United States Patent

[11] 3,632,933

[72] Inventors **James E. McClain;**
Argus F. Parks, both of Greenville, Tex.

[21] Appl. No. **22,554**
[22] Filed **Mar. 25, 1970**
[45] Patented **Jan. 4, 1972**

[73] Assignee **Esco Manufacturing Company**
Greenville, Tex.

[54] RACK AND GEAR SPRING CHARGING MEANS FOR RECIPROCATING CONTACT

10 Claims, 12 Drawing Figs.

[52] U.S. Cl. ..... **200/153SC,** 200/78, 200/153 P
[51] Int. Cl. **H01h 3/30,** H01h 3/40, H01h 5/06
[50] Field of Search ..... 200/153 P, 153 SC, 78, 144 B; 335/171, 75–77

[56] **References Cited**

UNITED STATES PATENTS

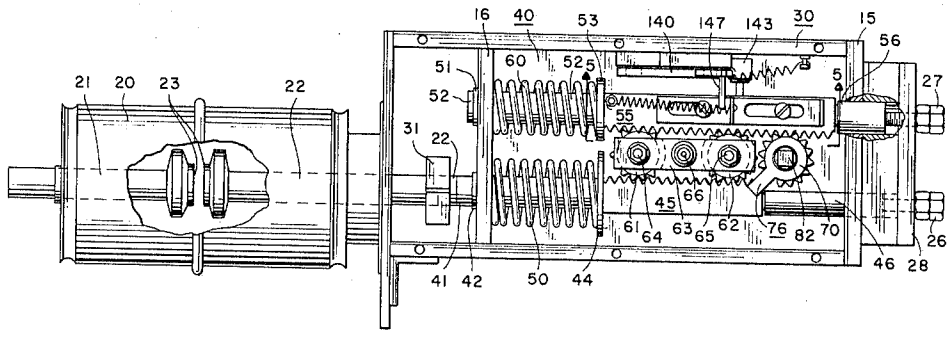
3,098,134	7/1963	Nijland	200/78
2,539,213	1/1951	Von Mehren	200/153 P
1,837,544	12/1931	Haller	200/78
1,380,595	6/1921	Ritz, Jr.	200/78

FOREIGN PATENTS

462,425	6/1928	Germany	200/153 P

Primary Examiner—Robert K. Schaefer
Assistant Examiner—Robert A. Vanderhye
Attorney—Kenneth R. Glaser

ABSTRACT: Disclosed is circuit interrupting apparatus of the type including a pair of coaxially disposed electrically conductive contact carrier rods, one of the carrier rods mounted for reciprocative movement between a closed position whereby the carrier rods are engaged, and an open position whereby the carrier rods are disengaged, and the current flow therethrough is interrupted. Improved actuator apparatus for translating the movable carrier rod into and out of engagement with the other contact carrier rod includes a pair of racks operatively coupled by rotary gears, the racks mounted for reciprocating motion in respective parallel linear paths. One of the racks is coupled to a gear and rotary shaft arrangement for urging the rack forward to compress a closing spring coupled thereto, a latch and roller keeper arrangement temporarily holding the closing spring compressed. Another latch arrangement engages the operatively coupled rotary gear against linear motion when the closing spring is compressed, tripping means coupled to the rotary shaft then releasing the compressed closing spring, the rearward movement of the one rack powering the other rack coupled to the reciprocating contact carrier rod forward to close the contacts. An opening spring coupled to this rack is then compressed by the forward movement of the rack. The opening spring is then automatically released from compression by latch release means coupled to relay circuitry responsive to excessive current through the apparatus, or manually released by latch release means operatively coupled to the rotary shaft.



