Jan. 23, 1951 O. VON MEHREN 2,539,213

CIRCUIT INTERRUPTER

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Fig. 2.

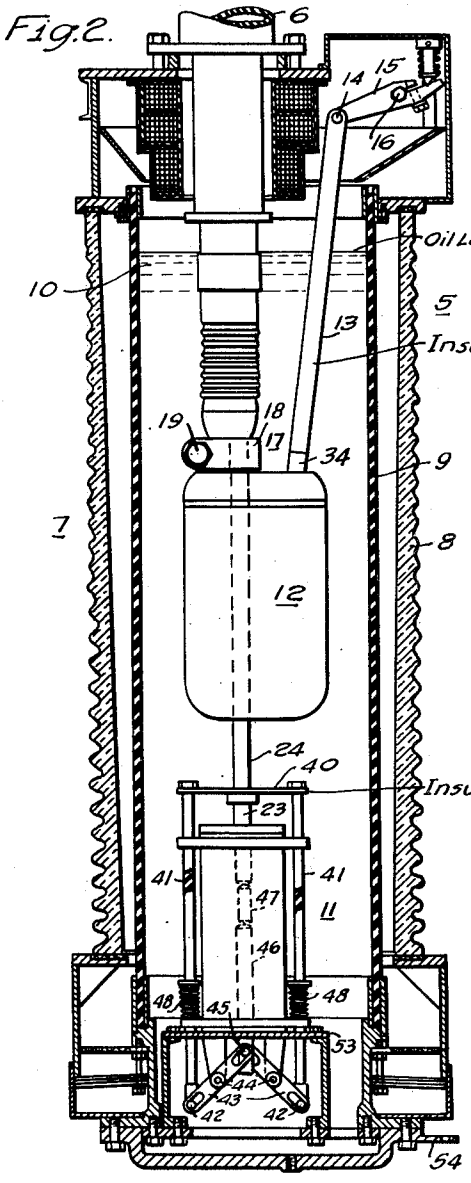
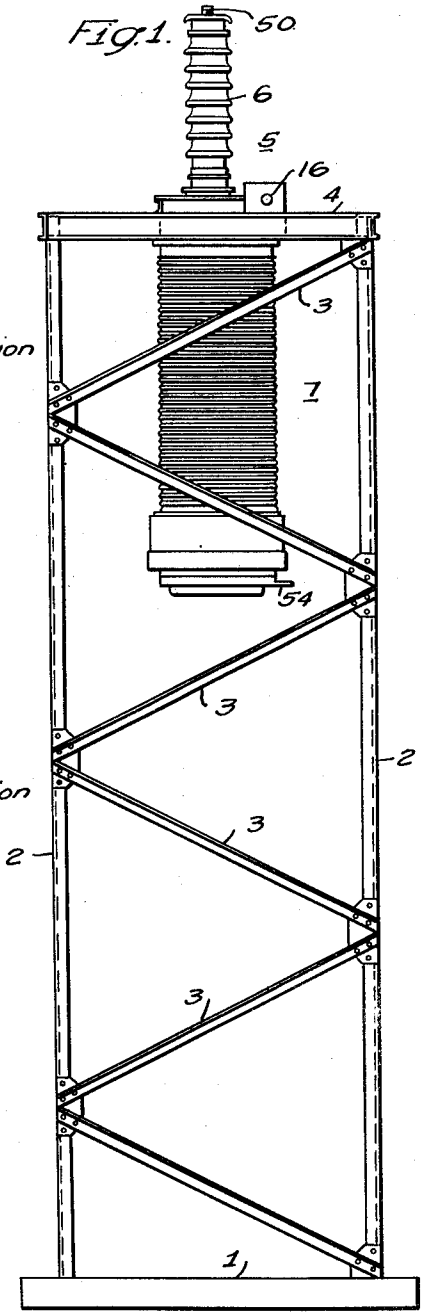


Fig. 1.



