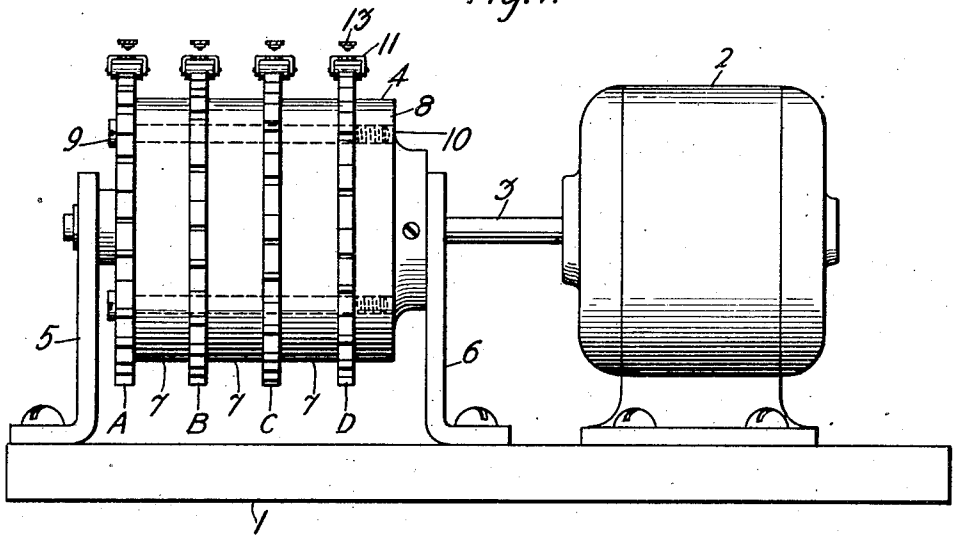
Dec. 1, 1925. 1,563,488

J. F. D. HOGE

CIRCUIT INTERRUPTER

Filed Nov. 17, 1921 3 Sheets-Sheet 1

Fig. 1.



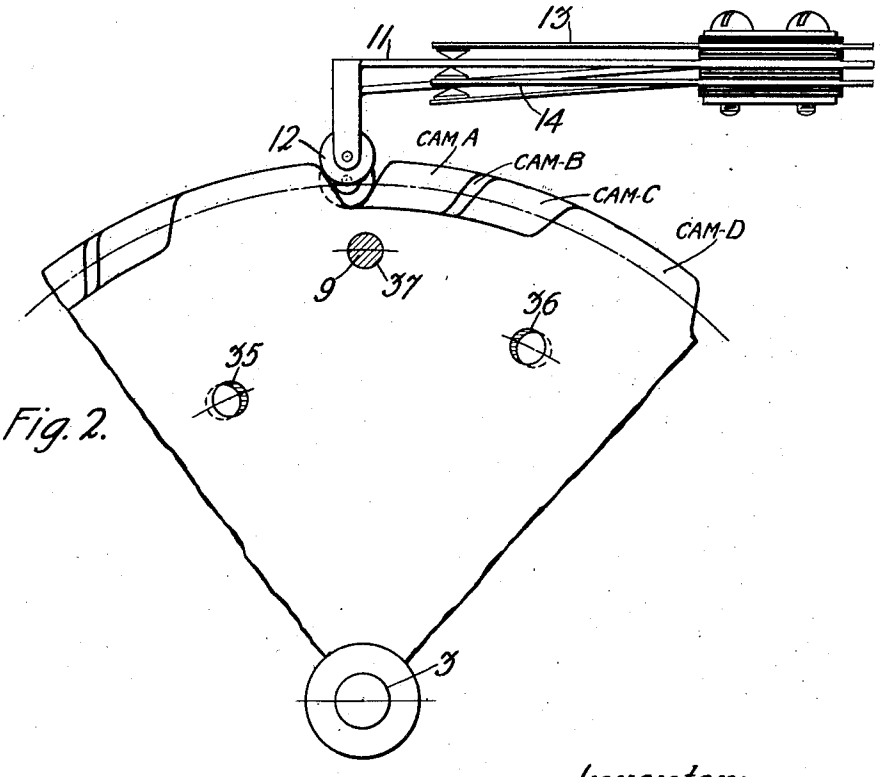


Fig. 2.