PATENTED JAN 4 1972

3,632,933

SHEET 1 OF 4

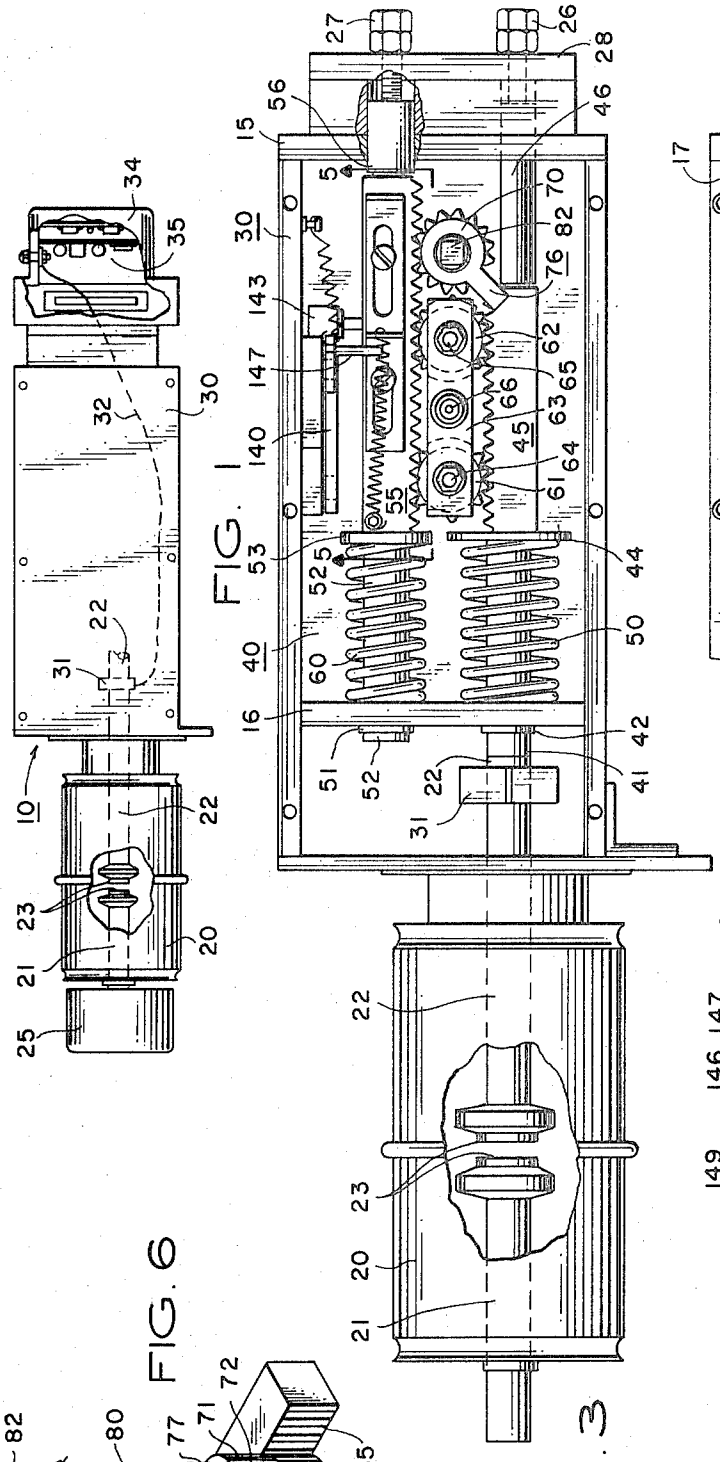


FIG. 1

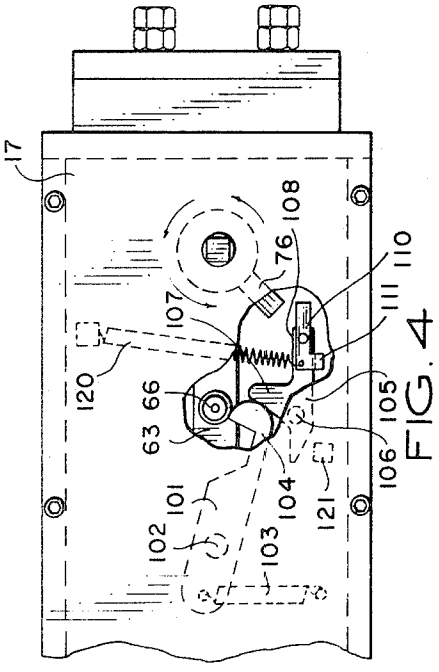


FIG. 4

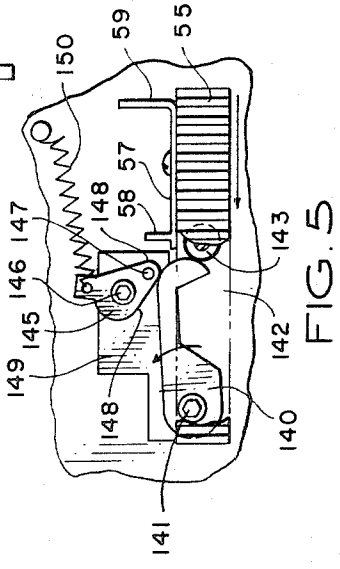


FIG. 5

FIG. 3

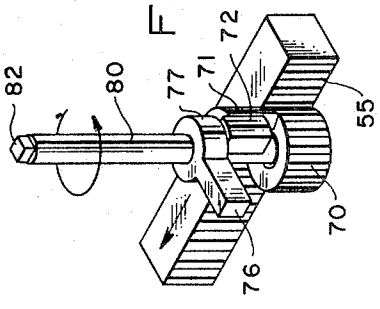


FIG. 6

INVENTORS

JAMES E. McCLAIN

ARGUS F. PARKS

Kenneth R. Glaser

ATTORNEY

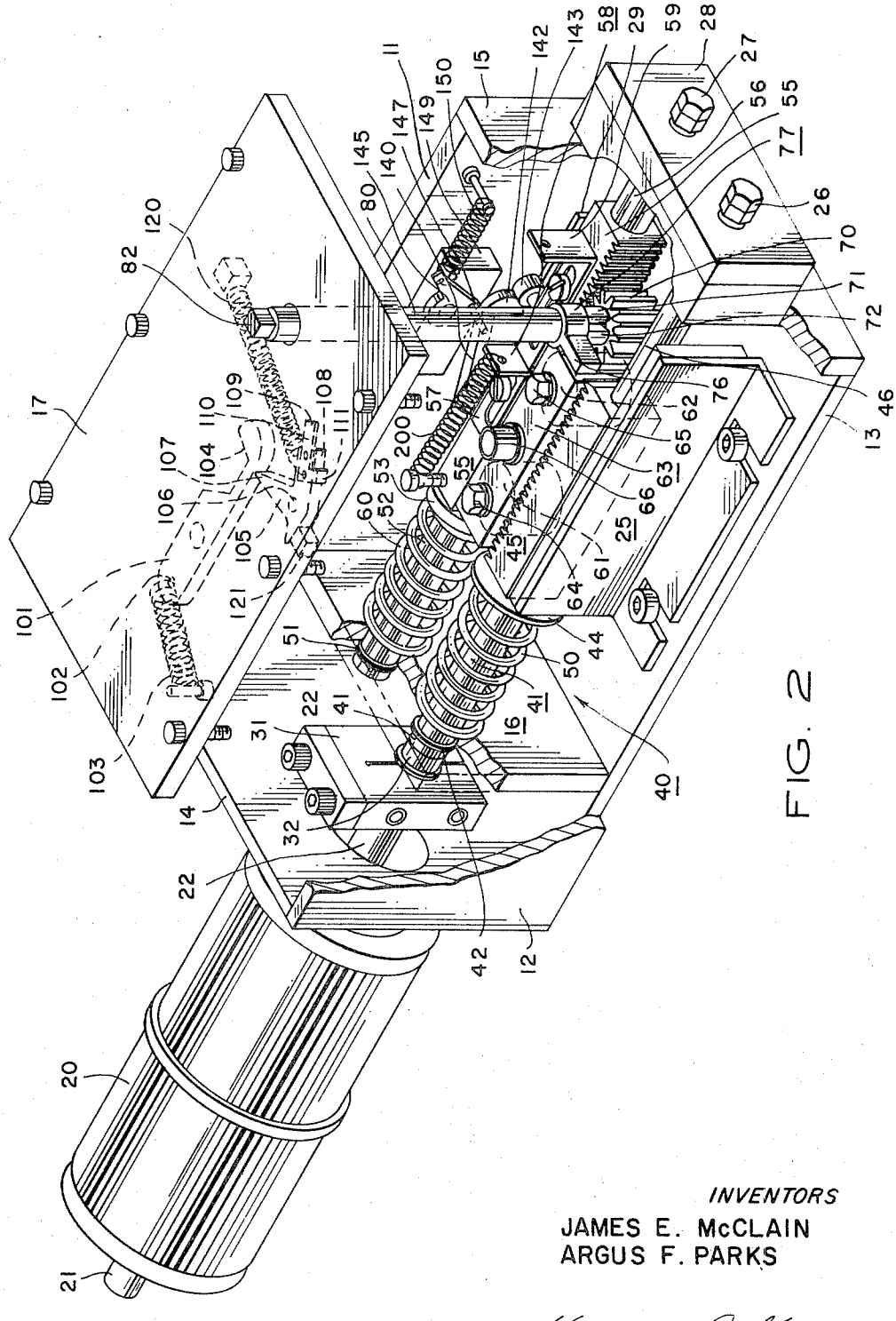


FIG. 2

INVENTORS

JAMES E. McCLAIN

ARGUS F. PARKS

Kenneth R. Glaser

ATTORNEY

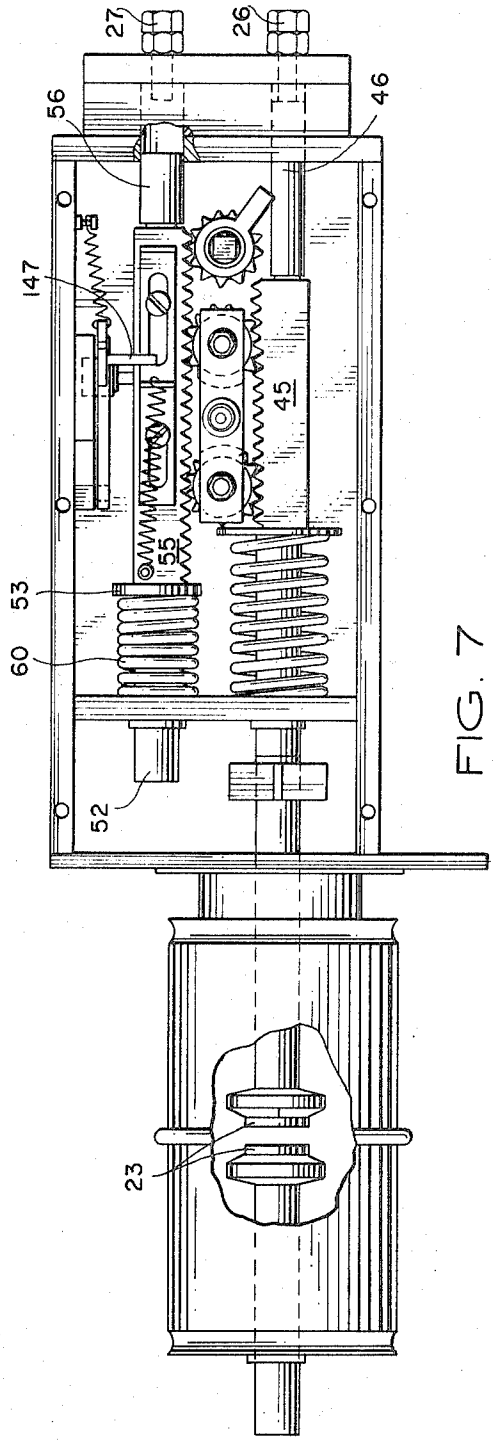


FIG. 7

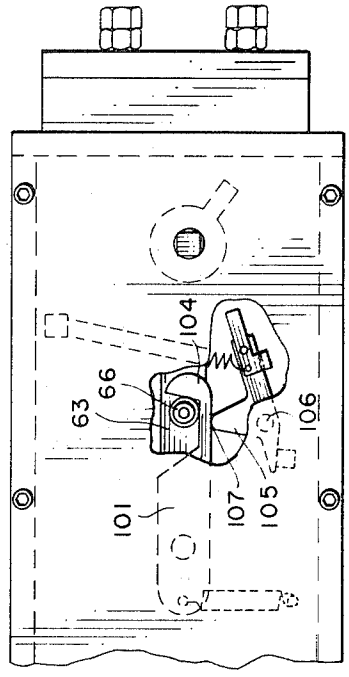


FIG. 8

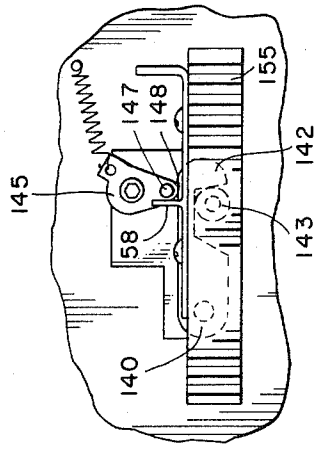


FIG. 9

INVENTORS

JAMES E. McCLAIN
ARGUS F. PARKS

Kenneth R. Glaser

ATTORNEY

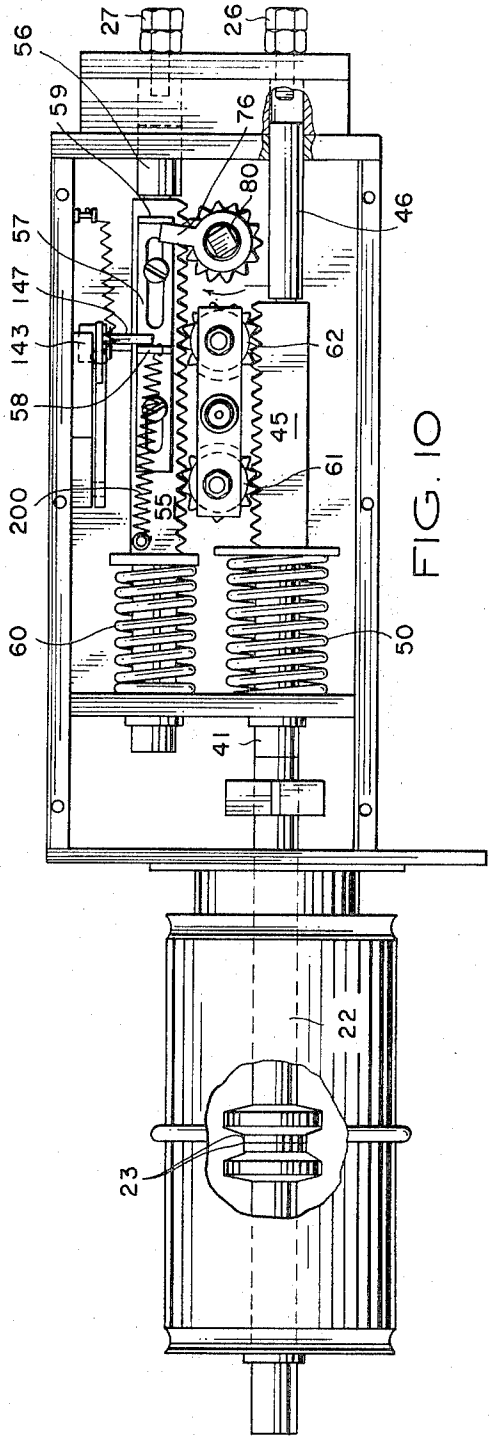