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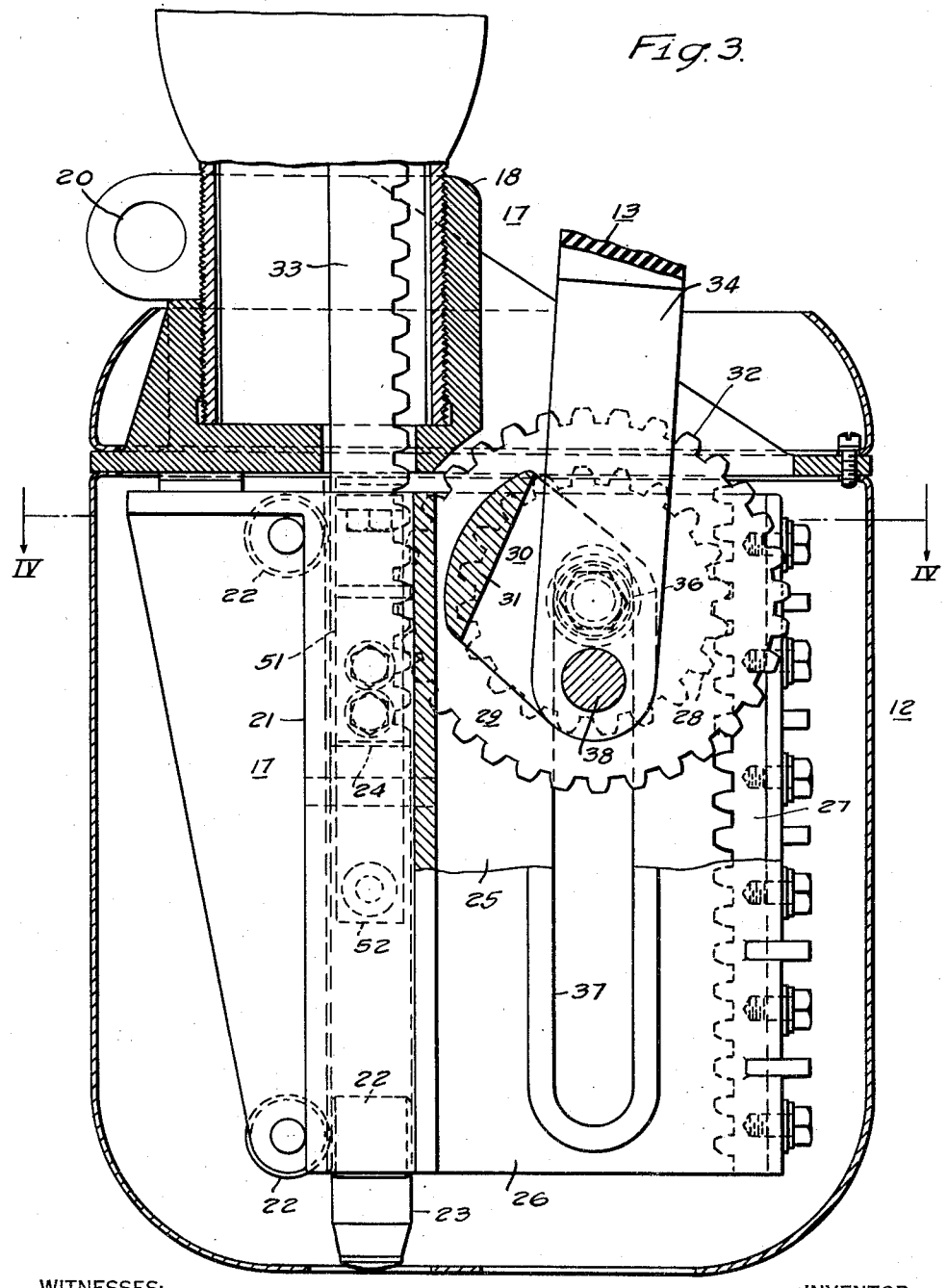
CIRCUIT INTERRUPTER

Filed May 2, 1947 5 Sheets-Sheet 2

Fig. 3.



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CIRCUIT INTERRUPTER

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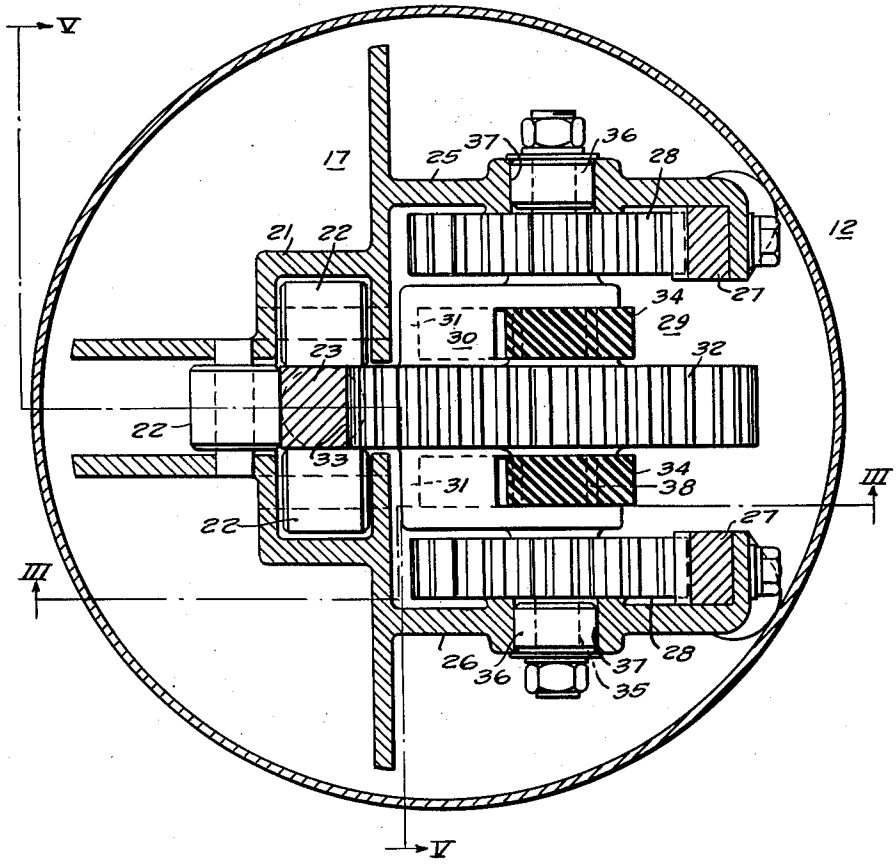
Fig. 4.



