Aug. 24, 1943. H. J. BROWN 2,327,576

BALANCED INTERRUPTER CIRCUIT

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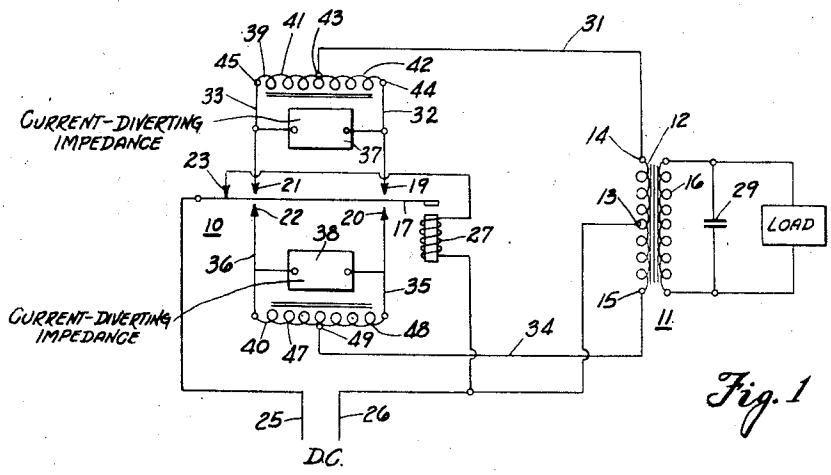


Fig. 1

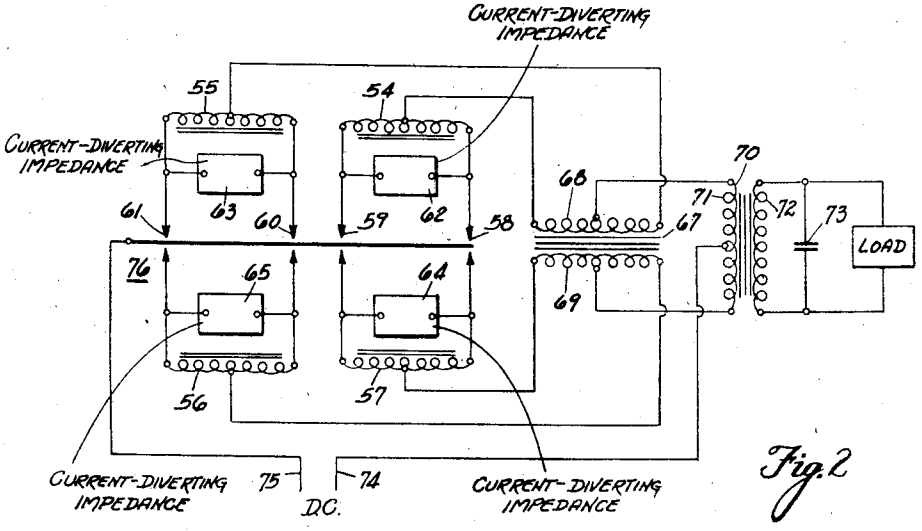


Fig. 2



Fig. 3

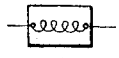


Fig. 4

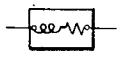


Fig. 5



Fig. 6

INVENTOR.
Harold J. Brown

BY Hoadley and Krost attys

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BALANCED INTERRUPTER CIRCUIT

Harold J. Brown, Indianapolis, Ind.

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14 Claims. (Cl. 175—365)

My invention relates in general to interrupter circuits and more particularly to an arrangement to prevent the damaging of the interrupting means. This application relates to the subject matter of my Patent No. 2,286,842 and my pending applications Serial Nos. 429,074, 429,075 and 429,076.

In the design of vibratory converters, substantially no difficulty is encountered in building a vibrator that is immuned to mechanical wear on the contact points. The impacts on closing and the wear due to rubbing can be so reduced that the device will operate indefinitely, if at the same time, the stressed parts are properly strain-relieved and operated well below their endurance limit. With such a vibrator, the problem is primarily one of reducing the effects of the electric current and voltages on the contacts so that any required performance may be achieved. Experience shows that in a vibrator where the make-and-break operating cycles run into the billions, the life and performance is strictly determined by the ability of the contact points to withstand the pitting and erosion of the electrical current flowing at the instance of the make-and-break. Nothwithstanding the fact that the most resistant materials available to the engineering art are used, the vibrator in many applications fails to meet the standards of reliability and life which are normally required. Also, there is need for increased power output capabilities for vibratory converters. By using larger transformers and larger vibrators, increased power has been obtained, but in general, a less satisfactory result is noted especially as regards vibrator life and reliability on the contact interrupting points. Vibrators with several sets of points in parallel have also been used in an effort to increase the power handling capacities, but here too the life and reliability of the contacts do not come up to expectations. The principal reason for the lack of satisfactory results lies in the character of the contacting materials when interrupting the current. Generally speaking, the current in a contact "necks" down to an extremely high current density prior to separation, even though large shunting capacities be used. For reasonable values of current relative to the material used, the contact is subject to melting and vaporization at the final tip, and if two or more contacts are in parallel, the final single trailing contact is subject to the attack of this high current density. Similar destructive effects take place when the contact engagement is made, as the condensers necessary to operate the equipment are then charged or discharged. One of the more noticeable effects is material transfer from one contact to the other, another is pitting and erosion, and in severe cases, there is arcing which is very destructive.