FIG. 10

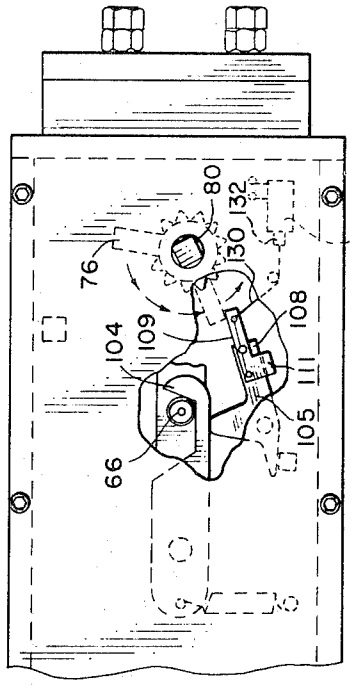


FIG. 11

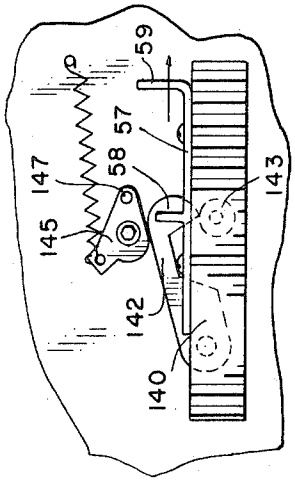


FIG. 12

INVENTORS

JAMES E. McCLAIN
ARGUS F. PARKS

Kenneth R. Glaser

ATTORNEY

RACK AND GEAR SPRING CHARGING MEANS FOR RECIPROCATING CONTACT

This invention pertains to circuit interrupting apparatus, more particularly to actuating mechanism for reciprocating coaxially disposed contact carriers of circuit interrupting apparatus into and out of engagement with one another, and even more particularly to a rack and gear arrangement for powering a drive shaft coupled to a contact carrier rod in both the opened and closed directions.

Within the electric power industry, there is a continuing need for newer and more sophisticated devices to protect high-power equipment in the event that the currents therein become excessive. Various types of protective devices, such as fused or circuit breakers have been designed for this purpose, all such devices suffering one or more disadvantages.

It is therefore a primary object of the invention to provide new and improved circuit interrupting apparatus of the type to be inserted into external circuit means whose current is to be interrupted.

It is another object of the invention to provide a new and improved actuator mechanism for opening and closing reciprocatively mounted contact carrier rods disposed within a vacuum bottle or interrupter.