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Dec. 1, 1925. 1,563,488

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CIRCUIT INTERRUPTER

Filed Nov. 17, 1921 3 Sheets-Sheet 2

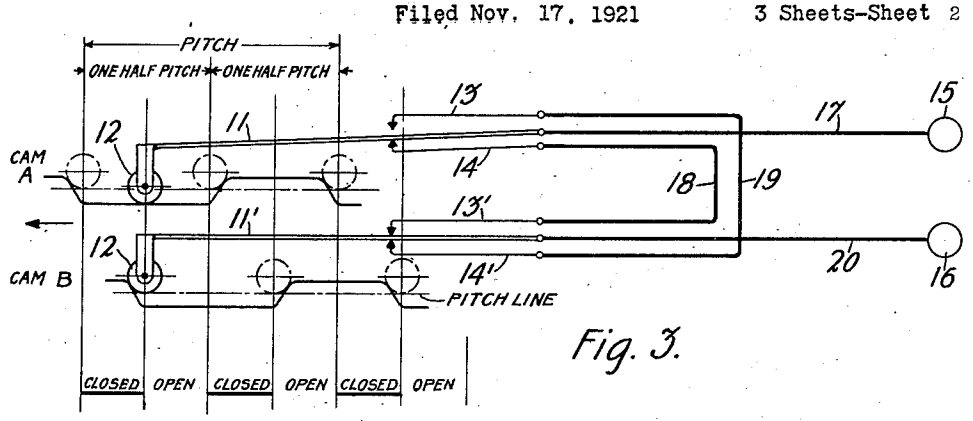


Fig. 3.

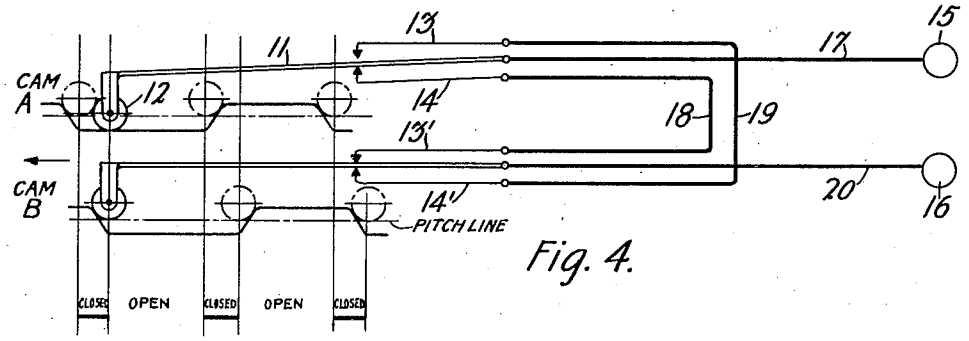


Fig. 4.

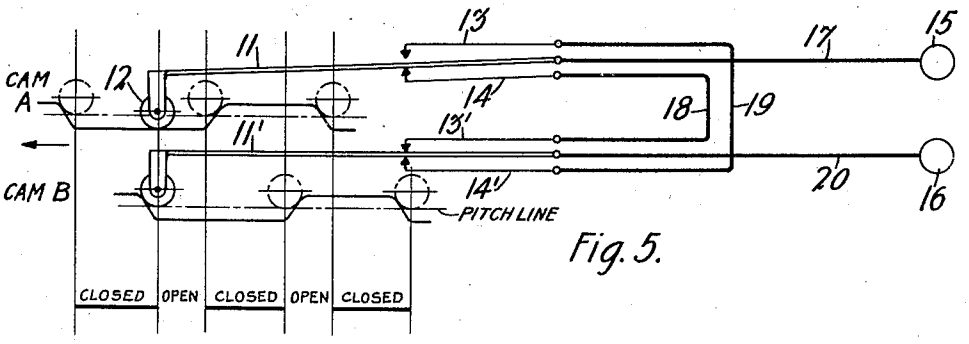


Fig. 5.

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CIRCUIT INTERRUPTER

Filed Nov. 17, 1921 3 Sheets-Sheet 3

Fig. 6.

