

May 21, 1946.

A. G. STEINMAYER ET AL

2,400,850

MULTIPLE CIRCUIT INTERRUPTER

Filed June 25, 1942

6 Sheets-Sheet 1

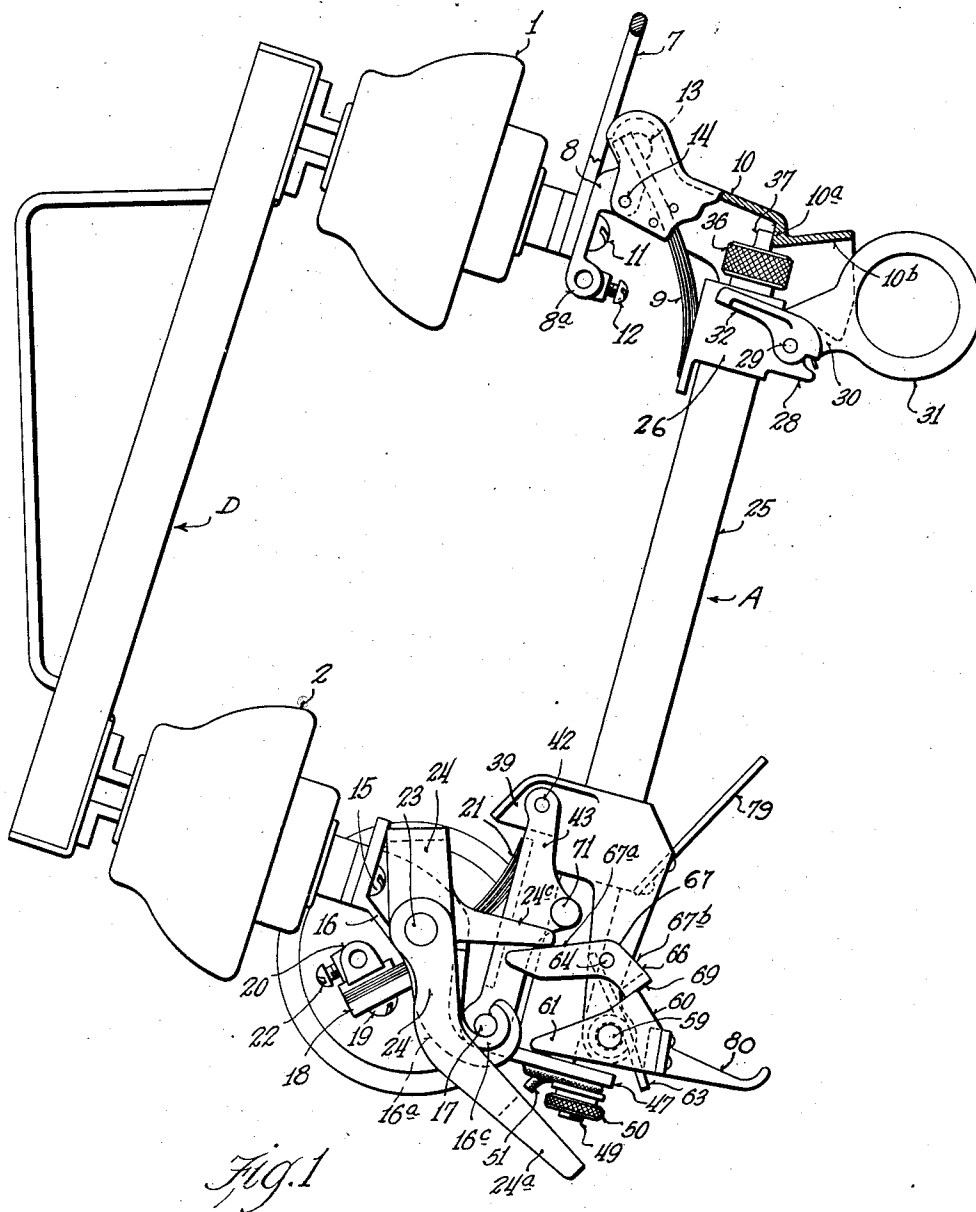


Fig. 1

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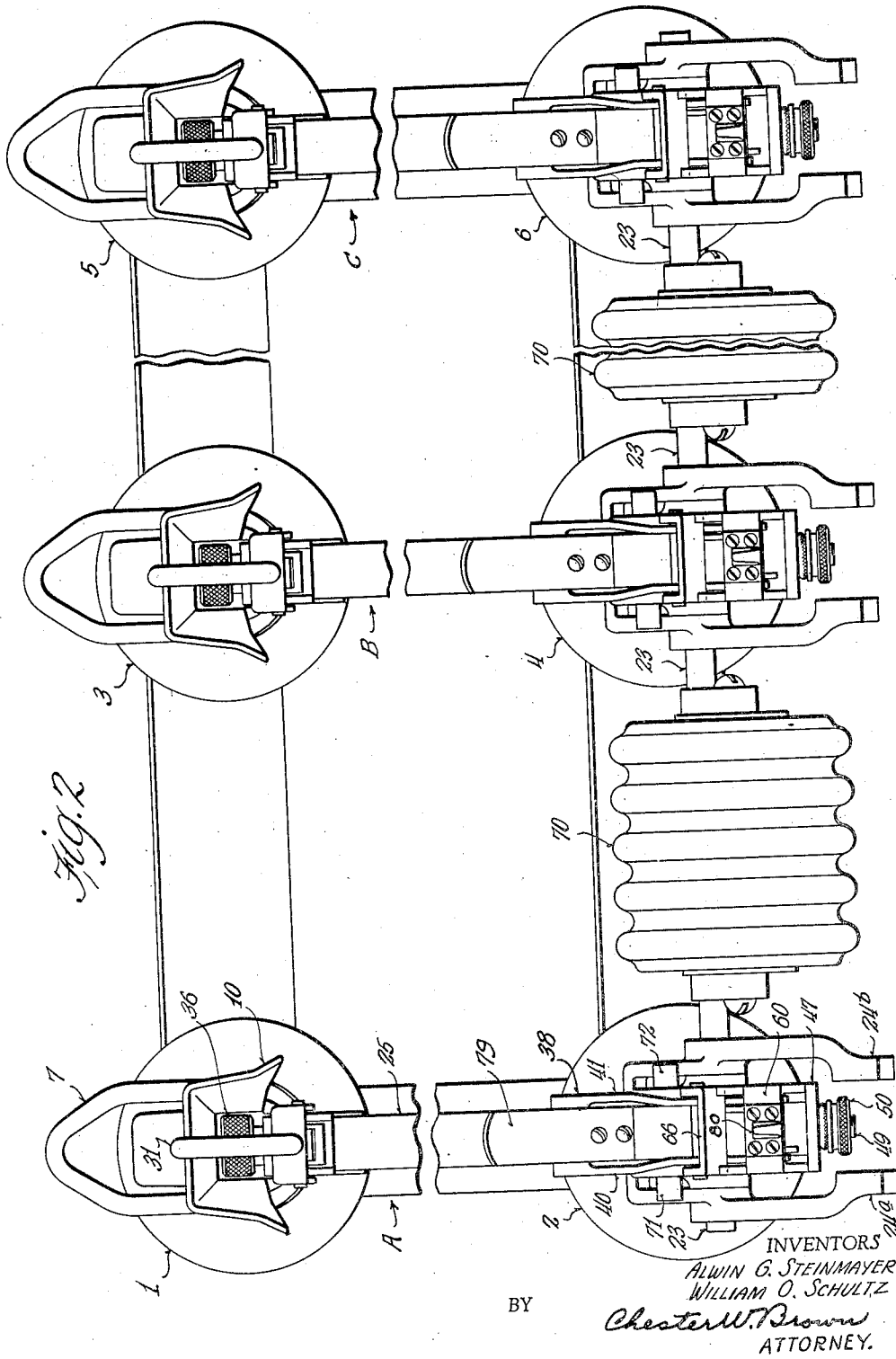