It is a further object of the invention to provide new and improved actuating mechanism of circuit interrupting apparatus for powering a reciprocatively mounted contact carrier rod into contact with a fixed contact carrier rod where the entire apparatus is trip-free and may consequently be opened at any time in response to excessive currents or faults detected by said apparatus.

It is a still further object of the invention to provide an improved actuating mechanism for powering a reciprocatively mounted contact carrier rod in the closed and opened position, the requisite power be initially stored by spring compression means which, when released, advances the carrier rod into engagement with a fixed contact carrier rod, trip release means responsive to excessive current conditions tripping the movable carrier rod open, thereby to interrupt the circuit in which the carrier rods are disposed.

In accordance with these and other objects, the present invention is directed to actuating mechanism coupled to one of a pair of coaxially disposed contact carrier rods, the actuating mechanism reciprocatively translating the one carrier rod into and out of engagement with the other contact carrier rod, thereby to respectively "close" and "open" the circuit in which the carrier rods are electrically connected. The actuator mechanism comprises a pair of racks adapted to reciprocate in parallel linear paths, pinion gear means operatively coupling the racks together. As one of the racks is urged forward in response to the rotation of an operating shaft coupled to that rack, a closing spring coupled to that rack is compressed and temporarily held in the compressed condition by latch means engaging a roller keeper on the forwardly urged rack. Simultaneously, the pinion gear means is latched against linear travel, thereby operatively coupling the racks together. Trip release means responsive to the rotation of the operating shaft disengages the latch from the first rack; the closing spring thereafter powering the first rack rearward, the other rack consequently being urged forward to force the movable contact carrier rod into engagement with the other contact carrier rod, thus closing the circuit. The forward movement of the other rack then compresses an "opening" spring coupled thereto. A trip release mechanism responsive to excessive current through the contacts, or to the manual rotation of the operating shaft then disengages the latch from the pinion gear means, thereby to power the reciprocatively mounted contact carrier rod into disengagement, and "opening" the current.

Other features, advantages, and objects of the invention will become more readily understood from the following detailed description taken in conjunction with the attached drawings, where identical numerals refer to similar parts, and wherein:

FIG. 1 is an overall view of circuit interrupting apparatus of the type to be electrically coupled into external circuit means, which current is to be interrupted;

FIG. 2 is an overall partially broken away perspective view of the actuating mechanism coupled to the reciprocating contact carrier rod illustrated in FIG. 1;

FIGS. 3, 7, and 10 are top views of the actuator mechanism illustrated in FIG. 2 and the coaxially disposed contact carrier rods, schematically illustrating the various cycles of operation thereof;

FIGS. 5, 9, and 12 are partial side elevational views taken along the line 5—5 of FIG. 3 schematically illustrating the latch mechanism for one of the racks in various cycles of operation thereof;

FIGS. 4, 8 and 11 are top views of another latch mechanism disposed on the cover plate illustrated in FIG. 2, schematically illustrating the various cycles of operation thereof; and

FIG. 6 is a perspective view of the operating shaft and drive means for urging one of the racks forward.

Referring now to the drawings, and initially to FIG. 1, there is depicted an overall view of circuit interrupting apparatus 10. The apparatus 10 generally includes a vacuum bottle or interrupter 20, generally known by those skilled in the art, a pair of coaxially disposed electrically conductive contact carrier rods 21 and 22 extending therein with electrical contacts 23 at the end face of each rod. One of the rods 21 extends through an end wall of the substantially evacuated chamber 20 and may be rigidly or immovably connected with an enlarged terminal portion 25. The other rod 22 extends through an opposite wall of the interrupter 20 and is mounted for reciprocative movement between a "closed" portion, whereby the contact faces 23 are in engagement with one another, and an "open" position (as shown in FIG. 1) whereby the contact faces 23 are disengaged. The axially movable rod 22 extends into the housing 30 and is coupled therein to actuating mechanism 40 (FIG. 2) of the present invention for reciprocatively translating the carrier rod 22. The rod 22 has a lug member 31 connected thereto to which one or more current carrying cables 32 have one end coupled, the other end of the current cables 32 being connected, for example, to an enlarged terminal portion 34 housing relay circuitry 35.

The entire apparatus 10 is ordinarily removably electrically connected into external circuitry (not shown) by way of enlarged terminal portions 25 and 34. When the contact faces 23 are engaged (the apparatus is in its "closed" mode) uninterrupted current flows through the line by way of terminals 25 and 34, rods (and associated contacts) 20 and 22, and power cables 32. On the other hand, when an excessive current or "fault" is sensed by relay circuitry 35, the carrier rod 22 is tripped or translated open, disengaging the contacts 23 and interrupting the current. As subsequently described, the carrier rod 22 may also be manually tripped to the open position.

Referring now to the remaining figures, and initially to 106 2, there is now specifically described the details and features of the actuating mechanism 40 contained within the housing 30 and coupled to the reciprocating carrier rod 22. The housing 30 includes a pair of sidewalls 11 and 12, and a pair of front and rear end walls 14 and 15, respectively connected to a base plate 13. An intermediate wall 16 is disposed between and parallel to the end walls 14 and 15. A cover plate 17 is disposed over the housing and may be secured by conventional bolts to the sidewalls 11 and 12.

