

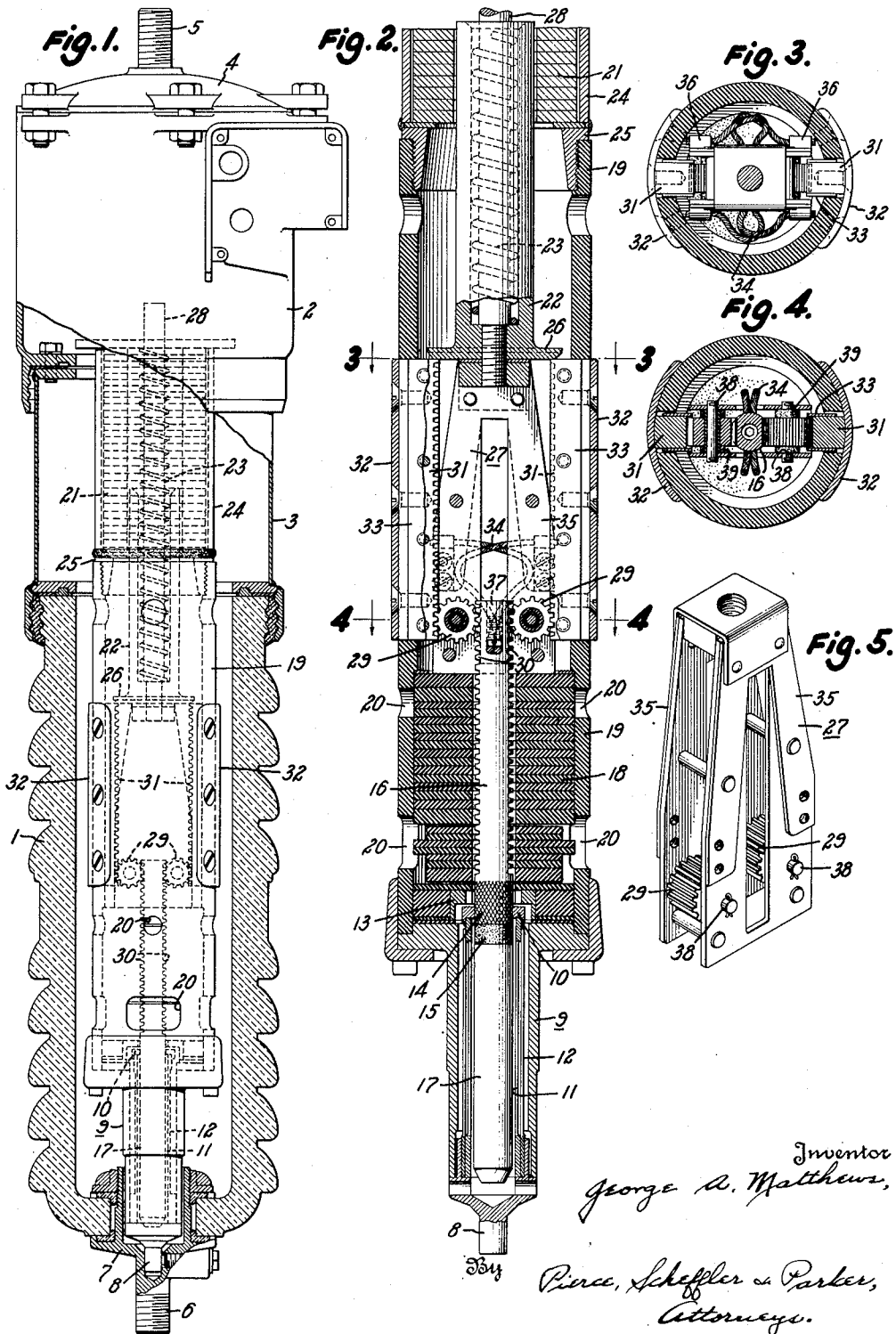
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CIRCUIT BREAKER WITH EXTENDED CONTACT TRAVEL

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CIRCUIT BREAKER WITH EXTENDED
CONTACT TRAVEL

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This invention relates to circuit breakers and more particularly to circuit breakers of high voltage ratings.

It is well known that in an arc interrupting device there are always certain limits of current, voltage, and sometimes power factor, which give a practical limit to the maximum rating which the device can safely handle. That is, the maximum current rating is often a function of the pressure of the contact fingers, the mass of the current carrying and arcing contacts, and also the mass or weight of the various component parts exposed to the excessive pressures met with in interrupting a heavy current arc. In a similar manner, the voltage rating is often limited by the net break distance or the spacing of the arc interrupting parts when in the open position. This latter spacing is a measure of the impulse strength of the device when in the open position and, since the space between the arcing contacts is often contaminated by carbonized oil, gas and other deleterious products, the contact separation must be considerably longer to be effective under all conditions than the steady state conditions might indicate.