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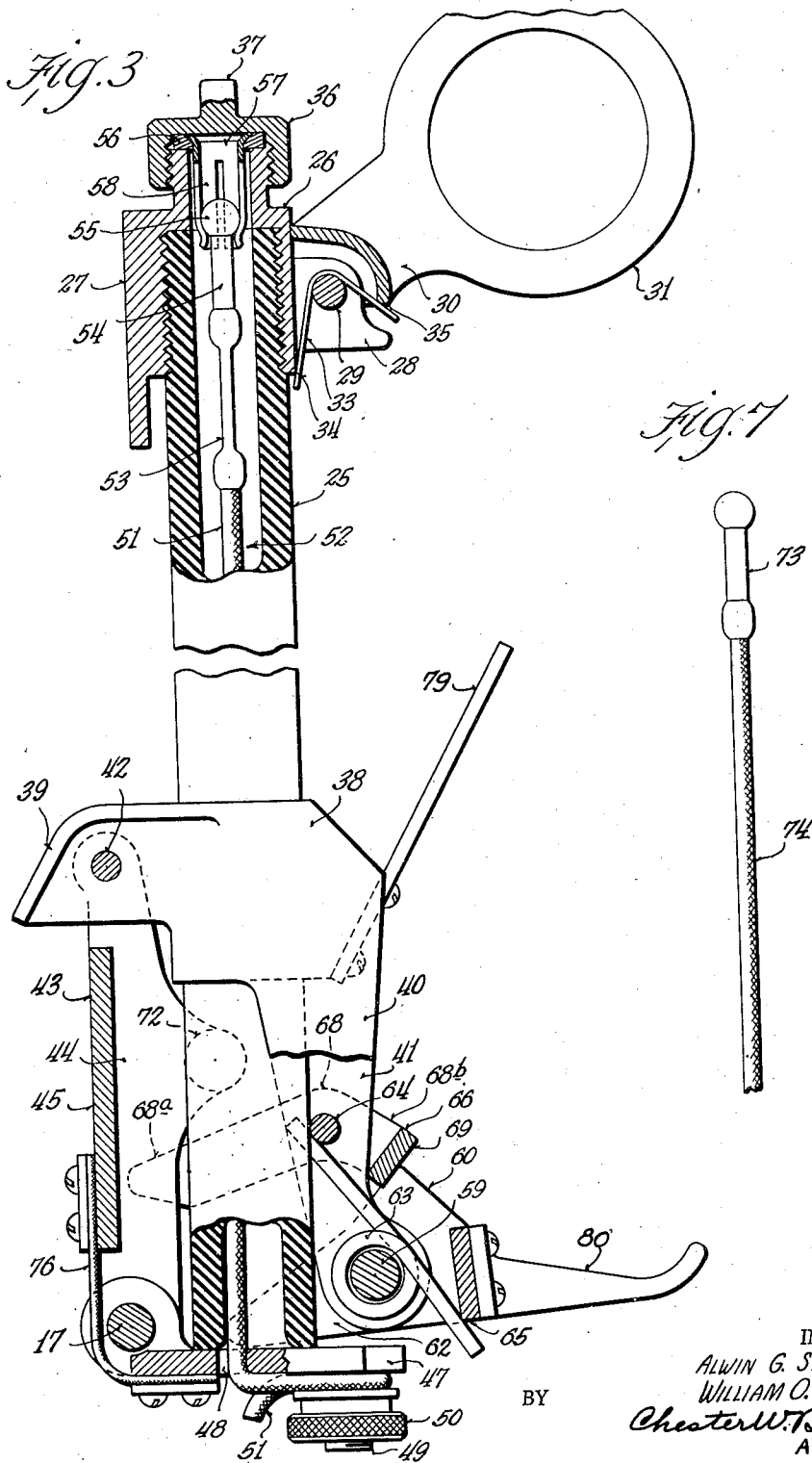
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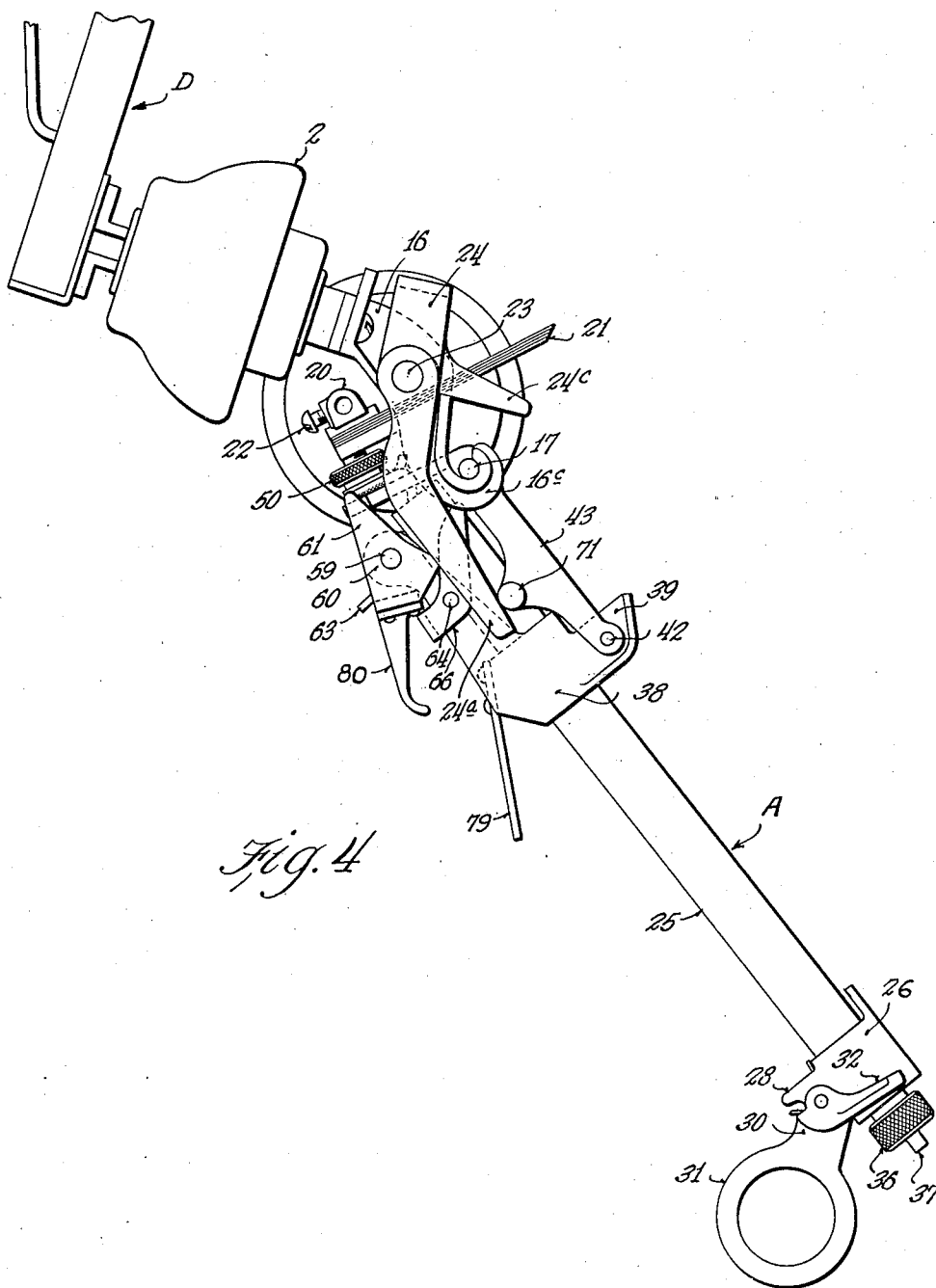
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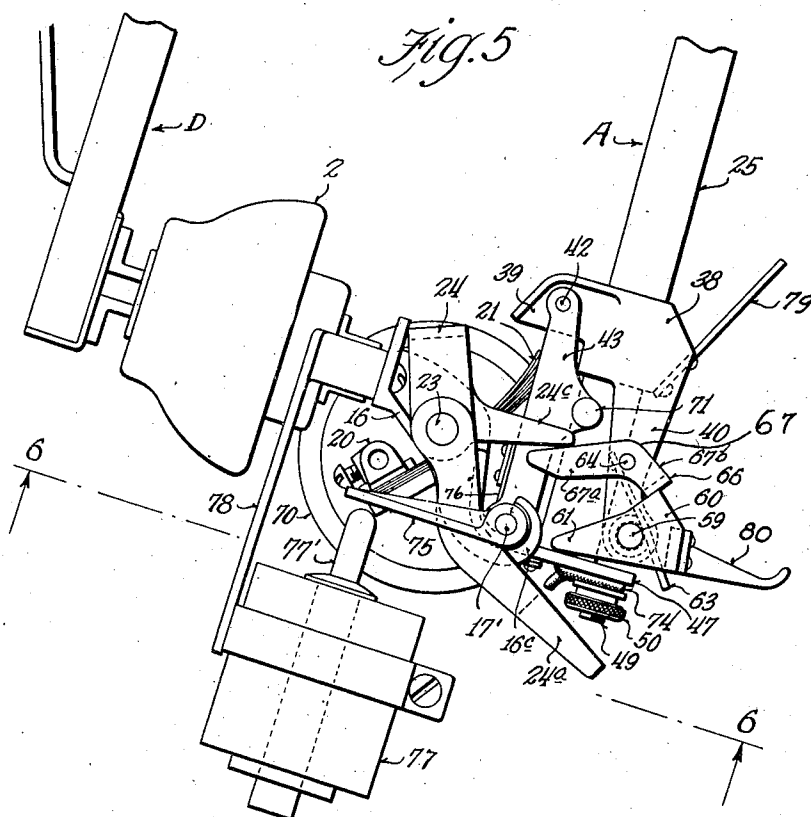