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CIRCUIT INTERRUPTER

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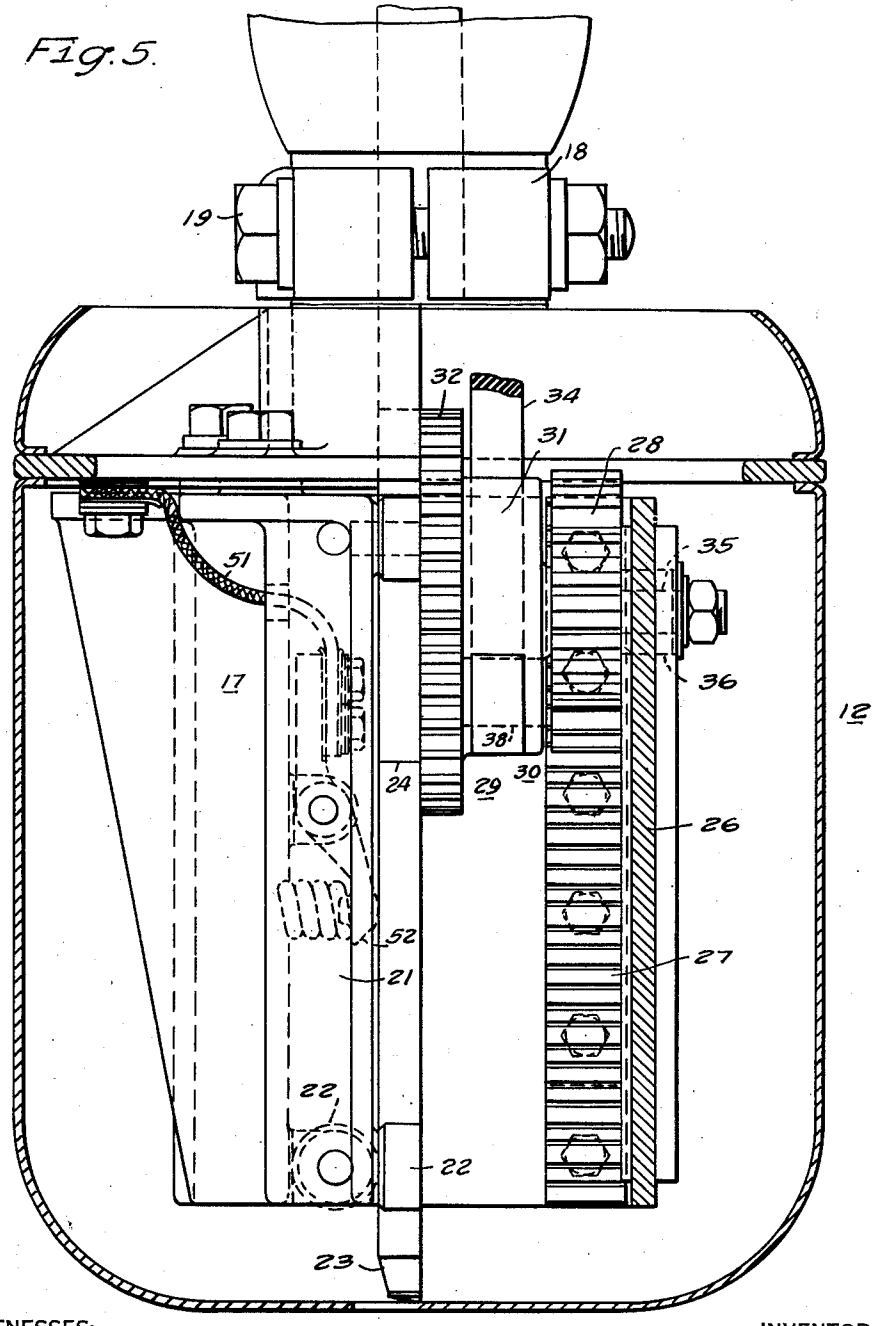
Fig. 5.



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CIRCUIT INTERRUPTER

Filed May 2, 1947 5 Sheets-Sheet 5

Fig. 8.