Contact point disintegration due to electrical current falls in two categories; namely, the disintegration resulting from making the contact and the disintegration resulting from breaking the contact. Both may be partially controlled by the proper handling of the circuit constants but it is unfortunately true that changes in the circuit which improve the performance at the "break" may harm the performance at the "make," and vice versa. Therefore, the design of a good and efficient converter circuit which will give long life and reliability against breakdowns presents a difficult problem to solve and a satisfactory circuit cannot be prescribed on the basis of a superficial examination. Furthermore, the absence of sparking is no criterion of a satisfactory circuit, as it is often true that the performance of mildly sparking contacts will be superior to dark ones. A further characteristic of contact points is that various thresholds of current exist below which material transfer and erosion do not occur at all or in small amounts.

An object of my invention is, therefore, the provision of reducing the electrical disintegration effect below the threshold value where material transfer and erosion do not occur at all or in small amounts.

Another object of my invention is to prevent the current flowing through one contact from diverting into another, as one contact is opened prior to another.

Another object of my invention is to forcibly prevent the current flowing in two or more vibrator contacts from re-establishing itself in a single final trailing contact tip during the short interval of time involved between the successive openings of the parallel contacts and to insure that the burden of interrupting the circuit is divided between the pair of parallel contacts.

Another object of my invention is the provision, in a circuit interrupter having a plurality of parallel interrupting paths, of preventing the current which is interrupted in an interrupted path incident to slight variations in the interruptions of the plurality of interrupting paths from suddenly re-establishing itself in a yet uninterrupted path during the short interval of time involved between the successive interruptions of the parallel paths.

Another object of my invention is to keep the flow of the interrupting current in the interrupting contacts less than that certain threshold value below which material transfer and erosion of the contacts do not occur at all or in small amounts.

In a set of parallel contacts, the current will divide between the contacts according to Ohm's law. Since the contact resistance is small compared to the rest of the vibratory circuit, which is ordinarily the case, the opening of one of two

parallel contacts will not effect the total current flow, and the total current will then flow through the remaining closed trailing contact. The time required for this diversion will be very small, perhaps less than 10^{-6} seconds, as indicated by the residual inductance and resistance of the closed loops through the two parallel contacts. In any practical vibrator, the differences in opening time may be a thousand times this value so the problem may be stated as one of increasing the diversion time perhaps a thousand or more times its ordinary value.

Therefore, another object of my invention is to provide for increasing the diversion time perhaps a thousand or more times its ordinary value.

Another object of my invention is the provision of a balancing inductance taken in combination with a current-diverting impedance for preventing the current flowing in two or more vibratory contacts from re-establishing itself in a single final trailing contact tip during the short interval of time involved between the successive openings of the parallel contacts and to insure that the burden of interrupting the current is divided between the pair of parallel contacts.

Another object of my invention is to prevent the current flowing through one contact from diverting into another as one contact is open prior to the other without the liability of inductance in the vibratory load circuit.

Other objects and a fuller understanding of my invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:

Figure 1 diagrammatically illustrates a vibratory interrupting circuit involving the features of my invention;

Figure 2 is a diagrammatic illustration showing an extension of the circuit in Figure 1 in that the current flows through four sets of parallel contacts for the vibratory converter instead of two sets of parallel contacts in Figure 1; and

Figures 3, 4, 5 and 6 illustrate, respectively, the different kinds of current-diverting impedances which may be employed in my circuit interrupting system.

With reference to Figure 1 of the drawing, my invention comprises in general a vibratory interrupter 10, a transformer 11, a secondary buffer condenser 29, two balancing inductances 39 and 40 and two current-diverting impedances 37 and 38.