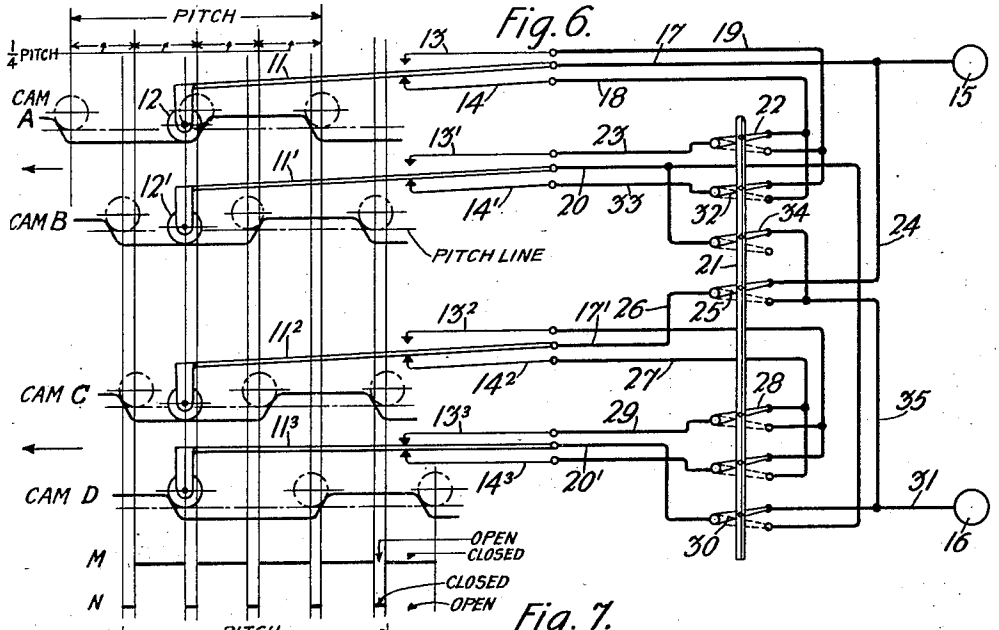
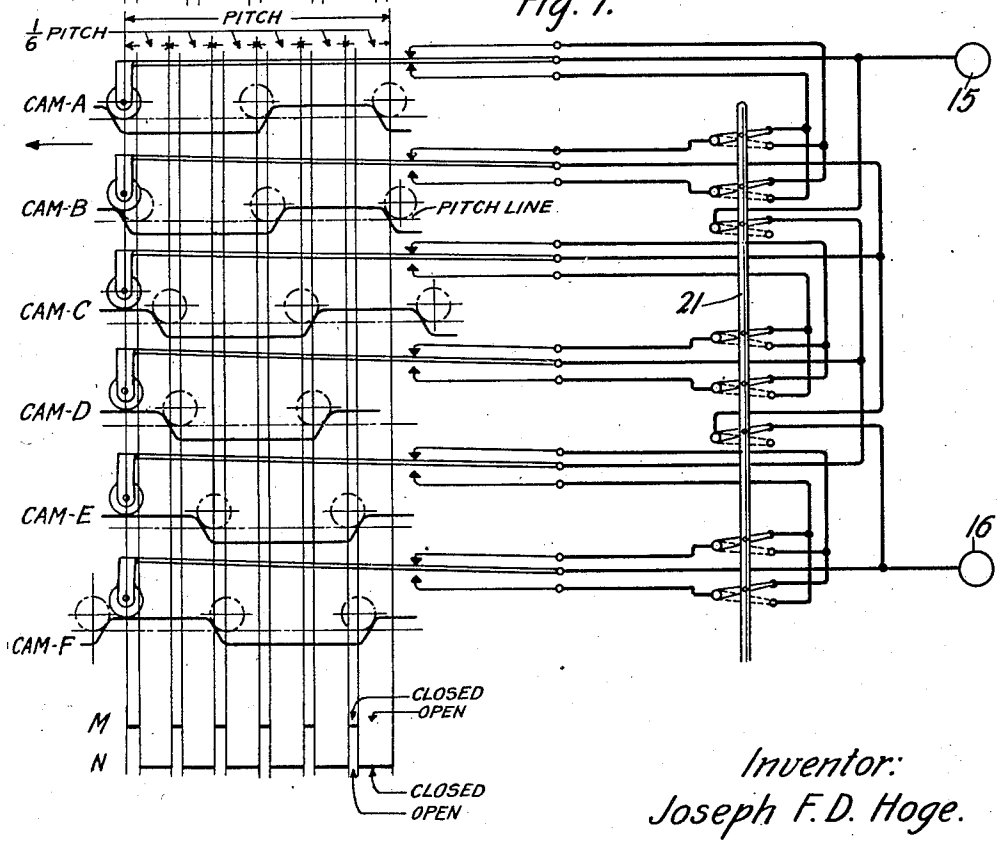


Fig. 7.