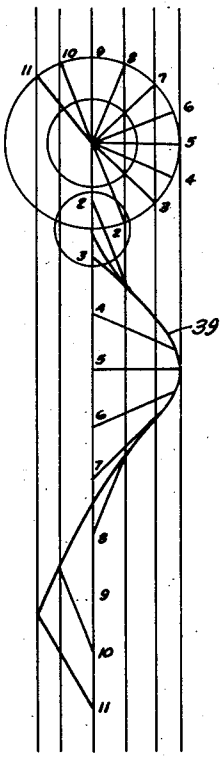


Fig. 7.

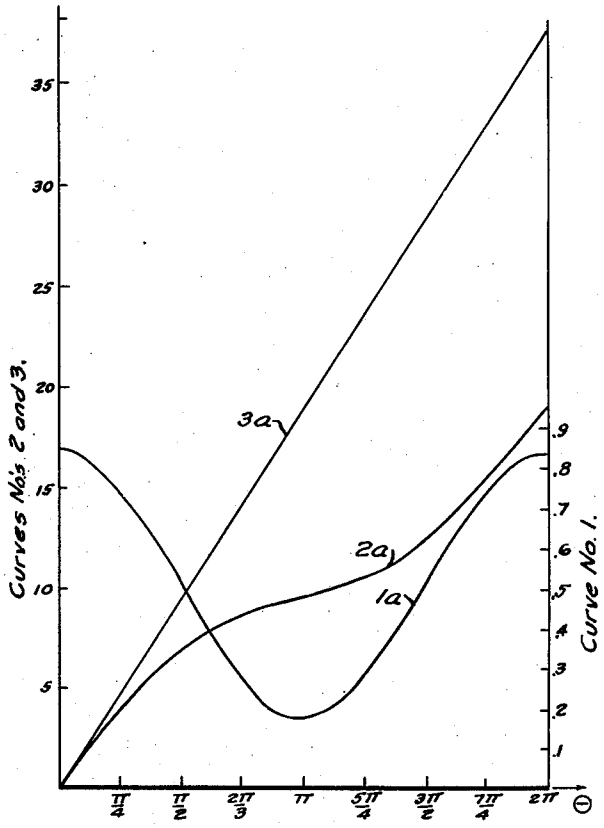
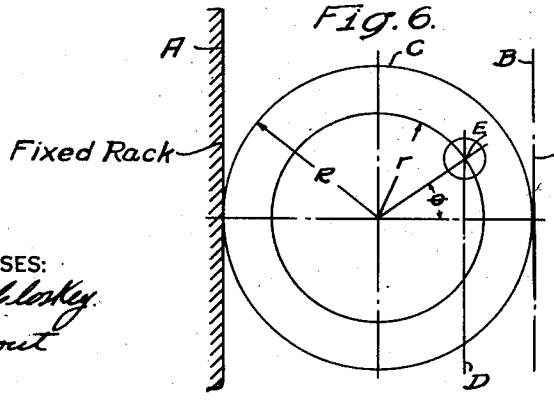


Fig. 6.



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Patented Jan. 23, 1951

2,539,213

UNITED STATES PATENT OFFICE

2,539,213

CIRCUIT INTERRUPTER

Oswald von Mehren, Lorain, Ohio, assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 2, 1947, Serial No. 745,469

12 Claims. (Cl. 200—153)

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This invention relates to circuit interrupters in general, and, more particularly, to operating mechanisms for the contact structures thereof.

The general object of my invention is to provide an improved operating mechanism for a circuit interrupter in which a large kinematic ratio between operating rod and moving contact is possible during the initial portion of the closing stroke, and in which a large static contact pressure may be obtained when the interrupter is closed.

Another more specific object is to provide an improved operating mechanism for a circuit interrupter involving two relatively movable racks, one of the racks being relatively stationary and the other being formed on the side of the movable contact, and to interconnect the two relatively movable racks by the use of gear means which is actuated by an eccentrically pivoted operating rod.

Another object is to provide an improved circuit interrupter of the type utilizing a terminal bushing extending interiorly into casing means and having an improved operating mechanism secured to the interior end of the terminal bushing which will be of a high-speed simplified type. Preferably I employ a rack formed on the side of the movable contact and meshing with gear means which cooperate with a stationary rack secured to the interior end of the terminal bushing.

Further objects and advantages will readily become apparent upon a reading of the following specification, taken in conjunction with the drawings, in which:

Figure 1 is a side elevational view of a circuit interrupter embodying my invention;

Fig. 2 is a vertical sectional view through the interrupter shown in Fig. 1, the contacts being shown in the closed circuit position;

Fig. 3 is an enlarged view, partly in section, of my improved operating mechanism, taken along the line III—III of Fig. 4, looking in the direction of the arrows, and the contacts being in the fully open circuit position;

Fig. 4 is a sectional view, taken along the line IV—IV of Fig. 3;

Fig. 5 is a sectional view of my improved operating mechanism, taken along the line V—V of Fig. 4;

Fig. 6 is a diagrammatic view illustrating the principles involved in the operation of my improved mechanism;

Fig. 7 is a graph illustrating the principles of my invention; and

Fig. 8 shows a travel curve of the position of

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the eccentric pivot during successive closing positions.