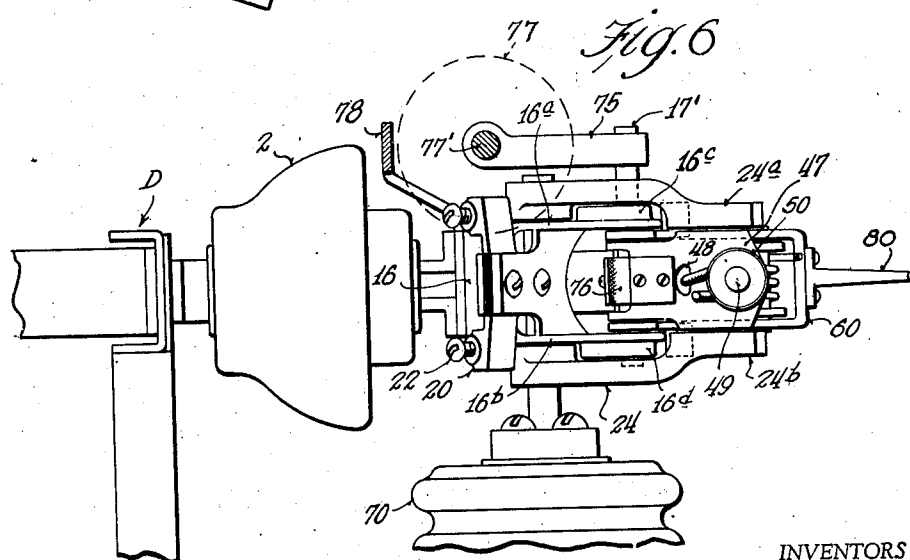
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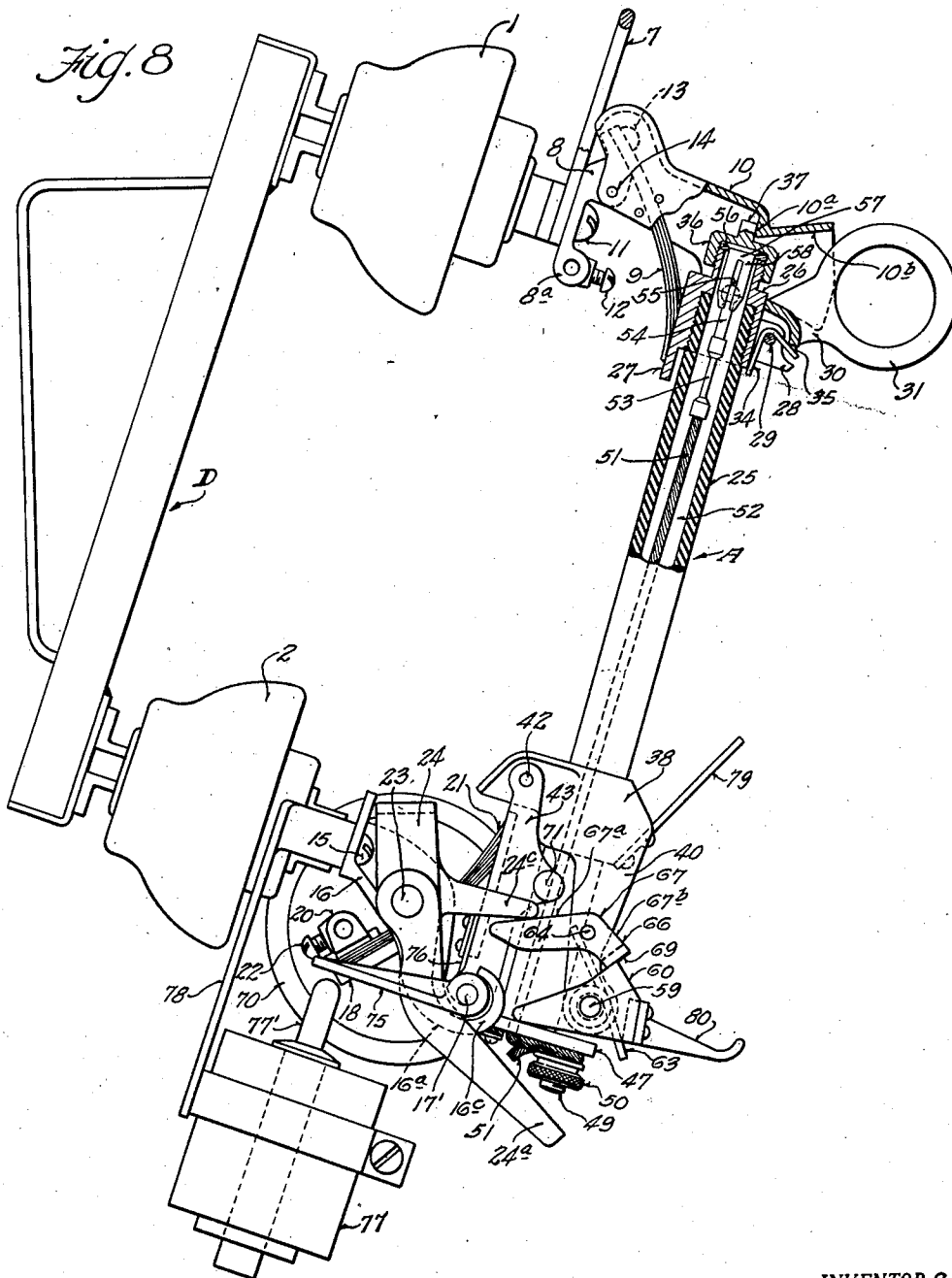
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UNITED STATES PATENT OFFICE