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Patented Dec. 1, 1925.

1,563,488

UNITED STATES PATENT OFFICE.

JOSEPH F. D. HOGE, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

CIRCUIT INTERRUPTER.

Application filed November 17, 1921. Serial No. 515,821.

To all whom it may concern:

Be it known that I, JOSEPH F. D. HOGE, a citizen of the United States, residing at New York, in the county of New York, State of New York, have invented certain new and useful Improvements in Circuit Interrupters, of which the following is a full, clear, concise, and exact description.

This invention relates to electrical circuit interrupters and is directed particularly to means and methods for obtaining relatively high freqeuency interruptions.

The primary object of the invention is the provision of an interrupter whereby relatively high frequencies of definite predetermined make and break periods are obtainable.

A further object is the provision of an interrupter whereby the ratio of make and break periods may be altered at will.

Still another object is the provision of means whereby the relative duration of make and break periods may be quickly interchanged.

For relatively low frequency circuit interruptions, it is common practice to employ a pair of contact springs cooperating with a cam wheel, whereby contacts are made and broken at the desired frequency; or as an alternative arrangement, it is also common practice to employ a commutator and brush in which the metallic segments and insulators are suitably proportioned to give the required ratio of make and break. Such devices are well known in the art and under certain conditions operate satisfactorily at the frequencies for which they are employed. But for relatively high frequencies, that is, frequencies higher than those for which interrupters of the character referred to are ordinarily employed, it has been found that certain difficulties are encountered. In the case of interrupters employing make and break contact springs, the greatest difficulty arises in obtaining uniform make and break periods at high frequencies. This is due largely to the inertia of the contact springs and their tendency to excessive vibration at high operating speeds. In the case of interrupters of the commutator type, the difficulty has been due to excessive wear induced by high speed operation aggravated in many instances by arcing.

The principal feature of the invention, in accordance with the primary object above stated, resides in the novel method of obtaining relatively high frequency interruptions, which consists in superposing and combining the interruptions of a plurality of interrupters, and further consists in the novel means whereby the several sets of interruptions are combined to produce a relatively high frequency.

Another feature of the invention which is in accordance with the second mentioned object above stated, resides in the novel method and means provided for varying the ratio of the make period to the break period. This feature in its preferred embodiment consists in arranging certain cams so that they may be angularly adjusted with respect to other cams whereby the make periods of certain interrupters may be made more or less co-incident with the break periods of other interrupters.

Still another feature consists in the circuit arrangement whereby the relative duration of the make and break periods may be interchanged by the operation of a switch or equivalent device.

The preferred form of interrupter, in accordance with this invention, comprises a plurality of simultaneously rotatable cam wheels, with each of which is operatively associated a set of transfer contact springs, one of which is operated by its associated cam wheel to engage each of the other springs alternately. Suitable connections are provided between the sets of contact springs whereby the circuit may be interrupted by each set in its proper turn. Certain of the cam wheels are rotatable relative to the others, and means are provided for locking or otherwise securing them with their cams in any desired relative angular positions. By such provision the ratio of make period to break period is rendered adjustable to any desired value.

The preferred embodiment of that feature of the invention whereby the relative duration of make and break periods may be in-

terchanged will be described in connection with the detailed description hereinafter.

With reference to the drawings:

Fig. 1 is an elevational view of a motor driven interrupter constructed in accordance with this invention; Fig. 2 is an enlarged fragmentary view of the cams together with sets of interrupter springs; Fig. 3 is a diagram illustrating the operation of a two-cam interrupter in which the cams are adjusted to produce make and break periods of equal duration; Fig. 4 is a diagram illustrating the operation of a two-cam interrupter in which the cams are adjusted to produce a relatively short closed period and a long open period; Fig. 5 is a diagram illustrating the operation of a two-cam interrupter in which the cams are adjusted to produce a relatively short open period and a long closed period; Fig. 6 is a diagram illustrating a four-cam interrupter and includes a switching arrangement whereby the relative duration of make and break periods may be quickly interchanged; and Fig. 7 is a diagram illustrating a six-cam interrupter including a switching arrangement for quickly interchanging the relative duration of the make and break periods.