Referring to the drawings, and more particularly to Figure 1 thereof, the reference numeral 1 designates a base upon which is positioned vertically-extending framework including a plurality of upright angle irons 2 braced by diagonally-extending angle irons 3 and forming a support platform 4 at the upper end thereof. The platform 4 rigidly supports in place a circuit interrupter generally designated by the reference numeral 5, and including a high-voltage condenser bushing 6 extending through the support 4 and having the lower end thereof interiorly positioned within casing means generally designated by the reference numeral 7.

Fig. 2 shows more clearly the internal construction of the circuit interrupter 5 with the contact structure of the circuit interrupter being shown in the closed circuit position. It will be noted that I have provided an external hollow column of porcelain 8, serving as a weatherproof housing for the circuit interrupter. Interiorly positioned within the porcelain 8 is an insulating cylinder 9 containing a suitable arc-extinguishing fluid 10, in this instance circuit breaker oil, filling the casing 9 to the level indicated.

Immersed within the liquid 10 is an arc-extinguishing structure generally designated by the reference numeral 11, which may be of various types, but is preferably of the type more clearly set forth in United States patent application filed May 2, 1947, Serial No. 745,541, by Robert E. Friedrich and Oswald von Mehren, and assigned the assignee of the instant application. The contact structure within the extinguishing structure 11 is operated by an operating mechanism generally designated by the reference numeral 12, and shown more clearly in Figs. 3-5 inclusive.

An insulating operating rod 13 is employed to actuate the mechanism 12. The upper end of the operating rod 13 is pivotally connected, at 14, to a crank arm 15 pivotally mounted on a shaft 16, which may be operated externally of the interrupter 5 by any suitable means (not shown).

Certain structural features of the interrupter shown are set forth and claimed in United States patent application filed April 30, 1945, Serial No. 591,047, now Patent Number 2,534,920, Dec. 19, 1950, by Leon R. Ludwig and Benjamin P. Baker, and assigned to the assignee of the instant application.

Before going into the specific structural details of my improved operating mechanism, it may be desirable to make a study of the principles thereof, as set forth more fully in Figs. 6 and 7.

of the drawings. In circuit breaker design, the problem often arises of providing an operating mechanism combining the following requirements:

(1) Straight-line motion of the moving contact.

(2) Large kinematic ratio between operating rod and moving contact.

(3) Large static contact pressure when breaker is closed.

The last two requirements work against each other and can not be satisfied by the use of fixed fulcrums. So far, complicated and roomy link arrangements have been used for this purpose. The invention forming the subject of the present disclosure aims at providing a simple, effective, and compact device which is susceptible of extensive variations for its adaption to the dimensional requirements of each application.

Referring to Fig. 6, which diagrammatically illustrates the principles of my invention, the device consists of a fixed rack A, a moving rack B, a gear (or set of gears) C connecting the two racks, and an operating rod D. Considering the simplest arrangement, where only one gear is used to connect the two racks, we see that if the operating rod D were to engage the connecting gear C at its center (not shown), the arrangement would simply be an application of a well-known elementary mechanism, where the ratio of motion and of force between the operating rod D and the moving rack B would be constant (in this case, 1/2 and 2/1 respectively).

If, however, the operating rod D is made to engage the connecting gear C through an eccentric pivot E, the lever ratio between the operating rod D and the moving rack B would no longer be constant, and its instananeous value would be found in the expression:

$$L=\frac{R+r\cos\theta}{2R} \qquad (1)$$

Since, in practice, the length of the operating rod D is many times the length of the radius r of the eccentric pivot E, we can neglect the variation in the angles at which the said operating rod D engages the said pivot E. Under these circumstances, the vertical component of the travel of the operating rod D is expressed by

$$S_D=R\theta+r\sin\theta \qquad (2)$$

while the corresponding travel of the moving rack is expressed by

$$S_B=2R\theta \qquad (3)$$

For the sake of illustration, let us give a numerical value to the radii R and r by making R=3 and r=2. By substituting these values in the above formulas (1), (2) and (3), the three functions have been plotted in Figure 7 in the corresponding curves $1a$, $2a$ and $3a$ in terms of various values of the angle θ through one complete revolution of the connecting gear.

By observing and comparing these curves, we see that as long as we limit the total angular displacement of the connecting gear to less than one turn, we have a large selection of combinations to suit any application.

For instance, if we were to choose a rotation of 180° from π to 2π, we would have this result:

Travel of operating rod, curve

$$2a=18.84-9.42=9.42$$

Travel of moving rack, curve

$$3a=37.68-18.84=18.84$$

Lever ratio at end of travel, curve $1a$=.833

This would give us the normal average kinematic ratio of 1/2 as if the gear had been engaged at its center, but the final lever ratio would be .333 instead of .5.