2,400,850

MULTIPLE CIRCUIT INTERRUPTER

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Application June 25, 1942, Serial No. 448,374

24 Claims. (Cl. 200—114)

This invention relates to protective devices for electric power transmission lines and electrical equipment connected thereto, and it has to do particularly with devices of that nature designed especially for use on lines comprising more than two conductors, wherein the occurrence of an open-circuit condition in one conductor alone might result in injury to motors or other equipment connected to the remaining intact conductors—through which remaining conductors current continues to flow. The invention is applicable, for example, to a three phase transmission line where a fault occurring in one phase-wire may cause the operation of an automatic cut-out in that wire without interrupting the flow of current in the other two phase-wires, and, in consequence, may cause the windings of three-phase motors connected to the uninterrupted phase-wires to be overloaded and resultantly injured.

The primary object of the present invention is to provide means which will operate automatically, in response to a fault current in one conductor of a transmission line, to open that conductor and, in addition, to open one or more or all of the other conductors constituting said line, irrespective of whether a sufficient fault current obtains in such other conductor or conductors to cause operation of fuses or circuit breakers individual thereto.

Another object of the invention is to provide apparatus of the aforementioned character which is easily adaptable, by addition or subtraction of separable units, for application, in any given installation, to any desired number of conductors.

A third object is to provide a multiple circuit-interrupter of the aforementioned character which is suitable for use on high voltage lines and wherein, to that end, all of the arcing occurs within expulsion tubes which are effective to extinguish the arcs.

A further object is to provide multiple circuit-breaking protective apparatus which can be either fuse-operated or electro-magnetically operated, as the user may desire.

An additional object is to provide an automatic multiple circuit-breaking device which can be operated manually as an air-break switch.

Still another object is to provide a circuit breaking device which is suitable for use either individually or in multiple and which, on the one hand, is operative electromagnetically to effect a quick break in response to a relatively large fault current and, on the other hand, is

operative through the rupturing of a fuse-link in response to a smaller fault current of predetermined extended duration.

It also is an object of the invention to devise equipment of the aforementioned character which is efficient and durable, yet susceptible of being produced at a cost which is not prohibitive.

Referring to the drawings:

Fig. 1 is an endwise elevational view of a multiple fuse structure;

Fig. 2 is a front elevational view of the multiple fuse structure of Fig. 1;

Fig. 3 is an enlarged detail, partly in elevation and partly in section, of a fuse-unit forming a component part of the structure of Figs. 1 and 2;

Fig. 4 is an endwise elevational view corresponding to Fig. 1, but depicting a fuse-unit in "dropped out" position—the upper portion of the supporting structure being omitted because of space limitations;

Fig. 5 is a fragmentary endwise elevational view illustrating a modification of the structure of Fig. 1 in which electromagnets are employed instead of fuses to effect the circuit-breaking operations;

Fig. 6 is a bottom view taken along the line 6—6 of Fig. 5;

Fig. 7 is a detail of a detachable conductive link which may be employed in lieu of a fuse-link when the apparatus is operated electromagnetically; and

Fig. 8 is an endwise elevational view similar to Fig. 1, embodying the disclosures of Figs. 3 and 5.

The apparatus of Figs. 1 to 4 inclusive is a plural or multiple fuse structure comprising a group of three identical fuse-units of the expulsion drop-out type and is suitable for insertion in a three-wire transmission line—each member of the group and the intercoupling therebetween being so constituted that if the fuse-link individual to any one unit blows the other two immediately thereafter will resultantly be caused to drop out and thereby interrupt their respective line wires. In Figs. 1 and 2 the fuse-units are depicted in their normal closed-circuit positions whereas in Fig. 4 a fuse-unit is shown in its dropped-out open-circuit position to which it moves immediately after the blowing of any one of the three fuse-links.

The three fuse-units are identified in Fig. 2 by reference letters A, B, and C respectively; and in Fig. 1 fuse-unit A is shown in endwise elevation. However, as previously stated, all three fuse-units

are identical and, accordingly, the fuse-unit marked A in Fig. 1 can be considered as equally illustrative of B and C.

The fuse-units are removably mounted on a stationary supporting structure, identified as a whole, in Fig. 1, by reference letter D, and including three pairs of insulators—of which the several insulators are identified by numerals 1-6 respectively. Insulators 1 and 2 constitute one pair, which is individual to fuse-unit A. Insulators 3 and 4 constitute a second pair, which is individual to fuse-unit B. Insulators 5 and 6 constitute a third pair, which is individual to fuse-unit C. The structure upon which the insulators are mounted requires no detailed description aside from pointing out that it is designed to support the insulators in spaced relation, as illustrated, and adapted for mounting on a cross arm.

Except as otherwise indicated, or as may be self-evident, the descriptive matter to follow (wherein reference is made to fuse-unit A and to insulators 1 and 2 and the attached parts) is applicable also to fuse-units B and C and their respectively associated supporting insulators and attached parts.

To upper insulator 1 are connected several parts, as follows: a dead-ending loop 7, terminal member 8, laminated contact blade or brush 9, and a latch 10. These are attached to the insulator by means of screws 11. Terminal member 8 has an integral apertured lug 8a designed to receive the bared end of a conductor wire of the transmission line, and a binding screw 12 serves to clamp the wire therein. The incoming wire may be wrapped around dead-ending loop 7 in the usual way in order to remove the tension thereof from lug 8a. Contact blade 9 is anchored at one end to terminal member 8 by means of screws 13. Latch 10 is pivotally connected at 14 to terminal member 8 and is rotatable to a limited extent around its pivotal connection. The free end of the latch is shown in its "down" position wherein a shoulder 10a, forming an integral part of the latch functions to latchingly engage a teat on the upper end of fuse-unit A—to be described later.

Attached to lower insulator 2 by means of screws 15 is a bracket 16 having a pair of horizontally spaced downwardly trending prongs 16a and 16b—of which only 16a is visible in Figs. 1 and 4. The free ends of prongs 16a and 16b terminate in hooks 16c and 16d, which are designed to receive within their bights the opposite ends of a trunnion pin 17, forming a part of fuse-unit A—the latter being rotatable about pin 17 to assume its "down" or "dropped-out" position wherein it is illustrated in Fig. 4. The spacing of hooks 16c and 16d and the disposition of the fuse-unit therebetween is shown most clearly in Fig. 6.

Integral with bracket 16 is a projection 18 to which is secured, by means of screws 19 and terminal connector 20, a laminated contact blade 21, which serves to effect a firm electrical contact with the lower terminal of the fuse-unit and functions also as a spring, for a reason which shortly will be explained. Terminal connector 20 is apertured to receive the bared end of a conductor wire and is provided with a binding screw 22 for clampingly engaging the wire.