A drive rod 41 disposed coaxially of the contact carrier rods 21 and 22 is rigidly coupled at one end to the free end of the movable contact carrier rod 22, the drive rod 41 extending through a bushing 42 in an opening in the wall portion 16. The other end of the drive rod is joined to a short rack 45 by the collar 44. The drive rod 42 is thus mounted for reciprocative movement through and by the wall 16, which movement is effected by the forward and rearward motion of the rack 45. The rack 45 is thus fixedly connected to the drive rod 41 as well as to a rear shaft 46 which extends through, and can reciprocate within, an opening in the rear wall 15 of the housing 30.

Disposed between, and having respective ends abutting against, the wall portion 16 and the collar 44 is an "opening" compression spring 50 surrounding the drive rod 42 which,

when free, drives the rack **45**, drive rod **41**, and contact carrier rod **22** in the rearward or "open" position, all as subsequently described.

Extending through and reciprocatively mounted within a bushing **51** disposed within another opening in the intermediate wall portion **16** is another drive rod **52** rigidly coupled by way of collar **53** to one end of another relatively long rack **55**. The other end of the rack **55** is also rigidly coupled to a rear shaft **56** which extends through and can reciprocate within an opening in the rear face **15** of the housing **30**.

A pair of screws **26** and **27** are provided within a rear plate **28**, and may be respectively adjusted within the plate **28** to limit the rearward travel of the rods **46** and **56**. A pair of pressure plates **25** and **29** are secured to base **13** to provide auxiliary guidance to the reciprocating movement of the racks **45** and **55**, respectively.

A "closing" compression spring **60** having respective ends abutting against the wall portion **16** and the collar **53**, is disposed around and supported by the drive rod **52**, and serves to drive, when released, the rack **55** (and drive rod **52**) in the rearward direction. A bracket member **57** having upwardly extending flanges **58** and **59** is slidably mounted to the top face of the rack **55**, the bracket **57** playing an integral part in releasing the spring **60** from compression, as subsequently described.

A pair of pinion gears **61** and **62** are disposed for simultaneous engagement or meshing with the racks **45** and **46**, and are rotatably mounted to an overlying carriage plate **63** by way of pins **64** and **65**, respectively. Secured to the top face of the carriage plate **63** and intermediate the pins **64** and **65** is a roller keeper **66**. Another gear **70** is disposed so as to have its teeth mesh only with the rack **55**, the gear **70** including, as an integral portion thereof, an upwardly extending shoulder **71**.

Operatively coupled to and journaled for rotation within the axial bore of the gear **70** is an operating shaft **80** extending through the cover **17** and into the base plate **13**, and having a protuberance or boss **72** adapted to engage the shoulder **71**. As subsequently described, the gear **70** in cooperation with the operating shaft **80** provides the charging or loading function of the closing spring **60**. A boss portion **76** rigidly attached to the shaft **80** by the collar **77** provides a tripping lever for both the manual closing and opening cycles of the actuating mechanism **40**. The shaft **80** may be rotated in either the clockwise or counterclockwise direction by a handle (not illustrated) engaging the end **82** thereof.

At the underside of the cover plate **17** is a latch arm **101** pivotally mounted to the plate **17** by a pin **102**, spring means **103** biasing the arm **101** in the counterclockwise direction. The latch arm **101** has a finger portion **104** adapted to engage the roller keeper **66** disposed at the top face of the carriage plate **63**. Trip release means **105** is also pivotally mounted by way of pin **106** to the cover plate **17** and includes a cam surface **107** for engaging the latch finger **104**, as pictured, to cam and hold the finger **104** in engagement with roller keeper **66**. Pivotally coupled to the leg portion **108** of the trip release means **105** is an extension arm **110** having a projection **109** and a downwardly extending boss or toggle **111** abutting the leg portion **108** of the trip release means **105**. The boss **111** is biased against the leg portion **108** by the spring means **120**. A stop **121** limits the extent of counterclockwise rotation of the trip release means **105**. Automatic tripping of the release means **105** may be effected by a wire **130** coupled to solenoid means **131** coupled to the fault sensing or relay circuitry **35**, (shown in FIG. **11**).

Pivotally connected by way of pin **141** to the sidewall **11** of the housing **30** is another latch arm **140** (FIGS. **2, 5, 9** and **12**) having a latch finger **142** adapted to engage another roller keeper **143** secured to the side of the rack **55**. Trip release means **145** is also pivotally mounted by way of a pin **146** to a plate **149** affixed to the sidewall **11**, the means **145** including an extension **147** adapted to engage the flange **58**. The release means **145** also includes a cam surface **148** for engaging the cam follower portion of the latch finger **142** to cam and hold the finger **142** in engagement with roller keeper **143**. Spring means **150** biases the trip release means **145** in the clockwise or latched position.

The operation of the apparatus, and particularly the actuator mechanism **40**, will now be described, beginning with the apparatus in its inactive state as shown in FIG. **3**, the vacuum interrupter contacts **23** being opened. Accordingly, the shaft **80** is rotated in the counterclockwise direction (FIG. **6**) until the boss **72** engages the shoulder **71**. Further rotation of the shaft in this counterclockwise direction then similarly rotates the gear **70**, and urges the rack **55** forward to compress the closing spring **60** between the collar **53** and the intermediate wall portion **16**.

The forward movement of the rack **55** causes the counterclockwise rotation of the gears **61** and **62** which consequently causes the carriage plate **63** to move in the same direction as, but at a lesser linear velocity than, the rack **55**. Since the gears **61** and **62** (and carriage plate **63**) are not fixed during this portion of the cycle, but are floating, they will roll freely along the teeth of the racks **45** and **55**, and the rack **45** (and driven rod **41**) will consequently remain stationary.