On the other hand, were we to choose this same half turn rotation from $\pi/2$ to $3\pi/2$, we would have:

Travel of operating rod, curve

$$2a=12.13-6.71=5.42$$

Travel of moving rack, curve

$$3a=28.26-9.42=18.84$$

Lever ratio at end of travel, curve $1a$=.5.

This would give us a kinematic ratio of .287 instead of 1/2 while the final lever ratio would be the same as if the gear had been engaged at its center. Of course, there is an infinite choice for all the initial and final angular positions of the pivot E, and also the results can be altered by adopting a different value for the ratio r/R.

To incorporate the above-mentioned principles into a mechanism for causing straight-line motion of the movable contact in a circuit interrupter, reference may be had to Fig. 3, which shows my improved mechanism 12 in the open circuit position. Referring to this figure, and also the sectional view set forth in Fig. 4, it will be observed that I have provided support means 17 threadedly secured to the lower end of the hollow terminal stud 18 extending interiorly through the bushing 6. The support means 17 may be clamped in position by a bolt 19 (Fig. 5) which passes through an aperture 20 of the support means 17 (Fig. 3). The support means 17 includes a downwardly extending guide housing 21, the configuration of which is more clearly shown in Fig. 4. Guide rollers 22 are employed to assist in guiding the vertical motion of the movable contact 23, which telescopes within the hollow terminal stud 18 as shown. Above the line 24, the movable contact 23 is rectangular. Below the line 24, the movable contact 23 has a rod-shaped configuration, the purpose for which will appear more clearly hereinafter.

Secured to two side plates 25, 26, integrally formed with the support means 17, are a pair of stationary racks 27. Meshing with the racks 27 are a pair of outside gears 28 of a gear carriage generally designated by the reference numeral 29. A supporting framework, generally designated by the reference numeral 30, interconnects the two concentrically mounted outside gears 28. The framework 30 comprises bridge portions 31, more clearly shown in Fig. 3, which connect each outside gear 28 with a large central or third gear 32. The third gear 32 meshes with a rack 33 formed on the side of the movable contact 23.

The lower end of the insulating operating rod 13 is forked and each leg 34 of the forked portion makes an eccentrically pivoted connection with the supporting framework 30. The off-center pivot connection 38 for the operating rod 13 is more clearly shown in Fig. 3. Jutting outwardly from each outside gear 28 is a shaft portion 35 about which is mounted a sleeve 36 which is guidably slid in a guide slot 37 formed in each of the two side plates 25, 26.

From an inspection of Figs. 3 and 4, it will be observed that the off-center pivot 38 will make a travel curve, as more clearly shown by the curve 39 of Fig. 8, during successive closing positions

of the interrupter. In other words, upon downward closing movement of the operating rod 13, the eccentric pivot 38 will first move more closely to the stationary gear racks 27, and then as the closing movement continues, it will move toward the left as shown in Fig. 8, to thereby bring a greater moment arm to bear upon the moving contact 23 to increase the contact pressure when the breaker is in the closed circuit position.

It will be noted that the gear means, including the three gears 28, 32, do not make a complete revolution, a complete revolution not being possible because of the two bridging portions 31.

Referring to Fig. 2, it will be observed that the line 24, being the point of separation between the rectangular and rod-shaped portions of the movable contact 23, will make engagement with an insulating bridge 40 which has secured thereto two insulating rods 41, the lower ends of which make pivotal connection, at 42, to a pair of levers 43, the latter being pivotally mounted on stationary pivots 44. The inner ends of the levers 43 make pivotal connection, at 45, to a lower movable contact 46, shown by the dotted lines in Fig. 2. The contact 46 separates from a relatively stationary contact 47 during the opening operation. Also separable upwardly from the stationary contact 47, is the movable contact 23.

Thus, during the closing stroke, the lower ends of the rectangular portions of contact 23 strike the bridge 40 to cause, through the medium of the rods 41 and levers 43, upward closing movement of the movable contact 46. This occurs simultaneously with downward movement of the rod-shaped portion of contact 23 so that the two contacts 23, 46 make simultaneous engagement with the relatively stationary intermediate contact 47. This construction is set forth and claimed in the aforesaid Friedrich and von Mehren application.

The electrical circuit through the two break interrupter includes line terminal 50, hollow terminal stud 18, support means 17, flexible conductor 51, slider contact 52, movable contact 23, intermediate contact 47, lower movable contact 46, lower support plate 53 to lower line terminal 54.

From the foregoing description, it will be apparent that I have provided an improved operating mechanism for a movable contact which combines a high-speed motion at the initial portion of the closing stroke with slower motion near the end of the stroke, with a greater static contact pressure being brought into play at the extreme end of the closing stroke. Thus, during the major portion of the closing stroke, where merely speed is required and contact pressure is not needed, the mechanism is high-speed in operation. Near the end of the closing stroke, where it is important to obtain a high degree of static contact pressure, my improved mechanism is operable to provide a greater lever arm acting upon the movable contact 23 by the position of the off-center pivot 38 at the end of the closing stroke.