On the base 1, Fig. 1, there is mounted a motor 2 having a shaft 3, which extends through the drum 4, and is journaled in brackets 5 and 6. The drum 4 comprises separators 7 and a head member 8, all of which are secured to and rotatable with shaft 3. Cams A, B, C and D are spaced apart by the separators 7 and are not secured directly to shaft 3, but are held by means of the screws 9 which pass through suitable apertures in the cams and separators, and engage the tapped apertures 10 in head member 8. The separators 7, head member 8, and the cams are preferably provided with several sets of apertures, as is best illustrated in Fig. 2, wherein the aperture 35 in cam D represents one of a set which may, for instance, comprise three apertures, an aperture corresponding to each screw 9, all of which would be preferably located on the same radius and spaced equidistantly. Aperture 36 represents one of another set of apertures, which set, like the one previously referred to, might also comprise three equi-distantly spaced apertures. Likewise, the aperture 37 represents one of still another set. In Fig. 2, the apertures 37 are shown in alignment with corresponding apertures in the other cams and the separators 7 while the apertures 35 and 36 are shown out of alignment with the corresponding apertures in the other cams and separators 7. As is evident, only one set of such apertures may be used at a time and as many sets must be provided as there are different cam settings desired.

As will be more clear from the explanation hereinafter, in a four-cam interrupter as shown in Fig. 1, the teeth of cam C must be staggered with respect to the teeth of cam A by an angle equivalent to one fourth the pitch of the teeth. In other words, each tooth of cam A moves in advance of the respectively corresponding tooth of cam C by a distance on the pitch line equal to one-quarter the pitch. In a six-cam interrupter, the alternate cams such as cams A, C and E, must be staggered so that corresponding teeth are angularly displaced by a distance on the pitch line equal to one-sixth of the pitch. And accordingly, in an eight-cam interrupter alternate cams would be displaced by a distance equal to one-eighth the pitch. The same principle holds true for any even number of cams except in a two-cam interrupter in which case there are no alternate cams. If the alternate cams are not spaced as above stated, the train of interruptions produced will not be uniform.

To produce a train of interruptions of equal make and break periods the teeth of the intermediate cams, which, in the case of a four-cam interrupter would be cams B and D, are displaced in relation to adjacent cams by an angle equal to one-half the displacement between successive alternate cams. In other words, to produce a uniform train of interruptions of equal make and break periods, corresponding teeth of successive cams are relatively displaced by equal angles. To produce unequal make and break periods, the alternate cams such as A and C are not disturbed relatively to each other, but the intermediate cams such as B and D are rotated through equal angles and in the same direction with respect to adjacent cams. The direction in which the intermediate cams are rotated in making such adjustments depends upon whether the ratio of make period to break period is to be increased or decreased.

The contact springs 11, 13 and 14 are so adjusted that the make and break occur simultaneously in both directions of the movement of follower spring 11. In the preferred arrangement, the follower spring 11 engages both springs 13 and 14 when the bottom of the roller 12 is on the pitch line as shown in Fig. 2. The cam teeth are so designed that the roller 12 rides above the pitch line throughout the same angular movement of the cam as it rides below the pitch line. Spring 11 therefore engages spring 13 for the same length of time as it engages spring 14.

While the motor 2 is shown directly connected to the interrupter, it will be understood that the connection may, if desired, be made through suitable speed reducing gears.

Any even number of cams may be employed, and with a given speed of operation the frequency of the resulting interruptions is equal to the product of the number of

cams and the frequency which would be obtainable with a single cam of the same proportions and rotating at the same speed.