Journalled in bracket 16 and extending there-through is a shaft 23, on which is mounted and secured a yoke member 24, the uppermost portion of which straddles bracket 16 to tie together a pair of downwardly trending fingers 24a and 24b which are spaced apart horizontally, as de-

picted in Fig. 2, and form integral parts of member 24. Also forming integral parts of yoke member 24 are a pair of horizontally extending spaced fingers 24c and 24d. Only finger 24c is visible in the drawings (see Fig. 1) but its companion, finger 24d, is located directly behind 24c and to the opposite side of fuse-unit A, as viewed in Fig. 1. Both these fingers perform identical functions and either could be eliminated; but the two are provided to achieve symmetry.

The fuse-units—all three of which are identical—are illustrated in detail in Fig. 3, and exteriorly on a smaller scale in the other figures of the drawings. Each fuse-unit includes an elongate tubular expulsion cartridge 25 which generally is made of thick-walled horn fiber or of Bakelite lined with horn fiber. To the upper end of tube 25 is threaded a metal ferrule 26, having at one side a flat surface 27 which, as shown in Fig. 1, is designed to be engaged by the free end of contact blade or brush 9—when the fuse-unit is in its normal "up" position. Diametrically opposite surface 27 and forming integral parts of ferrule 26 are a pair of horizontally spaced parallel, laterally projecting lugs or ears 28 which are drilled to receive a pin 29 serving as a pivotal support for a casting 30, which casting includes an eye 31 and a pair of spaced arms 32 disposed at opposite sides of the ferrule. Embracing pin 29 and disposed between lugs 28 is a leaf spring 33, one end of which bears at 34 against ferrule 26 while the other end presses upwardly at 35 against casting 30—thus biasing eye 31 upwardly and arms 32 downwardly about pin 29. Arms 32 are designed to engage and lift latch 10 compliant to a downward movement imparted to eye 31. The latter is provided to enable the fuse-unit to be unlatched manually, with the aid of a switch stick, whenever there may be occasion to withdraw a fuse-unit wherein the fuse-link has not blown.

The upper end of ferrule 26 is threaded to receive a removable cap 36 having an upwardly projecting teat 37 which, as shown in Fig. 1, is latchingly engaged by shoulder 10a of latch 10. To the exterior of expulsion cartridge 25, near the lower end thereof, is rigidly secured a casting 38 having a backwardly projecting lug 39 and a pair of horizontally spaced depending legs 40 and 41.

Projecting downwardly from lug 39 and pivotally connected thereto by a pin 42 is a link 43 of U-shape cross-section comprising a pair of spaced flanges 44, disposed astride the cartridge, and a web 45 interconnecting said spaced flanges.

Pivotally connected by pin 17 to the lower end of link 43 is a flipper arm 47, which is apertured at 48 and provided at its free end with a threaded lug 49 to which is applied a knurled nut 50. Lug 49 and nut 50 constitute a binding post to which is detachably anchored the exposed lower end of a flexible leader 51 forming one of the terminals of a fuse-link 52. The latter includes a fusible section 53 and an upper terminal 54 having a spherical head 55.

Resting on the upper end of ferrule 26 and secured in place by cap 36 is an internally beveled conductive ring 56 in which is seated a downwardly extending spring connector 57 having a flared upper end conforming to the bevel on ring 56 and a plurality of depending resilient fingers 58 forming, conjointly, an expansible socket which is constricted at its lower end and thereby rendered operative to yieldably grip spherical head 55 and thus normally to support the upper end of the fuse-link and effect electrical connec-

tion therewith. The grip of fingers 58 on terminal 54 is adequate to withstand a desirable amount of permanent tension on the fuse-link, but is yieldable to an additional tensile force applied to the lower end of the fuse-link as hereinafter described.

The fuse-link electrically interconnects terminal connectors 8 and 20 and is designed to rupture at the fusible section 53 in response to a fault current of some determined magnitude; but in event the fault current is large enough in only one, or less than all, of the several transmission line conductor wires to blow the fuse-links therein, the objective is to effect a disconnection at each of the other fuse-units of the group so that all the several conductors of the line will be opened and not merely those in which a fuse blowout occurs. That objective is achieved by virtue of the unblown fuse-links being dislodged from their respective connectors 57 whenever one or more, but less than all of the group, blows out.

Pivotally supported on the lower ends of depending legs 40, 41 by means of a pin 59 is a U-shaped rotatable member 60 having a pair of lever arms 61, 62 disposed at either side of cartridge 25 and having their free ends in overlying non-contacting spaced relation to flipper arm 47. A coil spring 63 encircling pin 59 serves to bias member 60 in such manner that lever arms 61, 62 tend to move downwardly against flipper arm 47. One end of spring 63 is anchored against a pin 64 while the other end bears at point 65 against member 60. Spring 63 being quite stiff is capable of imparting enough force to member 60 to bring about an abrupt withdrawal of the fuse-link from connector 57. But member 60 is normally held in a cocked position by means of a trigger 66, which is pivoted on pin 64. The interlocking engagement between trigger 66 and member 60 is clearly shown in Fig. 1. Trigger 66 is a U-shaped member straddling cartridge 25 and comprising a pair of spaced legs 67, 68 interconnected at one end by a cross member 69. Legs 67 and 68 are each divided by pin 64 into two lever arms. Leg 67 includes a long lever arm 67a and a short lever arm 67b while leg 68 includes a long lever arm 68a and a short lever arm 68b. Lever arms 67a and 68a are normally disposed below fingers 24c and 24d, respectively, and are engageable by the free ends of said fingers when the latter move downwardly from the position indicated in Fig. 1; and the trigger is thus rotatable counterclockwise, as viewed in Fig. 1, to release member 60 and bring about a withdrawal of the fuse-link from connector 57, as previously stated.

The sole function of yoke member 24 is to operate trigger 66 in response to the dropping of one of the other fuse-units to the "down" position in which it is shown in Fig. 4. Yoke member 24, therefore, constitutes a part of the interlock mechanism which interconnects and interrelates the several fuse-units in such manner that an operation of one will immediately bring about sequential operation of the others.

Referring to Fig. 2, it is pointed out that consecutive shafts 23 are coupled together through coupling members 70, each comprising a rugged ribbed insulator. Couplings 70 are preferably eccentric to shafts 23 for the purpose of providing a rotational bias which will aid the rotation of said shafts. But the aforementioned eccentricity, while considered desirable, is purely optional and not essential to the operativeness of the device.

It helps to offset inertia and thus to quicken the response.

It will be evident that yoke members 24 rotate in unison and not otherwise.

Normally, the flexible leader 51, passing through aperture 48, serves to hold link 43 and flipper arm 47 in the position wherein they are shown in Figs. 1 and 3; but when the fusible section is ruptured by a fault current, the leader is no longer so effective and, under the force of gravity and the spring action of contact blades 9 and 21, the cartridge will move downwardly and outwardly about pins 42 and 17 as centers of rotation. As a result, teat 37 moves downwardly and becomes disengaged from shoulder 10a, and the fuse-unit thereafter rotates unrestrainedly about pin 17 toward its "down" position. In the course of said downward movement a pair of laterally projecting lugs 71, 72, carried by link 43 engage fingers 24a and 24b (see Fig. 4) and thereby effect a clockwise rotation of yoke member 24—due to the weight of the fuse-unit being imparted to said fingers. Since, as previously pointed out, all the several yoke members are connected together by shafts 23 and couplings 70, they will all rotate in unison. Rotation of the other yoke members 24 causes downward movement of their respective fingers 24c, 24d, thereby actuating triggers 66 to trip members 60. The latter, upon being released by their triggers, rotate counterclockwise, as viewed in Fig. 1, and, in the manner previously described, cause their respectively associated fuse-links to be abruptly withdrawn from their supporting connectors 57. Each of the fuse-units thus released, as an indirect result of the blowing of one fuse-link, will drop down to the open-circuit position illustrated by Fig. 4.