The rearward travel of the carriage plate **63** thus forces the roller keeper **66** into engagement with the latch finger **104**, and the latch arm **101** is cammed in the clockwise direction (FIG. **4**) until the keeper **66** is fully latched, as shown in FIG. **8**. Simultaneous with the latching of the roller keeper **66**, the forward movement of the rack **55** urges the roller keeper **143** against the latch finger **142**, camming the latch arm **140** upward and in the counterclockwise direction, as shown in FIG. **5**, until the keeper **142** is fully latched (FIG. **9**).

As a consequence of the just described operation, the apparatus is in its "charged" condition, as represented by the FIGS. **7–9**. Accordingly, while the contacts **23** remain open, the spring **60** has now been fully loaded (compressed) (FIG. **7**), and is held in this condition due to the latching of the rack **55** in its forward position by the latch arm **140** and keeper **143** combination, as observed most clearly in FIG. **9**. The finger **142** is maintained in its latching relationship with the roller keeper **143** due to the pressure exerted by the spring-biased release means **145**, the extension **147** being adjacent and slightly rearward the flange member **58**. It is to be noted that as the latch arm **140** is pivoted upward, as shown in FIG. **5**, the resulting pivotal movement of the release means **145** enables the flange **58** on the bracket **57** to pass under the extension **147** as the rack **55** (and bracket **57**) travels forward.

In a similar manner, the finger **104** has fully latched the roller **66** (FIG. **8**), the carriage plate **63** therefore being held in its forwardmost position, and the gears **61** and **62** are retained against linear travel in the rearward direction. The spring biasing of the latch arm **101**, as well as the pivotal engagement of the cam surface **107** against the cam follower portion of arm **101**, maintains the plate **63** and gears **61** and **62** in this latched position.

Now, to close the vacuum interrupter contacts **23**, the shaft **80** is rotated in the clockwise direction until the boss **76** engages the rear projection **59** of the bracket **57** (as shown in FIG. **10**). Since the shaft **80** is journaled for rotation within the axial bore of the gear **70**, and since the boss **72** is disengaged during this clockwise rotation from the shoulder **71**, the gear **70** (and consequently the rack **55**) remain stationary. Further clockwise rotation of the shaft **80** then drives the slidingly mounted bracket **57** in the rearward direction (as pictured in FIG. **12**), forcing the extension **58** against the projection **147**, pivoting the the release means **145** away from engagement with the latch finger **142**, and releasing the latch arm **140** from latching engagement with the roller keeper **143** on the rack **55**. Spring **200** is then employed to return the bracket **57** to its original position.

As a consequence of this release step, the rack **55** is freed, and the power of the compressed spring **60** forces the rack **55** in the rearward direction. Since the carriage plate **63** is maintained in latched relationship by the latch arm **101** during this

phase of the cycle, rearward travel of the rack **55** rotates the gears **61** and **62** and drives the rack **45** and drive rod **41** forward. In this regard it should be pointed out that the compression spring **60** must be strong enough to overcome the force of the spring **50**. The resultant forward motion of the rack **45** and drive rod **41** thus compresses or loads the spring **50**, and reciprocates the rod **22** to close the contacts **23** (FIG. **10**).

The automatic and manual tripping or opening operation of the contacts **23** is now described and specific reference to FIG. **11**. The solenoid **131** affixed to the underside of the cover plate **17**, for example, is coupled to fault sensing or relay circuitry **35**, and has its translatable plunger **132** coupled to a wire **130** which, in turn, is connected to projection **109**. When an overload or fault condition is sensed by the relay circuitry **35**, a resulting output signal from the circuitry translates the plunger **132** inward, and pulling the wire **130** to pivot the projection **109** in the clockwise direction, forcing the toggle **111** against the leg portion **108**, and pivoting the means **105** out of engagement with the latch finger. The latch finger **104** is then cammed out of engagement with the roller keeper **66**, and the power of the compressed spring **50** forces the freed rack **45**, drive rod **41**, and carrier rod **22** rearward, thereby to open the contacts **23**, interrupt the circuit in which the apparatus is inserted, and return the mechanism to the inactive state illustrated in FIG. **3**. Various types of relay circuitry known in the art may be employed for the circuitry **35** coupled to the solenoid **131** which is responsive to excessive current conditions. As one example, however, the relay circuitry described in copending U.S. Pat. application, Ser. No. 788,773, assigned to the assignee of the present application, may be employed. It is to be noted that the actuator mechanism **40** is trip-free in that the contacts **23** may always be automatically tripped open at any point in the operating cycle.

Manual tripping or opening of the contacts **23** is also provided by rotating the shaft **80** in the counterclockwise direction as illustrated in FIG. **11** to force the boss **76** into engagement with the leg **109**, the resulting pivotal movement of the trip release means **105** opening the contacts **23** in the manner just described.