The rollers 22 guide the downward movement of the movable contact 23 and prevent its lateral movement, thus insuring firm immeshment with the center gear 32.

During the opening operation, the operating rod 13 is moved upwardly by clockwise rotation of the shaft 16 to thereby cause upward movement of the gear carriage 29. The upward movement of the gear carriage 29 causes upward travel of the movable contact 23, the compression springs 48, thereupon simultaneously causing upward movement of the rods 41 and downward separating motion of the contact 46 from the intermediate relatively stationary contact 47. Thus, the mechanism is operable to create two simultaneous breaks during the opening operation. As is well-known to those skilled in the art, fluid under pressure is employed to effect rapid extinction of the arcs drawn at the two breaks.

Although I have shown and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In a circuit interrupter, means defining a fixed rack, a movable contact having a rack formed along one side thereof, rotatable gear means rotatable about a moving axis meshing with both the fixed rack and the rack formed on the side of the movable contact to cause by such rotation opening and closing movements of the movable contact, a movable operating rod connected to the rotatable gear means on an eccentric pivot with respect to the axis of rotation of the gear means to cause the actuation thereof and hence opening and closing movements of the movable contact.

2. In a circuit interrupter, means defining a pair of stationary racks, a pair of rotatable gears rotatable about a moving axis and meshing with the pair of racks, movable support means interconnecting the two rotatable gears and including a third movable gear, a movable contact having a rack formed along one side thereof, the third movable gear meshing with the rack formed on the movable contact, and movable operating rod means pivotally connected to the support means on an eccentric pivot with respect to the axis of rotation of the pair of rotatable gears for causing opening and closing movements of the movable contact.

3. In a circuit interrupter, a pair of relatively movable contacts, one of the contacts being movable and having a rack formed along one side thereof, a movable gear carriage including three concentrically positioned movable gears rotatable about a moving axis, a pair of stationary racks, meshing with the two outside movable gears, the middle gear meshing with the rack formed on the side of the movable contact, and an operating rod eccentrically pivoted to the movable gear carriage to cause the actuation thereof and hence opening and closing movements of the movable contact.

4. In a circuit interrupter, a pair of relatively movable racks, a pair of relatively movable contacts cooperable to establish an arc, one of the racks being formed on one of the contacts, movable gear means rotatable about a moving axis and meshing with the two racks to cause relative movement therebetween, and an operating rod eccentrically pivoted with respect to the moving axis connected to the movable gear means to cause the actuation thereof and hence opening and closing movements of the contacts.

5. In a circuit interrupter, casing means, an insulating terminal bushing supported adjacent one end of the casing means and having one end thereof extending interiorly within the casing means, an operating mechanism secured to the interiorly extending end of the terminal

bushing and including a relatively stationary rack, a movable rod-shaped contact telescopically related to the terminal bushing and having a rack formed along one side thereof, movable gear means forming a part of the operating mechanism and meshing with both the relatively stationary rack and the rack formed on the side of the movable contact, an arc extingushing structure positioned adjacent the other end of the casing means, contact means including the movable contact for establishing an arc within the arc extinguishing structure, an operating rod, and the operating rod being connected to the gear means on an eccentric pivot to cause the actuation thereof and hence opening and closing movements of the movable contact.

6. In a circuit interrupter, casing means, an insulating terminal bushing supported adjacent one end of the casing means and having one end thereof extending interiorly within the casing means, an operating mechanism secured to the interiorly extending end of the terminal bushing and including a relatively stationary rack, a movable rod-shaped contact telescopically related to the terminal bushing and having a rack formed along one side thereof, movable gear means forming a part of the operating mechanism and meshing with both the relatively stationary rack and the rack formed on the side of the movable contact, an arc extinguishing structure positioned adjacent the other end of the casing means, contact means including the movable contact for establishing an arc within the arc extinguishing structure, an operating rod, rotatable means for actuating the operating rod disposed adjacent the end of the casing means which supports the terminal bushing, the operating rod extending substantially along the side of the interiorly extending end of the terminal bushing to the operating mechanism, and the operating rod being connected to the gear means on an eccentric pivot to cause the actuation thereof and hence opening and closing movements of the movable contact.

7. In a circuit interrupter, a substantially elongated cylindrical casing having a weatherproof exterior, an arc extinguishing structure supported interiorly of the casing adjacent one end thereof, terminal means for the interrupter disposed adjacent the said one end of the casing, a high voltage terminal bushing having the lower end thereof projecting interiorly within the casing and supported adjacent the other end of the casing, an operating mechanism secured to the lower projecting end of the terminal bushing, contact means associated with the arc extingushing structure including a movable rod-shaped contact for establishing an arc therein, the movable contact being adapted to be telescopically received by the terminal bushing in the fully open circuit position of the interrupter, a rack formed along the side of the movable contact, a relatively stationary rack forming a part of the operating mechanism, movable gear means meshing with both the relatively stationary rack and the rack formed on the side of the movable contact, an operating rod, and the operating rod being connected to the gear means on an eccentric pivot to cause the actuation thereof and hence opening and closing movements of the movable contact.