Attention is directed to the fact that the blowing of a fuse does not result in actuating the trigger of the fuse-unit in which the blown fuse is housed, but does, on the contrary, cause, indirectly, the triggers of the other fuse-units to be actuated. It will be observed that in Fig. 4 the trigger has been pressed and member 60 released. It follows that Fig. 4 illustrates one of the fuse-units which has been actuated secondarily, and not in response to a blow-out of its own fuse-link.

A modification of the device hereinbefore described is depicted in Figs. 5, 6, and 7. Here the operation is not predicated upon the blowing of a fuse, but is brought about instead by the energization of an electromagnet designed to be effectively actuable in response to excessive current flow of predetermined magnitude. The device is, therefore, a gang circuit-breaker, in the specific sense, as distinguished from a gang or multiple fuse. No fuse-link is included in the modified device. Instead, there is substituted the conductive link shown in Fig. 7, comprising a terminal 73 and a flexible leader 74 connected directly to said terminal without the interposition of a fusible section. Terminal 73 is substantially identical with terminal 54 of Fig. 3, and the link of Fig. 7 is interchangeable with fuse-link 52.

In Fig. 5 the omitted upper portion of the device is identical with that of Figs. 1 to 4 inclusive; and the lower portion, illustrated, is identical with Fig. 1 except that pin 17' is longer than pin 17, and except for the addition of some parts which now will be described. The added parts consist of a lever 75, solenoid 77, plunger 77', and supporting bracket 78. Lever 75 is drivingly secured in pin 17' and overlies the upper end of plunger 77', which latter extends axially through

solenoid 77 and constitutes an armature which is movable upwardly in response to a sufficient energization of the solenoid. The solenoid is connected in series circuit with the line conductor in which the unit is inserted and its design, as well as that of the plunger, is such that the plunger will not be actuated until the line current rises to some prescribed value above normal. Upon actuation of the plunger, lever 75 and pin 17', together with flipper arm 47, which is secured to pin 17', are rotated clockwise; and the conductive link comprising flexible leader 74 and terminal 73 (Fig. 7) is thereupon abruptly withdrawn from connector 57 (Fig. 3). The line conductor is thus opened and the cartridge drops to the down position as illustrated in Fig. 4.

Figs. 5 and 6 illustrate a single unit, of which as many as may be required are coupled together to form a group. For a three-phase line the group will usually comprise three units. Each unit comprises all the parts shown in Figs. 5 and 6, including the solenoid and plunger, and each is inserted individually in one of the line conductors. Intercoupling of the units may be precisely the same as previously described with reference to Figs. 1 to 4. It will be noted that with the first-described embodiment of the invention operation is initiated by the blowing of a fuse, whereas with the second-described embodiment operation is initiated by the actuation of an electromagnet—which causes a withdrawal of the conductive link from its supporting connector. In both cases it is a break in the link extending through the cartridge which constitutes the commencement of the sequence of circuit-breaking operations; and said sequence and its means and mode of accomplishment are identical in each instance.

Each fuse-unit is provided with a projecting tongue 79, secured to casting 38, which is adapted to be engaged by a special switch-stick for lifting and withdrawing the fuse-unit from the supporting structure; also for replacing the fuse-unit.

For the purpose of ensuring a good electrical connection between links 43 and 47, the latter are electrically tied together by a flexible jumper 76.

To insert a fuse-unit it first is lifted by means of a switch-stick to the position illustrated in Fig. 4, with pin 17 resting in the bights of hooks 16c and 16d. Then, after withdrawing the switch-stick from tongue 79, the free end of the unit is lifted to the "up" position shown in Fig. 1. During closure, teat 37 engages the inclined surface 10b of latch 10 and lifts the latch—which drops down as soon as the teat has passed the ledge of shoulder 10a.

To facilitate cocking, an arm 80 is attached to member 60. This provides an advantage against spring 63.

It will be apparent that the circuit-interrupting units are capable of being employed individually without any intercoupling medium. This renders it feasible to convert from one type of installation to another. Also, it is very easy to effect a conversion from the fuse-operated organization of Figs. 1 to 4 to the magnetically-operated organization exemplified by Figs. 5 and 6.

It was previously stated that when the electromagnetic solenoid of Figs. 5 and 6 is employed the conductive link of Fig. 7 is substituted for fuse-link 52. While that is generally true, it nevertheless is feasible to employ a fuse-link instead of the non-fusible link of Fig. 7 in conjunction with the device of Figs. 5 and 6; and in such event the fuse-link may advantageously be designed to respond to a fault current of extended duration, the

magnitude of which is not sufficient to enable the solenoid to actuate plunger 77' whereas the solenoid would operate more quickly than a fuse-link in response to a current of large magnitude. Fig. 8 illustrates a circuit interrupter embodying the magnetically operated device of Figs. 5 and 6 and combined fuse link and pull link 51—53—54 shown in Fig. 3. In this connection it should be noticed that a simple electromagnet is responsive exclusively to the magnitude of the energizing current and is not adapted to respond to a fault current of extended duration but of less magnitude than that which is necessary to effect an immediate actuation. On the contrary, the fusible section 53 can be designed to meet time-current specifications as well as maximum current specifications.

The structure of Figs. 1 to 4 and 8 can be operated manually as an air-break switch by pulling downwardly with a switch stick on finger 24a or 24b or pulling downwardly on flipper arm 47. Either manipulation will result in withdrawing link 52 from socket 58—thus causing all of the several fuse-units to drop out. With the structure of Figs. 5, 6 and 8 manual operation can be effected by pushing upwardly on plunger 77' or by rotating lever 75.

What is claimed is:

1. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each comprising, individually, an expulsion cartridge hinged at one end, latch means normally operative to engage and support the other end of said cartridge, a conductor extending lengthwise through said cartridge, means dependent upon the continuing integrity of said conductor for maintaining said cartridge in engagement with said latch means, mechanism individual to said cartridge for rupturing said conductor within said cartridge, and means intercoupling said mechanisms, said means being responsive to a preceding circuit-breaking actuation of any one of said units to actuate sequentially the aforesaid mechanisms associated with each of the other said units.

2. In a multiple circuit-interrupter, a group consisting of a plurality of circuit-interrupting units, each comprising, individually, an expulsion cartridge, hinge means for one end of said cartridge including a link pivotally connected at one end to said cartridge, a pivotal support for the other end of said link, a flipper arm pivotally connected to said link, a conductor extending lengthwise through said cartridge and having one end anchored to said flipper arm, latch means normally operative to releasably support the end of said tube remote from said hinge means, a spring-actuated member operative to actuate said flipper arm for rupturing said conductor within said cartridge, a trigger normally retaining said spring-actuated member in a cocked condition, a rotatable member in operative relation to said trigger for actuating said trigger and thus tripping said spring-actuated member, means movable with said cartridge for rotating said rotatable member in response to a circuit-breaking movement of said cartridge, and means intercoupling the said rotatable members individual to the several said units for synchronizing the rotation thereof.

3. The combination in a circuit-interrupter of structure including a pair of spaced terminals insulated from each other, a support associated with one of said terminals, a latch associated with the other of said terminals, a drop-out circuit-breaking device normally in closed-circuit

bridging relation to said terminals and including a tubular expulsion cartridge, one end of said cartridge being, when in closed-circuit position, releasably engaged by said latch, a link pivotally connected at spaced points to said support and said cartridge respectively, a severable conductor extending lengthwise through said cartridge and serving to electrically interconnect said terminals, said conductor being operative, normally, to retain said link in a posture which is effective to maintain said cartridge in engagement with said latch, the continuance of said engagement being dependent upon the continuing integrity of said conductor, spring-actuated means operative to sever said conductor within said cartridge and thereby release said cartridge from said latch, said cartridge being operative to drop out of its closed-circuit position upon disengagement from said latch and thereupon to move automatically to an open-circuit position, a trigger normally retaining said spring-actuated means in a cocked position, and means responsive to a preceding circuit-breaking operation of a second circuit-interrupter for actuating said trigger to trip said spring actuated means.

