

May 16, 1944.

R. H. GIBSON ET AL

2,348,896

CIRCUIT BREAKER

Filed Aug. 14, 1943

2 Sheets-Sheet 1

FIG. 1

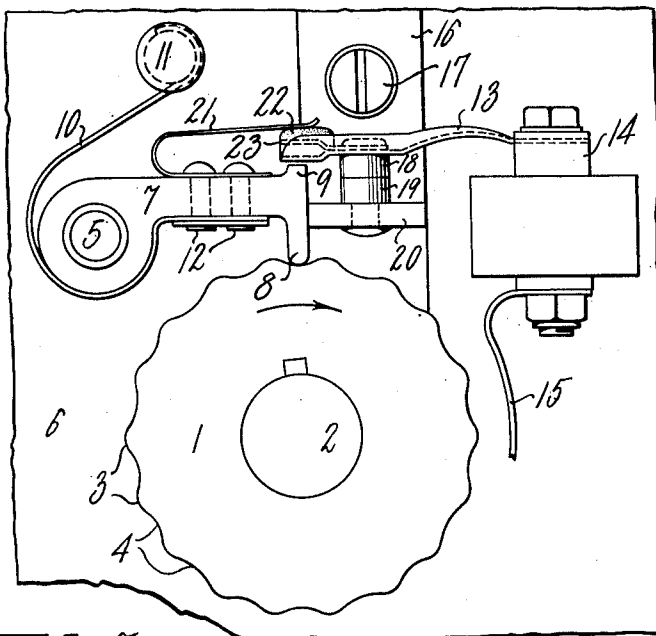


FIG. 3

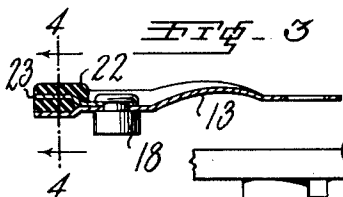


FIG. 2

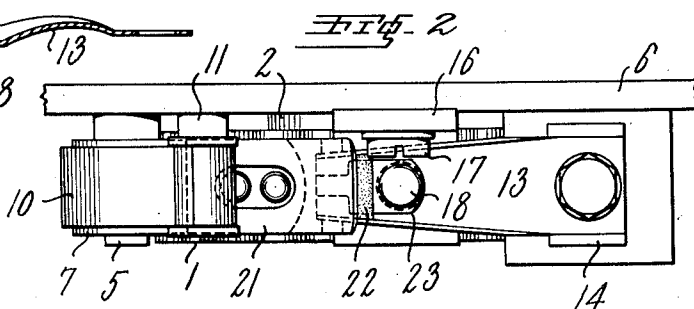


FIG. 4

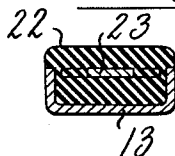
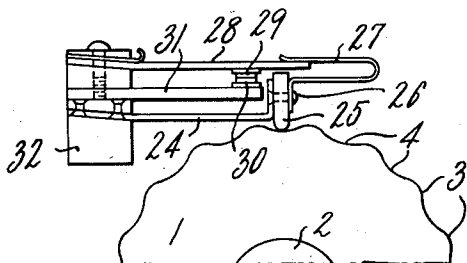