Now to enter upon a consideration of the principles of the invention, Fig. 3 will be first referred to, in which is shown a fragmentary development of two cams together with their associated contact springs. Both cams are assumed to be moving in the direction indicated by the arrow. As will be seen, the teeth of cam B are so staggered with respect to those of cam A that the roller 12 associated with the cam B is on the pitch line and about to drop below the pitch line when the roller 12 associated with cam A is midway between adjacent teeth. The teeth of cam B are staggered with respect to corresponding teeth of cam A by an angle equivalent to one-quarter the pitch of the teeth. This particular adjustment gives equal make and break periods, as indicated at the bottom of Fig. 3.

Starting with terminal 15, and tracing the circuit through to terminal 16 with the contact springs in the position shown, it will be seen that the circuit is closed and extends through conductor 17, follower spring 11, spring 14, conductor 18, spring 13′, follower spring 11′, and conductor 20. But at the next instant the roller 12 associated with cam B will have dropped below the pitch line thereof and the contact between springs 11′ and 13′ will have broken, and spring 11′ will engage only spring 14′. Then it will be seen that the circuit is broken. The next change in the circuit occurs when the roller 12 associated with cam A rises above the pitch line, thereby effecting a transfer of the follower spring 11 from engagement with the spring 14 into engagement with spring 13, whereupon the circuit will be again closed and will extend from terminal 15 through conductor 17, follower spring 11, spring 13, conductor 19, spring 14′, follower spring 11′, and conductor 20, to terminal 16. The operation may thus be traced through each of its successive changes, and it will be seen that a uniform train of interruptions of equal make and break periods is obtained, as indicated at the bottom of Fig. 3.

Figs. 4 and 5 are the same as Fig. 3 except that the angular displacement between the teeth of the two cams is different in each case. In Fig. 4 the displacement is less than in Fig. 3 and the closed period is correspondingly shorter, while the open period is longer. In Fig. 5 the displacement is greater than in Fig. 3, and the open period is correspondingly shorter while the closed period is longer. The cam adjustment may be carried to either extreme, wherein either the closed period or open period approaches zero.

Referring again to Fig. 3, it will be seen that with a single cam and a pair of contact springs cooperating therewith, the open and closed period would each be equal to one-half the pitch, whereas with the arrangement described, the open and closed periods are each equal to one-quarter the pitch. The frequency then is doubled without increasing the speed.

Fig. 6 illustrates diagrammatically a four-cam interrupter. There is included in this figure a multi-contact switch 21, by which the relative duration of the make and break periods may be interchanged. With the switch 21 in its normal position, the circuit of Fig. 6 is merely an extension of that shown in Figs. 3, 4 and 5. The contact springs associated with cams A and B are interconnected in the same way as cams A and B of Fig. 3, and the contact springs associated with cams C and D are likewise interconnected. Cam C is displaced with respect to cam A by an amount equal to one-quarter the pitch, and cam B is displaced with respect to cam A by an angle equal to that by which cam D is displaced with respect to cam C. The latter displacement is in accordance with the relative make and break periods which it is desired to obtain.

In Fig. 6 conductors 17 and 17′ each correspond to conductor 17 of Figs. 3, 4 and 5, and conductors 20 and 20′ correspond to conductor 20 of Figs. 3, 4 and 5. It will be noted that conductors 17 and 17′ of Fig. 6 are connected together, and conductors 20 and 20′ are connected together through blades of switch 30. Thus, it will be seen that the arrangement of Fig. 6, with the switch 21 in its normal position as indicated in full lines, is equivalent to two sets of cams and springs, as shown in Fig. 3, connected in multiple with the cams relatively displaced as described.

With the arrangement shown in Fig. 6, double the frequency of that produced by the arrangement of Figs. 3, 4 and 5 is obtained at the same speed of operation.

Diagram M at the bottom of Fig. 6 shows the relative make and break periods produced with the cams adjusted as shown, and the switch 21 in its normal position. Diagram N shows the relative make and break periods produced with the switch 21 in the position indicated by the dotted lines.

Adjustments of the relative make and break periods are effected by moving cams B and D with respect to cams A and C. In all cases the adjustment of cam B with respect to cam A should be of the same extent and in the same direction as the adjustment of cam D with respect to cam C. Otherwise, the train of interruptions will not be uniform. The result would be a series of make periods of different duration.

