a contact releasing member and comprising a solenoid including a tubular member, an energizing winding surrounding said tubular member, and a magnetic plunger positioned in said tubular member; the combination of a counting member movable towards engagement with said contact releasing member, a driving member mechanically releasably engageable with said plunger and with said counting member alternatively engaging and disengaging said counting member to impart step-by-step motion thereto on successive energizations of said winding in excess of a predetermined current value corresponding to an overload condition, latching means normally detachably associated with said counting member for releasably holding said counting member during progressive stepping positions, hydraulically actuated time delay resetting means normally urged towards reset position and releasably engageable with said latching means and arranged to detach said latching means from said counting member after a predetermined period during which said winding is not subjected to overload condition, said hydraulically actuated resetting means being releasably engageable with said operating member and being actuated toward time delay operation simultaneously with each alternative disengagement of said driving member with said counting member.

3. In a tripping device for actuating a contact releasing member and comprising a solenoid including a tubular member, an energizing winding surrounding said tubular member, and a magnetic plunger positioned in said tubular member; the combination of a counting member movable towards engagement with said contact releasing member, mechanical clutching means operatively associated with said plunger and with said counting member and adapted to alternatively engage and disengage said counting member to impart step-by-step motion thereto on successive energizations of said winding in excess of a predetermined current value corresponding to an overload condition, hydraulically actuated time delay resetting means normally urged towards reset position and releasably engageable with said clutch means and arranged to disengage said clutching means from said counting member after a predetermined period during which said winding is not subjected to overload condition, said resetting means hydraulically communicating with said magnetic plunger whereby said resetting means is releasably actuated towards time delay position on each operation of said magnetic plunger responsive to said successive overload energizations of said winding.

4. In a tripping device for actuating a contact releasing member and comprising a solenoid including a tubular member, an energizing winding surrounding said tubular member, and a magnetic plunger positioned in said tubular member; the combination of a counting member movable towards engagement with said contact releasing member, a driving member mechanically releasably engageable with said plunger and adapted to alternatively engage and disengage said counting member to impart step-by-step motion thereto on successive energizations of said winding in excess of a predetermined current value corresponding to an overload condition, latching means comprising embracing clutch members normally detachably associated with said counting member for releasably holding said counting member during progressive stepping positions, time delay resetting means releasably engageable with said latching means and arranged to detach said latching means from said counting member after a predetermined period during which said winding is not subjected to overload condition, said resetting means being hydraulically actuated towards time delay position responsive to said successive overload energizations of said winding.

5. In a tripping device for actuating a contact releasing member and comprising a solenoid including a tubular member, an energizing winding surrounding said tubular member, and a magnetic plunger positioned in said tubular member; the combination of a counting member movable towards engagement with said contact releasing member, a driving member mechanically releasably engageable with said plunger and adapted to alternatively engage and disengage said counting member to impart step-by-step motion thereto on successive energizations of said winding in excess of a predetermined current value corresponding to an overload condition, latching means normally detachably associated with said counting member for releasably holding said counting member during progressive stepping positions, hydraulically actuated time delay resetting means releasably engageable with said latching means and arranged to detach said latching means from said counting member after a predetermined period during which said winding is not subjected to overload condition, said resetting means being mechanically urged toward time delay position on disengagement with said plunger responsive to successive overload energizations of said winding.

6. A tripping device for actuating a contact releasing

member, comprising a tubular member having a first and a second portion, an energizing coil surrounding said first portion, said second portion including a time delay resetting means, a magnetic plunger located within and normally urged outwardly from said first portion of the tubular member, said plunger having a bore terminating at one end in a flared surface and having its opposite end terminating in a longitudinal passage extending from the opposite end of said plunger, a cylindrical member seated within said bore and enclosed at one end, an elongated non-magnetic counting pin seated within said cylindrical member and movable towards engagement with said contact releasing member, said cylindrical member having a series of circumferentially spaced apertures and being slidable relative to said pin and to said plunger, spheroidal wedging members disposed within said apertures and interposed between said counting pin and the flared surface of said plunger bore, said cylindrical member arranged to engage and disengage said wedging members and said pin to impart linear motion to said pin in a step-by-step manner on successive energization of said energizing coil in excess of a predetermined current value corresponding to an overload condition, a time delay resetting means operatively associated with said cylindrical member and arranged to be actuated towards time delay position on each successive operation of said magnetic plunger responsive to said successive overload energizations of said winding, and a counting pin holding means arranged to temporarily graspingly engage said pin during each progressive linear step and being adapted to be released from said engagement after a predetermined time delay period measured by the operating characteristics of said resetting means.

7. A tripping device for actuating a contact releasing member, comprising a tubular member having a first and a second portion, an energizing coil surrounding said first portion, said second portion including a time delay resetting means, a magnetic plunger located within and normally urged outwardly from the first portion of said tubular member, said plunger having a bore terminating at one end in a flared surface and having its opposite end terminating in a rod-receiving passage extending from the opposite end of said plunger, a cylindrical member seated within said bore and closed at one end, an elongated non-magnetic counting pin seated within said cylindrical member and movable towards engagement with said contact releasing member, said cylindrical member having a series of circumferentially spaced apertures and slidable relative to said pin and to said plunger, spheroidal wedging members disposed within said apertures and interposed between said counting pin and the flared surface of said plunger bore, said cylindrical member arranged to engage and disengage said wedging members and said pin to impart linear motion to said pin in a step-by-step manner on successive energizations of said energizing coil in excess of a predetermined current value corresponding to an overload condition, a resetting piston seated in said second portion of said tubular member and having a connecting rod seated within the rod-receiving passage of said plunger and urged towards releasable engagement with the closed end of said cylindrical member, and a counting pin holding means arranged to temporarily graspingly engage said pin during each progressive linear step and further being adapted to release said pin after a predetermined time delay measured by the operating characteristics of said resetting piston.

8. A tripping device for actuating a contact releasing member, comprising a cylindrical member having a bore defining a first portion and a second portion, a magnetic pumping plunger located within said first portion, an energizing coil surrounding said first portion, said plunger being normally urged outwardly from said bore and being provided with a longitudinal passage substantially coextensive therewith, said passage being open at one end and normally closed at the opposite end by a check valve adapted to open on outward motion of said plunger, said second portion providing a time delay reset cylinder and hydraulically connecting with said first portion by means of a passage normally closed at the reset cylinder and by means of a check valve, a reset piston located in said reset cylinder having an effective stroke measured by a pre-positioned discharge port disposed in the wall of said reset cylinder, a pivoted lever arm normally urged towards and releasably engageable with said piston, a rotatable-slidable driving member pivoted at one end and slidably engageable at the opposite end thereof with said magnetic plunger, a rotatably pivoted counting member having a series of ratchet teeth and movable towards engagement with said contact releasing member, a driving pawl positioned on said driving member adapted to alternatively engage and disengage the ratchet teeth in a step-by-step manner responsive to successive energizations of said coil in excess of a predetermined current value corresponding to overload condition and magnetically actuating said plunger towards pumping position, and a holding pawl alternatively engageable with the ratchet teeth of said counting member during each progressive counting step, said holding pawl adapted to be disengaged after a predetermined time delay measured by the operating characteristics of said reset piston.

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