As illustrated, the vibratory interrupter 10 supplies an interrupting direct current to the primary winding 12 of the transformer 11 which in turn supplies an alternating current to the load from the secondary winding 16. The center tap 13 of the primary winding is connected to the one side 26 of the direct current source and the other side 25 of the direct current source is connected to the vibrating reed 17 of the vibratory interrupter. As diagrammatically shown, the vibratory interrupter comprises two parallel sets of interrupting contacts in which one set comprises the oppositely disposed contacts 19 and 20 with the vibrating reed 17 operating therebetween and in which the other set comprises the oppositely disposed contacts 21 and 22 with the vibrating reed 17 operating therebetween. The vibrating reed 17 is actuated by an electro-magnet 27 which is energized through an additional contact 23 engaging the vibrating reed 17. The oppositely disposed contacts 19 and 21 on one side of the vibrating reed 17 are connected in parallel through a first circuit connection means comprising a conductor 31 and two branch circuits 32 and 33. The right-hand end of the conductor 31 is connected to the end 14 of the primary winding 12 of the transformer and the left-hand end of the conductor 31 is connected to a center-tap 43 on the balancing inductance 39 which divides the winding thereof into two halves 41 and 42 which are respectively connected in series with the two branch circuits 32 and 33. The current-diverting impedance 37 is connected across the two branch circuits 32 and 33 in parallel with the winding of the balancing inductance 39.

The oppositely disposed contacts 20 and 22 on the other side of the vibrating reed 17 are connected in parallel through a second circuit connection means comprising a conductor 34 and two branch circuits 35 and 36. The right-hand end of the conductor 34 is connected to the end 15 of the primary winding 12 of the transformer and the left-hand end of the conductor 34 is connected to a center tap 49 of the winding for the balancing inductance 40 and divides the winding into two halves 47 and 48 which are respectively connected in series with the two branch circuits 35 and 36. The capacitor 29 is connected in the secondary load circuit of the transformer and constitutes the buffer condenser for the system.

In operation, the load current divides substantially equally between the two sets of parallel contacts when the contacts are closed. The flowing of the current through the two halves of the windings of the balancing inductances cancel out the inductive impedances of the said winding with respect to the vibratory load circuit. Consequently, I am able to achieve parallel operation of two sets of contacts without liability of the inductance in the load circuit. The only effect upon the load circuit will be that of any IR drop that may exist.

During the interruption of the parallel contacts, should the contact 19, for example, open slightly prior to the opening of the contact 21, then the combination of the balancing inductance 39 and the current-diverting impedance 37 operates to prevent the current which is interrupted by the contact 19 from suddenly re-establishing itself in the yet uninterrupted parallel contact 21 during the short interval involved between the successive openings of the parallel sets of contacts. The description with reference to the operation of the joint action of the balancing winding and the current-diverting impedance during the short interval of time involved between the successive openings of the parallel sets of contacts 19 and 21 may be described with reference to the following assumption: let it be assumed that the system possesses a resistance of one ohm between the secondary capacitor 29 and the E. M. F. of the direct current source 25 and 26, and further that 10 amperes is flowing through the vibratory primary circuit, making 5 amperes through each of the sets of parallel contacts. With one ohm appearing in the system, then the resistance of the current-diverting impedance is preferably made 4 ohms, since it is connected across both halves of the balancing windings 41 and 42. In other words, the impedance ratio of a transformer is equal to the square of the turns and in the instant case the secondary turns of the balancing inductance 39, which comprises both halves of the windings 41 and 42 is twice the number of turns upon the winding 41, which comprises the primary winding of the balancing

inductance, acting as a transformer during the short interval of time during the successive openings of the contacts 19 and 21. With the resistance of the current-diverting impedance 4 ohms and with the resistance of the system one ohm, then the burden upon the interruption of the contacts 19 and 21 is equally divided.

The reverse situation would occur should the contact 21 open slightly prior to the contact 19. Similarly, the description with reference to the contacts 19 and 21 applies the same for the contacts 20 and 22 wherein the balancing inductance 40 and the current-diverting impedance 38 act to keep the current which is interrupted in an interrupted contact from re-establishing itself in a yet uninterrupted contact. The impedance of the current-diverting impedance may be of any value other than the ideal value explained in the above mentioned calculation but it must be remembered that as the impedance of the current-diverting impedance increases beyond its ideal value then the first contact which opens takes a larger share of the burden upon the interruption of the contacts and should the value of the current-diverting impedance be decreased below the ideal value then the second contact to open takes the increased burden during the interruption of the contacts. In other words, as the impedance of the current-diverting impedance approaches infinity, then the first contact to open takes all the burden and as the impedance of the current-diverting impedance approaches zero then the second contact to open takes all of the burden. By making the impedance of the current-diverting impedance four times the impedance of the vibratory load circuit, an ideal situation exists to keep the current flowing through the contact which is last to open the same throughout the period involved between the successive openings of the contacts. Therefore, in Figure 1 I have illustrated a system which achieves parallel operation of the contacts without the liability of inductance in the load circuit while at the same time I prevent the current which is interrupted in one of the contacts from being re-established in the other contact during the short interval of time between the successive openings of the contacts.