With the contact springs in the position shown in Fig. 6 and the switch 21 in its normal position as indicated by the full

lines, the interrupter circuit extends from terminal 15, through conductor 17, follower spring 11, spring 14, conductor 18, switch blade 22, conductor 23 to contact spring 13′ at which point that branch of the circuit is broken. Another branch extends from conductor 17 through conductor 24, switch blade 25, conductor 26, conductor 17′, follower spring 11^2, spring 14^2, conductor 27, switch blade 28, conductor 29, spring 13^3, follower spring 11^3, conductor 20′, switch blade 30 and conductor 31 to terminal 16. The circuit is therefore closed, but at the next instant follower spring 11^3 will disengage spring 13^3 and the circuit will be open, as will be clear from an examination of the diagram. The open period subsists until the follower spring 11 is moved upwardly out of engagement with the spring 14 into engagement with spring 13, whereupon the circuit is again closed, and may be traced as follows: terminal 15, conductor 17, follower spring 11, spring 13, conductor 19, switch blade 32, conductor 33, spring 14′, follower spring 11′, conductor 20, switch blade 34, conductors 35 and 31, to terminal 16. This closed period subsists until follower spring 11′ is lifted out of engagement with spring 14′ and into engagement with spring 13′, whereupon the circuit is again broken. Each successive change may be traced as in the foregoing instances, and it will be seen that a continuous train of make and break periods is produced as indicated by diagram M at the bottom of Fig. 6.

When switch 21 is thrown into the position indicated by the dotted lines, a number of circuit changes is effected as follows: the connection between 13′ and 14 is broken, the connection between 13 and 14′ is broken, a connection is established between 13 and 13′ and between 14 and 14′. Likewise the connection between 13^2 and 14^2 is broken, and the connection between 13^3 and 14^3 is broken. 13^2 is connected to 13^3, and 14^2 is connected to 14^3. The parallel connections between conductors 17 and 17′ and between conductors 20 and 20′ are also broken, and connections are established whereby these last mentioned conductors are put in series relation.

The circuits may be readily traced for all positions of the cams with respect to the follower springs, and it will be found that with the particular cam adjustment shown, a uniform train of interruptions, as indicated by diagram N at the bottom of Fig. 6, will be obtained. This last mentioned train of interruptions, it will be seen, is the reverse of that indicated at M and this reversal is effected by merely throwing switch 21.

It should be observed that when the switch 21 is in its dotted line position, the circuit is closed whenever the follower springs associated with cams A and B are in like positions, that is, both up or both down, and the follower springs associated with cams C and D are in like positions. For instance, if the follower springs 11 and 11′ are up, and 11^2 and 11^3 are down, the circuit is closed; or if they are all up or all down, the circuit is closed. The same holds true for all combinations wherein the follower springs comprising each pair are in like positions. The principle underlying the arrangement shown in Fig. 6 may be extended to combinations comprising any even number of cams.

Fig. 7 is a diagrammatic illustration of a six-cam interrupter. This differs from the four-cam interrupter only in the following respects: there are six cam wheels instead of four; the alternate cams are displaced relatively by one-sixth of the pitch instead of one-fourth; and the circuit connections are extended to take care of two additional sets of contact springs. With the cams set as shown in Fig. 7 and the switch 21 in its normal position (as shown) a series of interruptions in accordance with diagram M at the bottom of the figure will be produced. When the switch 21 is thrown into its off-normal position, as indicated in dotted lines, a series of interruptions in accordance with diagram N will be produced. Any desired ratio of make period to break period may be effected by shifting the relaitve positions of the intermediate cams B, D and F with respect to the alternate cams A, C and E. It is not at all necessary that the so-called intermediate cams be actually placed between the alternate cams. They may if desired be grouped together and the so-called alternate cams grouped together or any other relative disposition may be made of them. The only essential point with respect to locating the cams is that they shall operate their respective contact springs in the proper sequence.

The same results may be obtained by disposing the several sets of contact springs around a single cam wheel. With such an arrangement means could be provided for moving certain sets of contact springs with respect to the other sets whereby the relative duration of the make and break periods could be adjusted. Such an arrangement would, of course, come within the scope of the invention.

What is claimed is:

1. In a circuit interrupter, a plurality of sets of contacts, circuit connections between certain of said contacts, and means for operating said sets sequentially, a contact of one set being in series with a contact of another set, and a second contact of said first set being in series with a second contact of said second set.