FIG. 5

INVENTORS
ROBERT H. GIBSON &
WILLIAM B. CROCKER

BY
Edw. A. R. Pentel
ATTORNEY

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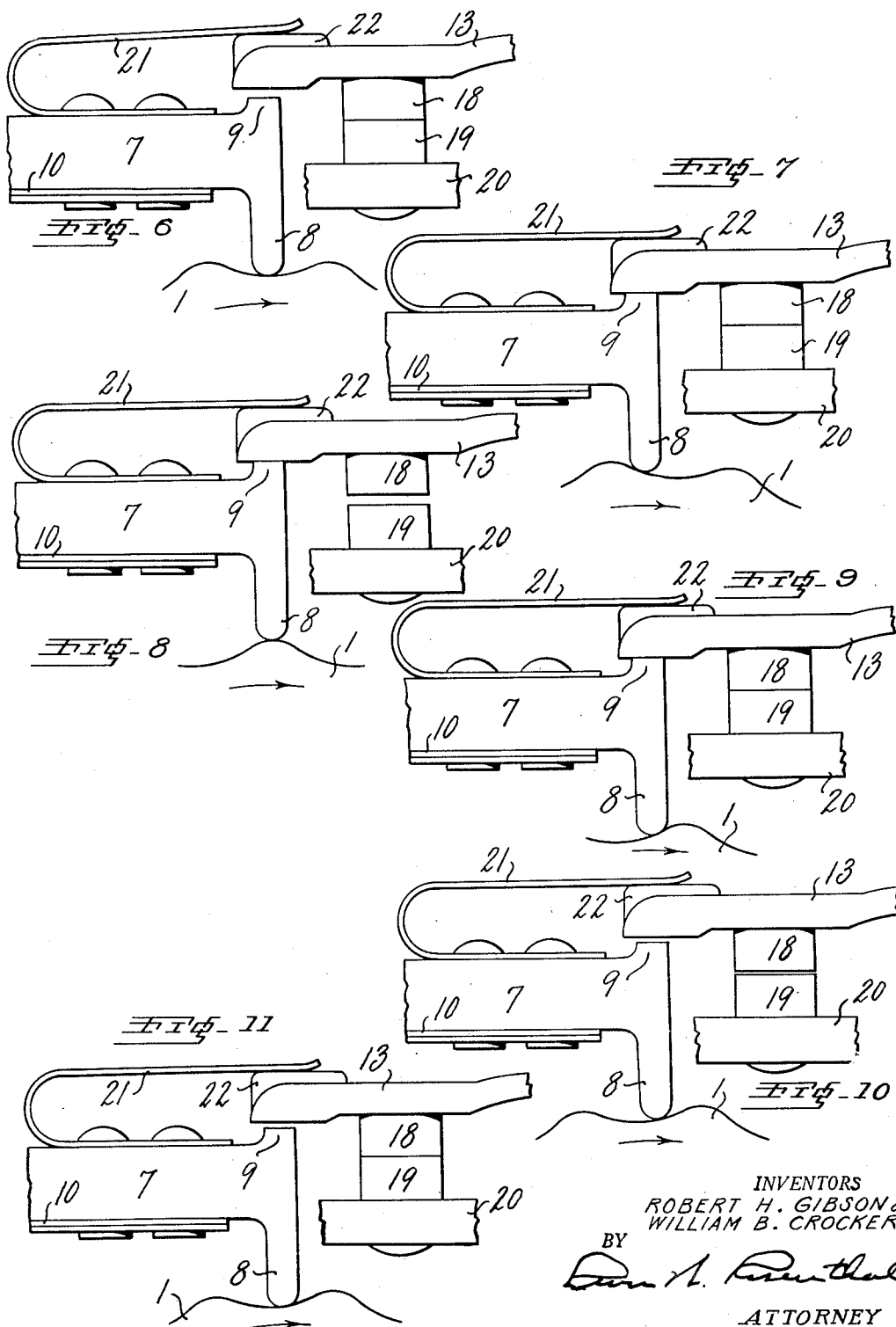
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2 Sheets-Sheet 2



INVENTORS
ROBERT H. GIBSON &
WILLIAM B. CROCKER

BY

Sam A. Renshaw

ATTORNEY

UNITED STATES PATENT OFFICE

2,348,896

CIRCUIT BREAKER

Robert H. Gibson, Springfield, Mass., and William D. Crocker, Suffield, Conn., assignors to American Bosch Corporation, Springfield, Mass., a corporation of New York

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12 Claims. (Cl. 200—30)

This invention relates to circuit breakers for electric circuits, and more particularly to those of the hammer or percussion type in which one of the cooperative contacts in the electrical circuit is mounted on a deflectable lever that is intermittently deflected by the hammer when actuated by a cam or other means to separate the contacts and open or otherwise modify the circuit, and then returned under spring pressure to reengage the contacts and restore the circuit. Such breakers using lobed cams have been used for example in the primary circuits of ignition generators as magnetos and battery-energized timer-distributors for the internal combustion engine driving them.