It has been general practice to provide more than one interrupting break in a circuit breaker to increase the interrupting rating and in some instances as many as four to six interrupting breaks in series have been employed. The total contact separation and the total rate of contact separation are increased, but the multiple-series-break type of circuit interrupter has many disadvantages which are not present in a single interrupting-break device. In the first place, the interrupting rating does not increase in the same ratio as the number of series breaks since the voltage does not divide evenly across all of the breaks during interruption, thereby stressing certain breaks more heavily than others. Multiple-series-break circuit breakers necessarily require much larger containers than a single-break breaker, and this increases manufacturing costs and frequently raises difficult problems in meeting space requirements. Furthermore, the voltage drop across a circuit breaker increases with the number of series-breaks, and this increase in voltage drop results in more watts-loss which is evidenced by an increase in the temperature rise of the equipment.

This expensive multiple-series-break expedient was adopted since, in general, it is neither practical nor possible to construct an arc-interrupting circuit breaker of high voltage rating as an enlarged scale replica of a circuit breaker which

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has operated satisfactorily at a lower voltage rating. Aside from any question of excessive costs and exaggerated space requirements, an enlarged replica will not provide that compromise between the conflicting mechanical and electrical design requirements which afforded the satisfactory operation obtained with a "standard" circuit breaker of the lower voltage rating.

A straight enlargement of the physical structure is not practical, for example, in the case of series-current operated circuit breakers such as disclosed in my Reissue Patent No. 22,872, and claimed in Patent No. 2,443,260, and in my co-pending application Serial No. 522,129, filed February 12, 1944, now Patent No. 2,487,025, granted November 1, 1949, "Circuit Breaker." Switchgear of this type includes a contact on an axially movable rod which is spring biased towards engagement with a cooperating stationary contact, and which is lifted into open-circuit position by the armature of an "operating coil" or solenoid in series with the breaker contacts and the protected distribution line. Circuit breakers now in use on nominally 5000 volt lines of The Detroit Edison Company provide a 4 inch stroke for the moving contact rod which is directly connected to the operating solenoid armature, but experience has shown that a greater contact separation is required for good interrupting performance for voltages above 8,000 volts and for currents in excess of 700 to 800 amperes. It is possible, of course, to re-design the entire circuit breaker for these voltage and current ratings but the present "standard" 5000 volt circuit breakers satisfy all requirements except that of long contact separation and, for economy in manufacture, it is advisable to use as many identical parts as possible in breakers of different voltage ratings.

Objects of the present invention are to provide circuit breakers of relatively small size and economical manufacture which afford long contact separations for adequate voltage isolation at high voltages. Objects are to provide circuit breakers of high voltage ratings in which the contact separation and rate of contact movement are substantially greater than the travel and rate of travel, respectively, of the primary contact-separating element. An object is to provide circuit breakers in which high operating speeds and high voltage isolation are obtained by a motion-multiplying mechanism between the primary contact-separating element and the movable breaker contact. An object is to provide circuit breakers of high interruption ratings in which motion-

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multiplying devices of minimum space requirements and of simple, rugged construction impart to the movable breaker contacts a straight line motion which is substantially greater, as to extent and as to speed, than the straight line motion of the primary contact-separating elements of the circuit breakers. Further and specific objects are to provide reclosing circuit breakers of the series-current operated type in which rack and pinion couplings are employed to separate the breaker contacts by a distance and at a rate which are multiples of the travel and the rate of travel, respectively, of the operating coil armature.

These and other objects and the advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1 is a side elevation, with parts in section, of a circuit breaker embodying the invention;

Fig. 2 is a fragmentary central longitudinal section, on an enlarged scale, of the operating mechanism and the breaker contacts;

Figs. 3 and 4 are transverse sections on lines 3—3 and 4—4, respectively, of Fig. 2; and

Fig. 5 is a perspective view of the gears and gear support which is secured to the solenoid armature.

The illustrated circuit breaker is of the fully-automatic, single-pole reclosing type, as described in my prior patents, which includes its own timing mechanism and requires no auxiliary circuits or devices for automatic operation. The control mechanism forms no part of the present invention and therefore is not illustrated. Many of the illustrated parts are identical with those used in the commercial manufacture under my patents of circuit breakers of lower voltage ratings, but it is to be understood that the invention is not limited to a conversion of such prior circuit breakers for use at higher voltages or to circuit breakers embodying the particular inventions disclosed in my prior patents.