The current-diverting impedances 37 and 38 comprise a resistor as shown in Figure 3, an inductance as shown in Figure 4, the series combination of a resistor and an inductance as shown in Figure 5, or the parallel combination of a resistor and an inductance as shown in Figure 6. In the event that a resistor as shown in Figure 3 is employed, the resistance thereof is preferably made substantially four times the resistance of the vibratory circuit, if an inductance as shown in Figure 4 is employed, the inductance is preferably made substantially four times the inductance of the inductance of the vibratory circuit. If the circuit contains both resistance and inductance in series, then the current-diverting impedances may be made preferably as shown in Figure 5 and here again the resistance is preferably made four times the resistance of the vibratory circuit and the inductance is preferably made four times the inductance of the circuit. If the vibratory circuit contains resistance and inductance in parallel, then the arrangement shown in Figure 6 may be preferably employed in which the resistance is made four times the resistance of the circuit and the inductance is preferably made substantially four times the inductance of the vibratory circuit.

In Figure 2 I show an extension of the circuit arrangement as shown in Figure 1 in that I control the proper division of the current between four sets of parallel contacts 58, 59, 60 and 61 by employing four balancing inductances 54, 55, 56 and 57 together with current diverting impedances 62, 63, 64 and 65. The operation of the balancing inductances and the current diverting impedances for the four sets of parallel contacts 58, 59, 60 and 61 is the same as that described with reference to Figure 1. The four balancing inductances 54, 55, 56 and 57 are connected to the primary winding 71 of the transformer 70 through a balancing inductance having two windings 68 and 69. As illustrated, the two ends of the winding 68 for the balancing inductance 67 are connected respectively to the center tap for the windings 54 and 55. Similarly, the two ends for the winding 69 upon the balancing inductance 67 are connected respectively to the center tap for the two windings 56 and 57. The two center taps for the windings 68 and 69 are connected to the two ends of the primary winding 71 of the transformer 70. The center tap for the primary winding 71 is connected to one side 74 of the direct current source and the other side 75 of the direct current source is connected to the vibrating reed of the vibratory interrupter 76. The secondary winding 72 of the transformer 70 supplies alternating current to the load and the capacitor 73 connected across the secondary winding of the transformer constitutes the buffer condenser for the vibrating system. The operation of the arrangement in Figure 2 is substantially the same as that explained in Figure 1 except that it comprises an extension thereof and here again I am able to achieve parallel operation of a plurality of sets of parallel contacts without adding impedance in the vibratory load circuit.

Summarizing, my invention includes the arrangement for preventing the current which is interrupted in an interrupted parallel contact path incident to slight variations in the breaking of the plurality of sets of contacts from suddenly re-establishing itself in the yet uninterrupted parallel contact path during the short interval of time involved between the successive openings of the contact means to prevent the damaging of the contacts.

While I have illustrated and described my invention as having particular utility in connection with interrupting parallel contacts, it is to be understood that my invention is not limited thereto and, therefore, includes any interrupting system comprising interrupting means having a plurality of parallel interrupting paths which are substantially simultaneously interrupted for jointly interrupting the current in the electrical system.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

I claim as my invention:

1. In an electrical system for converting current from a direct current source into alternating current and supplying the latter to a load, said system comprising a transformer having primary winding means with two ends and a center tap and secondary winding means supplying the