In high speed 4-stroke-cycle engines of many cylinders, as 18 cylinders operating at times at 3000 R. P. M. which is now proposed for aircraft, the breaker interruptions occur 450 times per second. This requires a breaker of higher operating speed than formerly practical with the hammer type, but still there exists substantially the same requirements of sharpness and accuracy in successive interruptions over long periods in service. One of the important factors resulting in the failure of these prior breakers operating at such high speed is due to the bouncing or chattering of the movable contact point upon its reengagement with the normally stationary contact. Various attempts to overcome this difficulty by lightening the deflectable lever, by varying its spring bias, by cushioning its reversal of movement at the extreme open position, and otherwise, have not always sufficed.

In accordance with our invention, the operating speed of breakers of the hammer type is increased materially by damping or otherwise reducing the bouncing action or tendency between the interrupter contacts by means of a damping spring which preferably exerts little or no pressure on the deflectable lever except at those times when the deflectable contact thereof bounces or tends to bounce from the stationary contact upon reengagement thereof, and/or which also preferably exerts pressure on the deflectable lever of an increasing amount from the instant of reengagement of the contacts. At such times the damping spring not only acts quickly and effectively to break up the oscillations of the deflectable lever at the natural period thereof, or the tendency thereof to oscillate, to thereby bring about more quickly the firm reengagement of the contacts, but also it adds its stress timely and effectively to that of the deflectable lever spring to still more quickly and reliably effect and hold such reen-

gement. Thus the circuit is more quickly closed at the contacts after interruption and the deflectable lever is ready sooner for its next interruption. This results in a faster operating breaker and reduces the sparking and arcing at the contacts with the reduced pitting and wear consequent thereto, and also it holds the circuit closed for a greater part of the cycle between interruptions to permit greater magnetization of the magnetic circuit of the ignition coil of the associated magneto or battery ignition system and to thereby increase the effectiveness of the train of ignition sparks generated.

Accordingly the primary object of our invention is to provide a circuit breaker of the hammer type with high operating speed of successive interruptions, and also with a comparatively long cyclic period of intermediate closure. We accomplish this object by means of a damping spring, preferably carried by the hammer in cooperation with the deflectable lever carrying one of the contacts, the deflectable lever being spring-biased in a direction to engage the contacts and the damping spring being constructed and arranged to be stressed in a direction to engage the contacts as soon as the deflectable lever contact starts or tends to bounce upon the other contact and/or preferably as soon as the contacts are first reengaged. Preferably the spring-bias of the hammer against its actuating member, whether the hammer is a spring lever of cantilever type or a spring-biased member of pivoted type or otherwise, is greater than the stress of the damping spring and in a direction to overpower the latter, the arrangement being such that the damping spring exerts little or no pressure on the deflectable lever while being actuated by or otherwise under the control of the hammer, but exerts a rapidly increasing pressure starting immediately upon reengagement of the contacts. Preferably also the hammer is away from contact with the deflectable lever during the period of contact closure, and in that period the damping spring exerts pressure on the deflectable lever and thereby holds the contacts closed with greater pressure while decreasing accordingly the pressure of the hammer on the cam or other actuating member.

Another object is to provide in breakers of this general type several alternative embodiments which are simple, inexpensive and compact in construction, and which are accurate, reliable and durable in operation throughout severe conditions of service. Preferably the damping spring is fastened to the hammer in a simple manner and

overlies the deflectable lever to cooperate therewith or with insulating material carried thereby.