Various modifications of the disclosed embodiment as well as additional embodiments may become apparent to those skilled in the art after reviewing the foregoing description without departing from the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. Actuating mechanism for reciprocatively translating a movable contact carrier rod for respective engagement and disengagement with electrically conductive means, said actuating mechanism comprising:

a. a first drive rod mounted for reciprocating movement along a first linear path, said first drive rod coupled to said movable contact carrier rod for advancing and retracting said contact carrier rod into said engagement and disengagement,

b. a second drive rod mounted for reciprocating movement along a second linear path parallel to said first linear path,

c. first means for urging said second drive rod in one direction along said second path,

d. second means for urging said second drive rod in an opposite direction along said second path while simultaneously urging said first drive rod in said one direction along said first linear path to a forwardmost position, thereby to advance said movable contact carrier rod into engagement with said electrically conductive means, said second means comprises a pair of racks respectively coupled to said first and second drive rods, at least one rotary gear simultaneously engaging said pair of racks, and a first spring means, when compressed, for urging said rack coupled to said second drive rod in said opposite direction along said second path; said latch means also preventing the linear travel of said rotary gear when said second drive rod is being urged in said opposite direction; and further including a second spring means coupled to said rack coupled to said first drive rod which, when compressed, urges said front drive rod in said opposite direction along said first path, thereby to disengage said movable carrier rod from said electrically conductive means, said second spring being compressed by the travel of said first drive rod in said one direction, said first spring means being compressed by the travel of said second drive rod in the said one direction,

e. latch means for holding said first drive rod in said forwardmost position, and

f. trip means for releasing said latch means, thereby to allow disengagement of said carrier rod from said electrically conductive means.

2. The apparatus as described in claim **1** including another latch means for holding said first spring means in the compressed state, second trip means for releasing said another latch means, and wherein said first mentioned latch means also holds said second spring means in the compressed state.

3. The apparatus as described in claim **2** wherein said first urging means comprises another rotary gear secured against linear motion engaging said rack coupled to said second drive means and an elongated shaft coupled to said another rotary gear for rotating said another gear and urging said rack in said one direction.

4. The apparatus as described in claim **3** wherein said second mean comprises two rotary gears simultaneously engaging said pair of racks, and a carriage plate coupled to said two rotary gears having a roller keeper disclosed thereupon, said first mentioned latch means adapted to engage said roller keeper.

5. Circuit interrupting apparatus, comprising:

a. a pair of coaxially disposed contact carrier rods, one of said rods being fixed, the other of said rods being mounted for reciprocating motion for engagement and disengagement with said fixed rod,

b. first rack means coupled to said reciprocatively mounted rod,

c. first spring means coupled to said first rack means, said first spring means being compressed in response to the advancement along a first linear path of said first rack means,

d. second rack means operatively coupled to said first rack means by rotary gear means simultaneously engaging said first and second rack,

e. second spring means coupled to said second rack means, said second spring means being compressed in response to the movement in a forward direction along a second linear path parallel to said first linear path of said second rack means, said second spring means, when compressed, powering said second rack means in a rearward direction along said second linear path,

f. means for advancing said second rack to a forwardmost position, thereby to compress said second spring means,

g. means for holding said rotary gear means against linear motion when said second rack is moving in said rearward direction, thereby to advance said first rack in a forward direction along said first linear path, whereby said reciprocatively mounted rod is advanced into engagement with said fixed rod, and said first spring is compressed, and

h. means for holding said reciprocatively mounted rod in engagement with said fixed rod and holding said first spring in said compressed state.

6. The apparatus as described in claim **5** wherein said means for holding said rotary gear means against linear motion and the means for holding said reciprocatively mounted rod in engagement with said fixed rod comprises a roller keeper coupled to said rotary gear, and a pivotally mounted latch for engaging said roller keeper as said second rack is advanced to its forwardmost position.

7. The apparatus as described in claim **6** including means for tripping said latch out of engagement with said roller keeper, thereby to release said rotary gear for linear travel and

release said first spring from its compressed condition, whereby said reciprocatively mounted rod is urged out.

8. The apparatus as described in claim 7 wherein said tripping means is responsive to excessive current conditions through said coaxially disposed contact carrier rods.

9. The apparatus as described in claim 8, including separate latch means for holding said second rack in said forwardmost position, and separate trip means for manually releasing said separate latch means.

10. Circuit interrupting apparatus, comprising:

a. a pair of laterally spaced conductive terminals,

b. a pair of coaxially disposed contact carrier rods respectively electrically connected to each of said conductive terminals, one of said carrier rods reciprocatively mounted for engagement and disengagement with the other of said carrier rods,

c. a substantially evacuated chamber,

d. contact faces disposed on respective one ends of said carrier rods within said substantially evacuated chamber,

e. a pair of racks mounted for respective reciprocating motion in first and second linear paths, one of said racks operatively coupled to said reciprocatively mounted carrier rod,

f. a rotary gear intermediate and having its teeth simultaneously mesh with said pair of racks said rotary gear being freed for linear travel along a path parallel to said first and second linear paths,

g. first and second compression springs respectively coupled to said pair of racks, each spring being compressed in response to the advancement of the coupled rack along the respective linear path in one direction and, when compressed, providing means for powering the coupled rack along the respective linear path in the opposite direction,

h. means for advancing said other rack in said one direction to a forwardmost position, said means comprising another rotary gear operatively engaged with said other rack, and a rotatable shaft journaled for rotation with said another rotary gear having means affixed thereto for rotating said another rotary gear,

i. first latch means for holding said other rack in said forwardmost position, said first latch means comprising a pivotally mounted latch adapted to engage roller keeper connected to said another rack,

j. first trip means for releasing said latch from said roller keeper, said first trip means being actuated by the rotation of said rotatable shaft,

k. second latch means for holding said first-mentioned rotary gear from linear motion while said other rack is powered in said opposite direction, thereby to advance said one rack in said one direction and advance said reciprocatively mounted contact carrier rod into engagement with said other contact carrier rod, said latch means comprising a pivotally mounted latch arm engaging another roller keeper coupled to said first mentioned rotary gear, and

l. second trip means for releasing said second latch means, said second trip means being actuated in response to excessive current through said spaced conductive terminals.

* * * * *