4. The combination in a circuit-interrupter structure, of a pair of spaced terminals, a drop-out circuit-breaking device normally in closed-circuit bridging relation to said terminals, said device including a tubular expulsion cartridge, a latch, a severable conductor extending lengthwise through said cartridge and serving normally to electrically interconnect said terminals, hinge means connected with said conductor and normally operative, conjointly with said latch, to support said cartridge in closed-circuit position, said hinge means and latch being dependent upon the continuing integrity of said conductor to maintain said cartridge latched in closed-circuit position, said cartridge being rotatable automatically about said hinge means to an open-circuit position when unlatched in response to a severance of said conductor, a spring-actuated means operative to sever said conductor within said cartridge, a trigger normally retaining said spring-actuated means in a cocked position, and means responsive to a preceding circuit-breaking operation of a second circuit-breaking device for actuating said trigger to trip said spring-actuated means.

5. The combination in a circuit-interrupter structure, of a pair of spaced terminals, a drop-out circuit-breaking device normally in bridging relation to said terminals, said device including a tubular expulsion cartridge, a conductor extending lengthwise through said cartridge and serving normally to electrically interconnect said terminals, said conductor including a joint within said cartridge which is severable in response to tension applied to said conductor for interrupting the electrical connection between said terminals, a latch for releasably supporting one end of said cartridge in conductive relation with one of said terminals, hinge means for supporting the other end of said cartridge, said hinge means including a link pivotally connected at one end to said cartridge, means for pivotally supporting the other end of said link, a member pivotally connected with said link near the supported end thereof, and normally lying across the end of said cartridge remote from the previously-mentioned end thereof, said conductor extending through an aperture in said member and having one end anchored to said member, and means responsive to a preceding circuit-breaking operation of a sec-

ond circuit-breaking device for actuating said member to apply tension to said conductor sufficient to sever said joint, the arrangement being such that said cartridge is unlatched in response to severance of said joint, said cartridge, when unlatched, being rotatable, automatically, about said hinge means out of the aforementioned bridging relation to said terminals.

6. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each comprising, individually, an expulsion cartridge hinged at one end, latch means normally operative to engage and support the other end of said cartridge in closed-circuit position, a conductor extending lengthwise through said cartridge, said conductor including, in series, a fusible section and a severable joint both within said cartridge, means dependent upon the continuing integrity of said conductor for maintaining said cartridge in effective engagement with said latch means, mechanism individual to said cartridge for rupturing said conductor at said joint, and means intercoupling said mechanisms, said means being responsive to a preceding circuit-breaking actuation of any one of said units to actuate the aforesaid mechanisms associated with each of the other said units, each said cartridges being automatically rotatable about its hinged end to an open-circuit dropped-out position in response to a rupture of its fusible section, said intercoupling means being actuable by each of said cartridges, individually, during the dropping-out movement thereof, to effect a dropping-out circuit-interrupting actuation of all the other said cartridges.

7. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each comprising, individually, a pair of spaced terminals, a drop-out expulsion cartridge normally bridging said terminals, a conductor extending lengthwise through said cartridge and normally interconnecting said terminals, said conductor including a fusible section, mechanism dependent upon the continuing integrity of said conductor for retaining said cartridge in closed-circuit bridging relation to said terminals, said cartridge being operative, automatically, to drop out of bridging relation to said terminals when said mechanism is rendered ineffective, and coupling means interconnecting said units, said coupling means being actuable in response to a dropping-out movement of any one of said cartridges individually, and operative, upon being so actuated, to rupture within their respective cartridges all the said conductors save that which is individual to the cartridge whose dropping-out movement actuated said coupling means.

8. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each comprising, individually, a pair of spaced terminals, a drop-out expulsion cartridge normally bridging said terminals, a conductor extending lengthwise through said cartridge and normally interconnecting said terminals, said conductor including a fusible section, mechanism including said conductor and dependent upon the continuing integrity thereof for retaining said cartridge in closed-circuit bridging relation to said terminals, said cartridge being operative, automatically, to drop out of bridging relation to said terminals when said mechanism is rendered ineffective, and coupling means interconnecting said units, said coupling means being actuable in response to a circuit-breaking drop-out movement of any one of said cartridges individually, and operative, upon being so actuated,

to effect, in turn, a circuit-breaking actuation of the remaining cartridges.

9. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each comprising, individually, a pair of spaced terminals, a drop-out expulsion cartridge normally bridging said terminals, a conductor extending lengthwise through said cartridge and normally interconnecting said terminals, said conductor including, in series, a fusible section and a severable joint both within said cartridge, mechanism dependent upon the continuing integrity of said conductor for retaining said cartridge in closed-circuit bridging relation to said terminals, said cartridge being operative, automatically, to drop out of bridging relation to said terminals when said mechanism is rendered ineffective, a snap action spring-actuated device for severing said joint to release said cartridge, a trigger normally holding said device in a cocked position, a shaft common to said units, a member carried by said shaft and rotatable thereby, said member being operative in response to a predetermined rotation to actuate said trigger and thereby trip said device, and means carried by said shaft for effecting the afore-mentioned predetermined rotation of said shaft in response to a drop-out movement of said cartridge.

10. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each comprising, individually, a pair of spaced terminals, a drop-out expulsion cartridge normally bridging said terminals, hinge structure for supporting one end of said cartridge adjacent one of said terminals, a latch normally retaining the other end of said cartridge in closed-circuit relation to the other of said terminals, severable conductive means interconnecting said terminals and including a conductor extending lengthwise through said cartridge, said hinge structure including a link which is pivotally supported at one end and pivotally connected at its other end to said cartridge, said link being connected with said conductor and normally anchored thereby in a posture wherein it is effective to retain said cartridge in engagement with said latch, said link being dependent for its effectiveness in so doing upon the continuing integrity of said conductive means, the latter being severable within said cartridge in response to application of a predetermined tension to said conductor, means including an electromagnet for applying tension to said conductor to sever said conductive means, a rotatable member including a lever arm arranged to be actuated in response to a circuit-opening drop-out movement of said cartridge, a spring-actuated member operative to apply tension to said conductor for severing said conductive means, a trigger normally holding said spring-actuated member in a cocked position, said rotatable member including means operative to actuate said trigger for tripping said spring-actuated member, and coupling means common to said units for interconnecting and effecting rotational coincidence between said rotatable members, said coupling means being cooperative with said rotatable members in response to a preceding circuit-breaking drop-out movement of the cartridge individual to any one of said units to actuate the triggers of all the others of said units and thereby initiate sequential circuit-breaking operation of said other units.

11. The combination in a circuit-interrupter, of structure including a pair of spaced terminals insulated from each other, an expulsion cartridge normally bridging said terminals, a conductor including a fuse-link extending through said car-

tridge and normally electrically interconnecting said terminals, mechanism including said conductor and dependent upon the continuing integrity thereof for maintaining said cartridge in its normal bridging relation to said terminals, said cartridge being operative automatically to move out of its normal terminal-bridging position to an open-circuit position in response to a severance of said conductor, and electromagnetic means operative in response to a predetermined fault current to sever said conductor.