Other objects and advantages will appear from the following description of circuit breakers of our invention taken in connection with the accompanying drawings which illustrate two embodiments thereof in application as examples to breakers, for magnetos or timer-distributors, having an 18-lobe rotatable cam as the actuating member for the hammer, and a deflectable spring lever of cantilever type for carrying one of the contacts. In these drawings:

Fig. 1 shows in plan view a circuit breaker of our invention having a spring-pressed rigid hammer of the pivoted type; Fig. 2 is a top view thereof; Fig. 3 is a horizontal section, partly in elevation, through the contact-carrying deflectable lever; Fig. 4 is a section, on an enlarged scale, on line 4-4 of Fig. 3; Fig. 5 shows in plan view a modified form of circuit breaker having a spring hammer of cantilever type; and Figs. 6-11 show, in plan view on an enlarged scale and partly broken away, the relative positions of the hammer and contacts at successive positions of the actuating cam between adjacent valleys thereof.

Referring first to the embodiment of Figs. 1-4, the actuating cam 1 is fast on shaft 2, the cam having eighteen lobes 3 with intermediate valleys 4 and the shaft being driven by an associated internal combustion engine through suitable gearing at cam shaft speed for an engine operating on a 4-stroke cycle. Pivoted on the stud 5, which is suitably supported from the interrupter disc or plate 6, is a hammer or percussion member 7 of insulating material having an integral cam follower portion 8 of suitable shape and an actuating head portion 9. This follower is held continually in engagement with the cam 1 by the biasing spring 10 which is looped on the stud 11 fastened to the disc 6, and which at its other end is fastened to the hammer by the rivets 12. A deflectable spring lever 13 of cantilever type is fastened at one end to an insulated live terminal post 14 supported by the disc 6 and electrically connected to the condenser lead 15 of the well known kind. The angle bracket 16 is adapted to be fastened in adjusted position on the disc 6 by adjusting screws, in the well known way, of which one is shown at 17. The cooperative contacts 18 and 19 are riveted respectively to the deflectable lever 13 and the upright part 20 of the bracket 16. The damping spring 21 overlies the outer end of the deflectable lever 13 and is fastened on the opposite surface of the hammer by the same rivets 12 as secure the spring 10 to the cam side of the hammer 7. On the end of the deflectable lever is molded a pad 22 of insulating material on which the free end of the damping spring 21 loosely rides. The metal member 23 reinforces this insulating pad and forms a washer for the riveted-over head of contact 18. The biasing spring 10 exerts considerably more pressure on the hammer in the direction of the cam 1 than the damping spring 21 exerts on the hammer in the other direction, at all operative positions of both springs, so that the biasing spring always overpowers the damping spring and holds the hammer in smooth sliding engagement with the cam surface at all times.

In the position shown in Figs. 1 and 6, in which the cam follower 8 of the hammer 7 rests in the bottom of a valley 4 between cam lobes 3, the head 9 of the hammer is separated about 0.020 inch from the deflectable lever 13. At this position the biasing spring 10 exerts between the

hammer and cam a pressure of about 14 ounces which increases to about 18 ounces when the follower rides on the top of the lobe. The lever 13 is spring-biased in a direction to engage the contacts 18 and 19 when new with a pressure of about 25 ounces between them and, with the parts in the position shown in Figs. 1 and 6, this pressure between such contacts is increased to about 35 ounces by the damping spring 21 which then engages the insulating pad with a pressure of about 4 ounces. It will also be observed that in this position, and in all other positions at which the damping spring 21 exerts pressure on the deflectable lever 13, the pressure of the hammer on the cam is reduced accordingly and therefore the wear of the cam lobes 3 and the follower 8 is somewhat decreased and likewise the lubricating requirement for the cam is somewhat ameliorated. Of course, this separation between the hammer and deflectable lever, and these pressures, may be variously modified from those exemplary values which have been found to give satisfactory operation.