2. In a circuit interrupter, a plurality of sets of contacts, means for operating said

contact sets sequentially, the contacts of each of said sets each being connected in series with a contact in another of said sets, the closed period of each contact being partially coincident with the open period of the contact in series therewith, and means for varying the relative duration of the coincident periods with respect to the non-coincident periods.

3. In a circuit interrupter, a plurality of sets of transfer contacts, means for operating said contact sets sequentially, two contacts of each set each connected to different contacts of another set, the make period of each contact being partially coincident with the break period of the contact in the other set with which it is interconnected.

4. In a circuit interrupter, a plurality of sets of transfer contacts, means for operating said contact sets sequentially, two contacts of each set each connected to different contacts of another set, the make period of each contact being partially coincident with the break period of the contact in the other set with which it is interconnected, and means for varying the relative duration of the co-incident period with respect to the non-coincident period.

5. In a circuit interrupter, two sets of transfer contact springs each comprising an operating spring and two other springs arranged to engage said operating spring alternately, said second mentioned springs being so connected that when the operating spring of one set is operated in one direction and the operating spring of the other set is operated in the other direction said operating springs are electrically connected, and means for mechanically operating said operating springs sequentially.

6. In a circuit interrupter, two sets of transfer contact springs, each comprising an operating spring and two other springs arranged to engage said operating spring alternately, circuit connections between said sets of contact springs whereby a circuit may be established between said operating springs by way of alternate paths each including a contact in each of said sets, and means for operating said sets sequentially so that the closed periods of the contacts in each path are partially coincident.

7. In a circuit interrupter, two sets of transfer contact springs each comprising an operating spring and two other springs arranged to engage said operating spring alternately, circuit connections between said sets of contact springs whereby a circuit may be established between said operating springs by way of alternate paths, each including a contact in each of said sets, means for operating said sets sequentially so that the closed periods of the contacts in each path are partially coincident, and means for varying the relative duration of said coincident period with respect to the non-coincident periods.

8. In a circuit interrupter, two sets of transfer contact springs each comprising an operating spring and two other springs arranged to engage said operating spring alternately, circuit connections between said sets of contact springs whereby a circuit may be established between said operating springs by way of alternate paths each including a contact in each of said sets, a cam wheel for each of said sets arranged to operate said sets sequentially so that the closed periods of the contacts in each path are partially coincident, said cam wheels being rotatably adjustable with respect to each other whereby the relative duration of said coincident periods with respect to the non-coincident periods are variable, and means for rotating said cam wheels.

9. A circuit interrupter comprising a plurality of operating devices, a set of contacts for cooperating with each of said devices, means for simultaneously operating said devices, circuit connections between said sets of contacts whereby their operations are coordinated to produce a train of circuit interruptions, and switching means for reversing the relative duration of the make and break periods.

10. A circuit interrupter comprising a plurality of sets of contacts, means for operating said contacts sequentially, connections between said contacts whereby their operations are coordinated to produce a train of circuit interruptions, and switching means for reversing the relative duration of the make and break periods.

11. The combination in a circuit of a plurality of interrupters connected in multiple, the open period of each interrupter being partially coincident with the closed period of another interrupter, and means for varying the relative duration of said coincident period with respect to the non-coincident period.

12. The combination in a circuit of a plurality of interrupters connected in multiple in which the open period of each interrupter is partially coincident with the closed period of another interrupter, and switching means for throwing said interrupters into series relation whereby the relative duration of the make and break periods may be reversed.

13. A circuit interrupter comprising a plurality of sets of interconnected contacts, means for operating said sets of contacts sequentially to produce frequency multiplication, said means comprising a plurality of coaxially aligned cam wheels, certain of said cam wheels rotatably adjustable relative to others of said cam wheels, and means to adjust the ratio of make period to break period to any desired value, said second

means comprising bolts cooperating with one of a plurality of sets of apertures in each of said cam wheels, each of said sets of apertures in each cam wheel being arranged to register with a corresponding set of apertures in the other cam wheel or wheels, the number of sets of apertures in each cam wheel being equal to the number of different cam settings desired.

In witness whereof, I hereunto subscribe my name this 15th day of November A. D., 1921.

JOSEPH F. D. HOGE.