In Fig. 1, the reference numerals 1 and 2 identify a hollow insulator and metal casing, respectively, such as employed to house my prior reclosing circuit breakers of lower voltage rating. These parts are joined by a metal sleeve 3 which provides the additional space for the extended travel of the movable breaker contact but the sleeve 3 may be omitted by substituting a longer hollow insulator or tank for housing the circuit breaker. The control and timing devices, not shown, are located in the metal housing 2, and the latter is closed by a cap 4 having an integral threaded stud 5 for connection to the distribution line. The other line terminal 6 is integral with a bushing 7 which is secured in an opening at the lower end of insulator tank 1 and is counterbored from its inner side to receive snugly the cylindrical tip 6 of the stationary contact assembly 9. The contact assembly comprises a cylindrical array of contacts 10 carried by resilient arms 11 which are backed up by spring fingers 12, and an arcing contact ring 13.

The movable contact system includes a ring contact 14 which is seated within the series of contacts 10 when the breaker is closed, and an arcing ring contact 15 on an axially movable rod 16 of metal of good conductivity, for example, a high-strength copper alloy. A cylindrical rod 17 of horn fibre extends below the movable arcing contact 15 and is lifted into the arcing chamber formed by stacked disks 18 of horn fibre or other material capable of promoting arc-inter-

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ruption when the breaker contacts are separated by a lifting of the rod 16. The disks 18 are arranged within a cylinder 19 of insulating material which is provided with openings 20 for admitting insulating oil, with which the hollow insulator 1 is filled, into the arcing chamber.

The power for lifting the rod 16 and associated contacts is developed by an operating coil or solenoid 21 and its armature or plunger 22. The plunger is hollow to receive a breaker-closing spring 23 which normally forces the armature downwardly to close the breaker contacts. The coil 21 is within a cylinder 24 of magnetic material which is welded to a metal bushing 25 having an upwardly tapered inner surface which is threaded into the upper end of the insulating cylinder 19 and which cooperates with the lower flange 26 of the armature 22 to form a dashpot for smoothly arresting the upward travel of the armature and breaker-operating mechanism.

The several parts as so far described are similar to or preferably identical with the corresponding parts of circuit breakers according to my prior inventions in which the axially movable contact-carrying rod 16 was connected directly to the armature 22. The present invention introduces a motion-multiplying mechanism between the armature 22 and the contact-carrying rod 16 to effect an extended contact separation of approximately twice the travel of the armature 22.

A skeleton frame 27 of generally inverted U-form is secured to the lower face of flange 26 of the armature 22 by the threaded end of a rod 28 which extends upwardly into the housing 2 for cooperation with the timing and control devices, not shown. A pair of gears 29 are journaled on the frame and mesh with racks 30 in opposite sides of the rod 16 which carries the movable breaker contacts. The gears 29 also mesh with rack bars 31 which extend through longitudinal slots in the insulating cylinder 19 and are secured thereby by arcuate metal plates 32. Guide flanges 33 are secured to the rack bars 31 to prevent movement of the gears 29 out of meshing engagement with the rack bars. Flexible jumpers 34 are secured to U-shaped strips 35 of copper or other good conductivity metal by clips 36, and the midportions of the jumpers are seated in a transverse slot in the upper end of the rod 16 and are secured thereto, electrically and mechanically, by a set screw or clamping bolt 37.

To prevent arcing destruction of the gears 29, the shafts 38 which support the gears are insulated from the frame 27 by insulating bushings 39, and the low resistance path for current flow from the U-shaped strips 37 to the rod 16 is through the flexible jumpers 34.

Upon energization of the operating winding 21 to attract the armature 22, the armature 22 and attached frame 27 move upwardly to roll the gears 29 along the rack bars 31, thereby effecting an upward displacement of the contact-carrying rod 16 through twice the displacement and at twice the speed of the movable frame 27. This amplified travel of the rod 16 results in a rapid and extended separation of the main breaker contacts 10 and 14, 15, thereby affording a wide contact separation which precludes restriking and insures adequate isolation at voltage ranges substantially higher than would be possible with the prior constructions in which the contact-carrying rod 16 was directly connected to the armature 22.

The illustrated arrangement of gears 29 which mesh with racks 30 on the contact-carrying rod 16 and with stationary racks 31 affords a 2-to-1 multiplication of the travel and rate of travel of the armature 22, but it will be apparent that other multiplication ratios may be had when idler gears of one diameter mesh with one rack and are fixed to idler gears of a different diameter which mesh with the other rack.