The operation of the embodiment of Figs. 1-4 is illustrated in Figs. 6-11 and will now be described with particular reference thereto. Fig. 6 shows the relation of the parts of the breaker with the cam follower 8 at the bottom of a valley between adjacent lobes of cam 1. In this position the contacts 18, 19 are held engaged with a pressure therebetween of about 25 ounces due to the spring-bias of the deflectable lever 13 and the additional pressure of about 10 ounces therebetween due to the stress of the damping spring 21, making a total of about 35 ounces. The pressure existing between the follower 8 and cam 1 is about 14 ounces due to the biasing spring 10, less about 4 ounces due to the stress of the damping spring 21 in the opposite direction, making a net pressure of about 10 ounces which results in reduced wear of the follower and cam and ameliorates the lubricating requirements therebetween.

Fig. 7 shows the relation of the same parts when the cam is rotated to a point where the cam follower is about half way between the bottom of the valley and the top of the lobe. At this instant the head 9 of the hammer just engages the deflectable lever 13, the breaker contacts 18, 19 still being engaged. However, since the pressure of the damping spring 21 is now reduced to substantially zero, the pressure between the contacts is reduced to that of the spring bias thereon of the deflectable lever 13 alone, amounting to about 25 ounces. At this time the pressure between the follower 8 and the cam 1 is increased somewhat as a result of greater stress in the biasing spring 10, and is further increased as a result of removing the oppositely directed pressure of the damping spring 21. This increase in pressure tends to hold the follower in sliding contact with the cam. Also the effectiveness of the blow of the head 9 on the deflectable lever is increased as a result of the decreased pressure between the contacts 18, 19, thereby separating them more quickly and resulting in less sparking and arcing between them upon separation thereof.

During the period in which the cam is rotating from the position shown in Fig. 7 to that in Fig. 8 where the follower 8 is at the top of a cam lobe, the contacts 18, 19 are separated about 0.010 inch and the pressure of the damping spring 21 remains substantially zero. In the position shown in Fig. 8, the bias of the deflectable lever spring is increased somewhat, and likewise

the bias of the spring 10, so that the tendency of the hammer to leave the cam is resisted more strongly, and the reversal of the deflectable lever is accomplished more readily, or in other words with less overthrow than otherwise would be the case. Any tendency of the deflectable lever to overthrow is further resisted by the resulting pressure then exerted by the damping spring 21.

In the period between the positions shown in Figs. 8 and 9 in which the contacts 18, 19 just reengage, the bias of the deflectable lever 13 and that of the spring 10 act together to hold the follower 8 in its descending movement against the cam 1. In this period also, the damping spring 21 exerts substantially no pressure on the deflectable lever. Immediately following the position shown in Fig. 9, the head 9 of the hammer starts to leave the deflectable lever 13 and there is a tendency for the contact 18 to bounce away from the contact 19, or possibly, in some cases, an actual separation of the contacts as indicated in Fig. 10. However, this tendency of the contact 18 to bounce is instantly resisted by the damping spring 21. In the first place, the pressure of this damping spring at the contacts increases at a high rate, due primarily to the increasing separation of the head 9 from the deflectable lever 13 and secondly due to the tendency or the actuality of the contact 18 to rise from the contact 19. In this way chattering between the contacts is quickly suppressed if not wholly eliminated. By giving the spring 21 such form and dimensions as produce a high rate of increasing bias during the position shown in Figs. 9 and 10, it has been found that, as a practical matter, the bouncing between the contacts is substantially suppressed or eliminated. As a result thereof, not only is the sparking and arcing between the contacts materially reduced or eliminated in this period also, but the cyclic period of closure between the contacts is increased to thereby permit greater magnetization of the magnetic circuit of the ignition coil of the associated magneto or battery ignition system and thus increase the effectiveness of the train of ignition sparks generated.