12. The combination in a circuit-interrupter, of structure including a pair of spaced terminals insulated from each other, an expulsion cartridge normally bridging said terminals, a conductive link extending through said cartridge and normally electrically interconnecting said terminals, mechanism including said link and dependent upon the continuing integrity of said link for maintaining said cartridge in its normal bridging relation to said terminals, said cartridge being operative automatically to move out of its normal terminal-bridging position to an open-circuit position in response to a severance of said conductor, and electromagnetic means operative in response to a predetermined fault current to sever said conductor.

13. The combination in a circuit-interrupter, of structure including a pair of spaced terminals insulated from each other, an expulsion cartridge normally bridging said terminals, a conductor extending through said cartridge and normally electrically connecting said terminals, said conductor including a conductive link and a severable joint within said cartridge, mechanism including said link and dependent upon the continuing integrity of said joint for maintaining said cartridge in its normal bridging relation to said terminals, said cartridge being operative automatically to move out of its normal terminal-bridging position to an open-circuit position in response to a severance of said joint, and electromagnetic means operative upon said link in response to a predetermined fault current to sever said joint.

14. In a multiple circuit-interrupter, a group comprising a plurality of circuit-interrupting units, each of said units comprising a drop-out expulsion cartridge, a severable conductive link extending through said cartridge and mechanism dependent upon the integrity of said link for normally supporting said cartridge in closed-circuit position, means intercoupling said mechanisms, each of said mechanisms being operative, in conjunction with said coupling means, to effect a sequential circuit breaking actuation of its individual unit in response to a preceding circuit-breaking actuation of one of the other units of said group, and manually actuable means operative to sever within said cartridge the conductive link of at least one of said units for resultantly effecting a circuit-interrupting drop-out movement of a plurality of said cartridges.

15. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each unit comprising, individually, a pair of spaced terminals, an expulsion tube normally bridging said terminals, a conductor extending through said tube and normally electrically interconnecting said pair of terminals, said conductor being severable within said tube in response to a fault current of predetermined magnitude traversing said unit, means intercoupling said units, and mechanism operative conjointly with said intercoupling means to sever said conductor within said tube

in response to an immediately preceding severance of the corresponding conductor of another of said units.

16. In a multiple circuit-interrupter, a plurality of circuit-interrupting units, each unit comprising, individually, a pair of spaced terminals, a drop-out expulsion tube normally bridging said terminals, a conductive link extending through said tube and normally electrically interconnecting said pair of terminals, said link being severable within said tube in response to a fault current of predetermined magnitude traversing said unit, means dependent upon the continuing integrity of said link for retaining said tube in its normal bridging relation to said terminals, mechanism operative to apply tension to said link for severing the same within said tube, and means intercoupling said units, said intercoupling means being operative to actuate said mechanism to effect a severance of said link in response to an immediately preceding circuit-interrupting operation of one of the other of said units.

17. The combination in a circuit-interrupter, of structure including a pair of spaced terminals insulated from each other, an expulsion cartridge normally bridging said terminals, a severable conductive link extending through said cartridge and normally electrically interconnecting said terminals, mechanism including said link and dependent upon the continuing integrity of said link for maintaining said cartridge in its normal bridging relation to said terminals, said cartridge being operative automatically to move out of its normal terminal-bridging position to an open-circuit position in response to a severance of said conductor, and electromagnetic means operative to apply tension to said conductor for severing the same.

18. A circuit-interrupter comprising a pair of spaced terminals, a drop-out expulsion cartridge normally bridging said terminals, a conductive link extending through said cartridge and including a fusible section, mechanism dependent upon the continuing integrity of said conductive link for maintaining said cartridge in its normal terminal-bridging position, and electromagnetic means for applying tension to said link for severing the same in response to a current above a certain predetermined amperage, said fusible section being designed to fuse on a current of extended duration and of less amperage than said first-mentioned current, said electromagnetic means being ineffective to sever said link in response to currents of less magnitude than said predetermined amperage.

19. In a multiple circuit-interrupter, a plurality of sub-groups each comprising a pair of spaced terminals, an expulsion tube, a severable joint within said tube, a conductor within said tube connected with said joint, a pair of normally engaged switch contacts exterior of said tube, said conductor, joint, and switch contacts forming, in series, a normally closed path interconnecting said terminals, mechanism including said conductor and operative, upon being actuated, to apply tension to said joint for severing said joint, said mechanism being further effective after severing said joint, but not otherwise, to effect disengagement of said switch contacts, and means interconnecting said sub-groups for actuating all of the said mechanisms individual to the remaining sub-groups, following an initiating circuit-interrupting operation of any one of said sub-groups.

20. In a multiple circuit-interrupter, a plural-

ity of sub-groups each comprising a pair of spaced terminals, an expulsion tube, a conductor including a fusible section within said tube, a severable joint within said tube in series with said fusible section, a pair of normally engaged switch contacts exterior of said tube, said conductor, severable joint and switch contacts normally forming a path interconnecting said terminals, means responsive to a severance of said joint and of said fusible section, alternatively, to disengage said switch contacts, and mechanism interconnecting said sub-groups, said mechanism being operative in response to severance of the fusible section of any one of said sub-groups to effect severance of the said joints of each of the remaining sub-groups.

21. In a circuit-interrupter, an expulsion tube, a conductor including a fusible section within said tube, a severable joint within said tube in series with said fusible section, said joint being severable in response to tension applied to said conductor, spring-actuated means for tensioning said conductor for severing said joint, and trigger means normally restraining said spring actuated means, said trigger means being operable to release said spring-actuated means and thus effect severance of said joint, said conductor being freely expulible from said tube upon melting of said fusible section and independently of the operation of said trigger means.

22. In a circuit-interrupter, an expulsion tube, a conductor including a fusible section within the bore of said tube and protruding from one end thereof, a severable joint within said tube, said joint being severable in response to tension applied to said conductor, spring-actuated means for tensioning said conductor for severing said joint, and trigger means normally restraining said spring-actuated means, said trigger means being operable to release said spring-actuated means and thus effect severance of said joint, said conductor being freely expulible from said tube upon melting of said fusible section and independently of the operation of said trigger means.

23. In a circuit-interrupter, a pair of spaced terminals, an expulsion tube having an external contact at one end engaging one of said terminals, the other end of said tube being pivotally supported to permit movement thereof for disengaging said contact from its co-operating terminal, latching means for holding said tube in its normal posture wherein said contact is engaged with said terminal, said latching means including a conductor within the bore of said tube and protruding from the end thereof remote from said contact, said conductor normally restraining said latching means against release of said tube, said conductor being included in series with said contact in a path normally interconnecting said terminals, said conductor being severable within said tube to deactivate said latching means and thereby release said tube to effect rotation thereof about its pivotal support to an open-circuit posture, spring-actuated means operative upon said conductor to sever the same within the bore of said tube, and trigger means normally restraining said spring-actuated means, said trigger means being operable to release said spring-actuated means.

24. In a circuit-interrupter, a pair of spaced terminals, an expulsion tube normally bridging said terminals, a contact member carried by one end of said tube externally thereof and operative normally to engage one of said terminals, said

tube being operative spontaneously when released, to effect a dropout movement and resultantly to break the engagement between said contact member and said terminals, a conductive link within the bore of said tube and protruding from the end thereof remote from said contact member, said link being severable within the bore of said tube by tension applied to said link, means including said link and restrained thereby for supporting said tube in closed-circuit posture and

operative upon severance of said link to release said tube, a spring-actuated member operative when released to apply tension to said link to effect severance thereof, and trigger means normally restraining said spring-actuated member, said trigger means being operable to release said spring-actuated means.

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