The advantages of the increased separation and increased rate of separation of the breaker contacts are obvious, but it is to be noted that the increased speed of reclosing of the contacts is also beneficial to reduce arcing when fault currents are involved when the circuit breaker is reclosed. The fault which initiated the opening of the circuit breaker may remain on the line when the breaker recloses and, as is well known, arcing to some degree takes place before the metal-to-metal engagement of contacts across which there is a voltage at the closing of the contacts. Pitting or erosion of the contacts is of course reduced with a decrease in the time interval between the initiation of the arcing and the actual closed condition of the contacts.

A particular advantage of the invention for a manufacturer is the economy which follows from the use of components of identical construction in reclosing circuit breakers of different voltage ratings. The introduction of the motion-multiplying mechanism between the operating coil armature 22 and the contact-carrying rod 16 necessitates the provision of racks 30 on the contact-carrying rod 16, and a longer insulating cylinder 19 than that of the circuit breaker of the lower voltage rating, also the housing extension sleeve 3 or a longer insulator 1, but the same control mechanism, operating solenoid, breaker contacts and arc-extinguishing assembly may be employed in the circuit breakers of different voltage ratings. Except for the extension of the housing by the insertion of sleeve 3 or the use of a longer insulator 1, the space requirements or bulk of the circuit breakers of higher voltage rating are the same as for breakers of lower voltage ratings.

It is to be understood, however, that the invention is not limited to circuit breakers of relatively high voltage rating which are constructed from standard parts of circuit breakers of a lower voltage rating. Nor is the invention limited to any particular voltage rating since it affords, for any given voltage rating, circuit breakers of smaller size and of higher contact-separating speeds than has been possible with prior constructions.

It is therefore to be understood that the invention is not limited to the particular construction herein illustrated and described as various modifications which may occur to those familiar with the design and construction of circuit breakers fall within the spirit and scope of the invention as set forth in the following claims.

I claim:

1. In an electromagnetically operated circuit breaker, the combination with an axially movable rod carrying a contact, a cooperating stationary contact, and spring means biasing said rod into position to engage said contacts, of an operating coil having an armature movable on energization of said coil axially in line with said rod and in a direction opposite the biasing action of said

spring means, and a motion-multiplying connection between said armature and said rod, whereby energization of said coil results in a separation of said contacts by substantially more than the travel of said armature, said motion-multiplying connection comprising a frame secured to said armature, gear means rotatably mounted on said frame, a stationary rack with which said gear means is meshed, and a rack on said rod in mesh with said gear means.

2. In an electromagnetically operated circuit breaker, the invention as recited in claim 1, in combination with flexible jumpers of high conductivity electrically connecting said frame and said contact-carrying rod.

3. In an electromagnetically operated circuit breaker, the invention as recited in claim 2, wherein said gear means is insulated from said frame.

4. In an electromagnetically operated circuit breaker, the combination with an axially movable rod carrying a contact, a cooperating stationary contact, and spring means biasing said rod into position to engage said contacts, of an operating coil having an armature movable on energization of said coil axially in line with said rod and in a direction opposite the biasing action of said spring means, and a motion-multiplying connection between said armature and said rod, whereby energization of said coil results in a separation of said contacts by substantially more than the travel of said armature, said motion-multiplying connection including a frame of approximately inverted U-form secured to said armature, a pair of gears journaled on said frame, stationary racks at the outer sides of and in meshing engagement with the respective gears, and racks at opposite sides of said contact-carrying rod and in mesh with the respective gears.

5. In an electromagnetically operated circuit breaker, the invention as recited in claim 4, wherein a cylinder of insulating material is positioned below said operating coil and forms a chamber in which said armature and said motion-multiplying connection are movable, and supporting means secures said stationary racks to said cylinder.

6. In an electromagnetically operated circuit breaker, the invention as recited in claim 5, wherein said supporting means comprises arcuate plates secured to said cylinder and supporting said stationary racks within the same.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
551,635	Herdman	Dec. 17, 1895
733,564	Sundh	July 14, 1903
836,994	Rider	Nov. 27, 1906
860,433	Andersen	July 16, 1907
2,318,030	Thompson	May 4, 1943
2,333,604	Wallace	Nov. 2, 1943
2,491,265	High	Dec. 13, 1949
2,534,920	Ludwig et al.	Dec. 19, 1950
2,539,213	Mehren	Jan. 23, 1951
2,541,917	De Mers	Feb. 13, 1951

FOREIGN PATENTS

Number	Country	Date
462,425	Germany	July 10, 1928