It has been found by tests with an oscillograph that with the parts arranged as shown and having the characteristics as noted, the crank shaft speed of an 18-cylinder 4-stroke engine may be increased from about 2800 R. P. M. to about 3200 R. P. M. before the engine starts to miss due to ignition failure, this result being due to both the reduction or elimination of the bouncing or chattering between the contacts and an increase of the cyclic period of closure of the contacts. Furthermore, it has been found that the sparking and arcing between the contacts is so reduced that the contact life is materially increased.

Fig. 5 shows the invention applied to a breaker of well known form (see Patent 1,866,492) having a spring hammer 24 of cantilever type with a cam follower 25 of insulating material. The same rivets as 26 holding the follower to the spring also secure the damping spring 27 in position to overlie the end of the deflectable lever 28. As in the first embodiment, the contacts 29, 30 are respectively carried by the deflectable lever 28 and the stationary support 31. Inasmuch as the stationary support 31 for the contact 30 is insulated from the interrupter disc or plate carrying the post 32, it is unnecessary in this embodiment to provide an insulating pad, as 23 in Fig. 1, on the deflectable lever.

The operation of this embodiment of circuit breaker is substantially the same as that of the

first embodiment and will be understood from the foregoing description thereof.

In the event of wear of the contact points, or of the cam 1 or follower 8, there will occur some changes in the spring pressures hereinbefore noted. However, the original condition may be substantially restored by adjusting the contact 19 of Fig. 1 or the entire unit of Fig. 5, in the well known ways.

It will be understood that many changes and modifications may be made in the two embodiments herein disclosed and that many other embodiments may be devised, without departing from the spirit of our invention. For instance, cams having other numbers of lobes may be used, although the improvement in the operation of the breaker, as herein noted, increases as the number of lobes increases, and also the cam may be normally stationary instead of rotatable as herein shown, while the other elements of the circuit breaker are rotatable. Also, instead of being actuated by a cam, the hammer may be actuated in any other suitable way as for example by an electromagnet, in connection with an ignition system or a current or voltage regulator or other electrical device employing intermittently separating contacts. Also the deflectable levers 13 and 28 may be of the pivoted rigid type instead of the cantilever spring type, in which case there would be provided a biasing spring of appropriate strength. Also the hammer of Fig. 1 of insulating material may be made of other suitable material or of separate parts, although the construction herein disclosed provides an unusual degree of reliability in operation as well as of simplicity, compactness and durability in construction. Also the spring stresses as specifically noted may be variously modified, the hammer 7 or 24 need not be arranged to part engagement with the deflectable lever 13 or 28 after the circuit contacts are engaged, and the damping spring 21 or 27 can be arranged to exert considerable pressure on the deflectable lever even when the hammer engages the lever but preferably such pressure as is overpowered by the spring bias of the hammer. Also, in Fig. 1, the insulating pad 23 could just as well be carried by the damping spring 21 at the end thereof. These and other changes are intended to be covered by the broad terms of the appended claims.

Having thus described our invention, what we claim is:

1. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in the direction to engage it with the other contact, an actuating member, a hammer which is spring biased in the direction to engage it with the actuating member and which is intermittently actuated by the actuating member to move the deflectable lever against its spring bias to thereby separate the contacts, and a damping spring which is carried by the hammer in cooperation with the deflectable lever and which is constructed and arranged to be stressed in a direction to re-engage the contacts whenever they bounce apart upon engagement thereof.

2. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in the direction to engage it with the other contact, an actuating member, a hammer which is spring biased in the direction to engage it with the actuating member to move the deflectable lever against its spring bias to thereby separate the

contacts, said hammer being constructed and arranged to be out of engagement with the deflectable lever during substantially the entire period of engagement of the contacts, and a damping spring which is carried by the hammer in cooperation with the deflectable lever and which is constructed and arranged to be stressed in a direction to engage the contacts whenever the hammer is out of engagement with the deflectable lever.

3. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in the direction to engage it with the other contact, an actuating member, a hammer which is spring biased in the direction to engage it with the actuating member to move the deflectable lever against its spring bias to thereby separate the contacts, and a damping spring which is carried by the hammer in cooperation with the deflectable lever and which is constructed and arranged to be stressed in a direction to engage the contacts whenever they bounce apart upon engagement thereof, the stress of said damping spring increasing rapidly with the extent of the bounce.

4. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in the direction to engage it with the other contact, an actuating member, a hammer which is spring biased in the direction to engage it with the actuating member and which is intermittently actuated by the actuating member to move the deflectable lever against its spring bias to thereby separate the contacts, and a damping spring which is carried by the hammer in cooperation with the deflectable lever and which is constructed and arranged to be stressed in a direction to re-engage the contacts whenever they bounce apart upon engagement thereof, the spring bias of the hammer being sufficient to overpower the bias of the damping spring at all operative positions of the deflectable lever.

5. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in a direction to engage it with the other contact, an actuating member, a hammer which is spring biased in a direction to engage it with the actuating member and which is intermittently actuated by the actuating member to move the deflectable lever against its spring bias to thereby separate the contacts, and a damping spring which is carried by the hammer in cooperation with the deflectable lever and which acts on the hammer in opposition to the spring bias of the hammer.

6. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in a direction to engage it with the other contact, an actuating member, a hammer which is spring biased in a direction to engage it with the actuating member and which is intermittently actuated by the actuating member to move the deflectable lever against its spring bias to thereby separate the contacts, and a damping spring which is carried by the hammer in cooperation with the deflectable lever and which is constructed and arranged to be stressed in the direction of the spring bias of the deflectable lever and opposite to that of the hammer.

7. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased

in a direction to engage it with the other contact, an actuating member, a hammer which is spring biased in a direction to engage it with the actuating member to move the deflectable lever against its spring bias to thereby separate the contacts, and a damping spring which is carried by the hammer and which overlies the deflectable lever in contact therewith.

8. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in a direction to engage it with the other contact, an actuating member, a pivoted hammer of rigid material which is spring biased in a direction to engage it with the actuating member to move the deflectable lever against its spring bias to thereby separate the contacts, and a damping spring which is carried by the pivoted hammer and which overlies the deflectable lever in contact therewith.

9. In a circuit breaker having cooperative electrical contacts, a deflectable spring lever of cantilever type which carries one of the contacts and which is stressed in a direction to engage it with the other contact, an actuating member, a hammer which is spring biased in a direction to engage it with the actuating member to move the deflectable lever against its spring stress to thereby separate the contacts, and a damping spring which is carried by the hammer and which overlies the deflectable lever in contact therewith.

10. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in a direction to engage it with the other contact, an actuating member, a pivoted hammer of rigid material, a spring biasing the hammer in a direction to engage it with the actuating member, a damping spring which is carried by the hammer and which overlies the deflectable lever in contact therewith, means for fastening the biasing and damping springs to the hammer, and a pad of insulating material between the damping spring and the deflectable lever to electrically insulate them.

11. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in a direction to engage it with the other contact, an actuating member, a pivoted hammer of rigid material, a biasing spring for the hammer to engage the hammer with the actuating member, a damping spring overlying the deflectable lever in contact therewith, and fastening means fastening the biasing and damping springs to the hammer on opposite surfaces thereof.

12. In a circuit breaker having cooperative electrical contacts, a deflectable lever which carries one of the contacts and which is spring biased in a direction to engage it with the other contact, an actuating member, a pivoted hammer of insulating material, a spring which is fastened to the hammer and which biases it in a direction to engage the hammer with the actuating member, and a damping spring which is fastened to the hammer and which overlies the deflectable lever, and a pad of insulating material carried by the deflectable lever in engagement with the damping spring to insulate them from each other.

ROBERT H. GIBSON.
WILLIAM D. CROCKER.