8. In a circuit interrupter, a substantially elongated cylindrical casing having a weatherproof exterior, an arc extinguishing structure supported interiorly of the casing adjacent one end thereof, terminal means for the interrupter disposed adjacent the said one end of the casing, a high voltage terminal bushing having the lower end thereof projecting interiorly within the casing and supported adjacent the other end of the casing, an operating mechanism secured to the lower projecting end of the terminal bushing, a relatively stationary contact and a movable rod-shaped contact cooperable to establish an arc within the arc extinguishing structure, the movable rod-shaped contact being adapted to be telescopically received by the terminal bushing in the fully open circuit position of the interrupter, a rack formed along the side of the movable contact, a relatively stationary rack forming a part of the operating mechanism, movable gear means meshing with both the relatively stationary rack and the rack formed on the side of the movable contact, an operating rod, the operating rod being connected to the gear means on an eccentric pivot to cause the actuation thereof, and hence opening and closing movements of the movable contact, rotatable means for actuating the operating rod disposed adjacent the said other end of the casing, and the operating rod extending interiorly of the casing substantially along the side of the projecting end of the terminal bushing.

9. In a circuit interrupter, an insulating casing, an arc extinguishing structure disposed interiorly of the casing and supported adjacent one end thereof, terminal means for the interrupter positioned adjacent the said one end of the casing, a pair of movable contacts movable adjacent opposite ends of the arc extinguishing structure, operating rod means interconnecting the motion of the pair of movable contacts, a terminal bushing projecting into the casing adjacent the other end thereof, an operating mechanism secured to the lower projecting end of the terminal bushing, one of the pair of movable contacts being adapted to be telescopically received by the terminal bushing and having a rack formed along one side thereof, the operating mechanism including a relatively stationary rack, gear means meshing with both the relatively stationary rack and the rack formed on the side of the movable contact, an operating rod, and the operating rod being connected to the gear means on an eccentric pivot to cause the actuation thereof.

10. In a circuit interrupter, an insulating casing, a high voltage terminal bushing supported adjacent one end of the casing and having the lower end thereof extending interiorly within the casing, an arc extinguishing structure disposed interiorly of the casing and supported adjacent the other end of the casing, terminal means for the interrupter disposed adjacent the said other end of the casing, the casing having an exterior of weatherproof material, a pair of movable contacts associated with the arc extinguishing structure and movable adjacent opposite ends thereof, an operating rod interconnecting the motion of the pair of movable contacts, means biasing the pair of movable contacts to the open position, an operating mechanism secured to the lower projecting end of the terminal bushing, one of the pair of movable contacts being adapted to be telescopically received by the terminal bushing and having a movable rack formed along one side thereof, the operating mechanism including a relatively stationary rack, movable gear means meshing with both the relatively stationary rack and the rack

formed on the side of the movable contact, an operating rod, and the operating rod being connected to the movable gear means on an eccentric pivot to cause the actuation thereof and hence opening and closing movements of the movable contact.

11. A circuit interrupter including casing means, an insulating terminal bushing supported adjacent one end of the casing means and having one end thereof extending interiorly within the casing means, an operating mechanism secured to the interiorly extending end of the terminal bushing and including a relatively stationary rack, a movable rod-shaped contact telescopically related to the terminal bushing and having a rack formed along one side thereof, movable gear means forming a part of the operating mechanism and meshing with both the relatively stationary rack and the rack formed on the side of the movable contact, an arc extinguishing structure positioned adjacent the other end of the casing means, contact means including the movable contact for establishing an arc within the arc extinguishing structure, an operating rod, and the operating rod being pivotally connected to the movable gear means to cause the actuation thereof and hence opening and closing movements of the movable contact.

12. A circuit interrupter including casing means, an insulating terminal bushing supported adjacent one end of the casing means and having one end thereof extending interiorly within the casing means, an operating mechanism secured to the interiorly extending end of the terminal bushing and including a relatively stationary rack, a movable rod-shaped contact telescopically related to the terminal bushing and having a rack formed along one side thereof,

movable gear means forming a part of the operating mechanism and meshing with both the relatively stationary rack and the rack formed on the side of the movable contact, an arc extinguishing structure positioned adjacent the other end of the casing means, contact means including the movable contact for establishing an arc within the arc extinguishnig structure, an operating rod, rotatable means for actuating the operating rod disposed adjacent the end of the casing means which supports the terminal bushing, the operating rod extending substantially along the side of the interiorly extending end of the terminal bushing to the operating mechanism, and the operating rod being pivotally connected to the movable gear means to cause the actuation thereof and hence opening and closing movements of the movable contact.

OSWALD VON MEHREN.

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