alternating current to the load, and a vibratory interrupter having two interrupting sets of parallel contact means substantially simultaneously operated during a vibratory interval for jointly supplying an interrupted direct current through a plurality of parallel contact paths to the primary winding means of the transformer, each of the two sets of parallel contact means including oppositely disposed contact means and vibratory contact means operating therebetween, said center tap being connected to one side of the direct current source and said vibratory contact means being connected to the other side of the direct current source, first circuit connection means including two branches each connecting respectively an oppositely disposed contact means on one side of the vibratory contact means to one end of the primary winding means and second circuit connection means including two branches each connecting respectively an oppositely disposed contact means on the other side of the vibratory contact means to the other end of the primary winding means; the arrangement for preventing the current which is interrupted in an interrupted parallel contact path incident to slight variations in the breaking of the plurality of sets of contact means from suddenly re-establishing itself in a yet uninterrupted parallel contact path and increasing the burden on the set of contacts therein during the short interval involved between the successive openings of the parallel sets of contacts, said arrangement comprising the combination of first current-diverting means connected across the oppositely disposed contact means on one side of the vibratory contact means, second current-diverting means connected across the oppositely disposed contact means on the other side of the vibratory contact means, and balancing inductance means having a first balancing winding with two ends and a center-tap dividing the said first balancing winding into two halves with a half thereof included in each of the branches of the first circuit connection means and having a second balancing winding with two ends and a center-tap dividing the said second balancing winding into two halves with a half thereof included in each of the branches of the second circuit connection means for developing, in series with each of the sets of parallel contact means, an inductive impedance to the flow of the current therein, the inductive impedance in the yet uninterrupted parallel contact path opposing the sudden re-establishment of the current of an interrupted parallel contact path during the short interval involved between the successive openings of the parallel sets of contacts in the yet uninterrupted parallel path, thereby preventing the damaging of the contacts, the said center-tap of the first balancing winding being connected to one end of the primary winding means of the transformer and the two ends of the first balancing winding being connected respectively to the two branches of the first connection means, thus forming a T-connection to balance out the inductive impedance of the said first balancing winding with respect to the current flowing through the primary winding means of the transformer, the said center-tap of the second balancing winding being connected to the other end of the primary winding means of the transformer and the two ends of the second balancing winding being connected respectively to the two branches of the second connection means, thus forming a T-connection to balance out the inductive impedance of the said second balancing winding with respect to the current flowing through the primary winding means of the transformer.

2. In an electrical system for converting current from a direct current source into alternating current and supplying the latter to a load, said system comprising a transformer having primary winding means with two ends and a center tap and secondary winding means supplying the alternating current to the load, and a vibratory interrupter having two interrupting sets of parallel contact means substantially simultaneously operated during a vibratory interval for jointly supplying an interrupted direct current through a plurality of parallel contact paths to the primary winding means of the transformer, each of the two sets of parallel contact means including oppositely disposed contact means and vibratory contact means operating therebetween, said center tap being connected to one side of the direct current source and said vibratory contact means being connected to the other side of the direct current source, first circuit connection means including two branches each connecting respectively an oppositely disposed contact means on one side of the vibratory contact means to one end of the primary winding means and second circuit connection means including two branches each connecting respectively an oppositely disposed contact means on the other side of the vibratory contact means to the other end of the primary winding means; the arrangement for preventing the current which is interrupted in an interrupted parallel contact path incident to slight variations in the breaking of the plurality of sets of contact means from suddenly re-establishing itself in a yet uninterrupted parallel contact path and increasing the burden on the set of contacts therein during the short interval involved between the successive openings of the parallel sets of contacts, said arrangement comprising the combination of first resistance means connected across the oppositely disposed contact means on one side of the vibratory contact means, second resistance means connected across the oppositely disposed contact means on the other side of the vibratory contact means, and balancing inductance means having a first balancing winding with two ends and a center-tap dividing the said first balancing winding into two halves with a half thereof included in each of the branches of the first circuit connection means and having a second balancing winding with two ends and a center-tap dividing the said second balancing winding into two halves with a half thereof included in each of the branches of the second circuit connection means for developing, in series with each of the sets of parallel contact means, an inductive impedance to the flow of the current therein, the inductive impedance in the yet uninterrupted parallel contact path opposing the sudden re-establishment of the current of an interrupted parallel contact path during the short interval involved between the successive openings of the parallel sets of contacts in the yet uninterrupted parallel path, thereby preventing the damaging of the contacts, the said center-tap of the first balancing winding being connected to one end of the primary winding means of the transformer and the two ends of the first balancing winding being connected respectively to the two branches of the first connection means, thus forming a T-connection to balance out the inductive impedance of the said first balancing winding

with respect to the current flowing through the primary winding means of the transformer, the said center-tap of the second balancing winding being connected to the other end of the primary winding means of the transformer and the two ends of the second balancing winding being connected respectively to the two branches of the second connection means, thus forming a T-connection to balance out the inductive impedance of the said second balancing winding with respect to the current flowing through the primary winding means of the transformer.

3. In an electrical system for converting current from a direct current source into alternating current and supplying the latter to a load, said system comprising a transformer having primary winding means with two ends and a center tap and secondary winding means supplying the alternating current to the load, and a vibratory interrupter having two interrupting sets of parallel contact means substantially simultaneously operated during a vibratory interval for jointly supplying an interrupted direct current through a plurality of parallel contact paths to the primary winding means of the transformer, each of the two sets of parallel contact means including oppositely disposed contact means and vibratory contact means operating therebetween, said center tap being connected to one side of the direct current source and said vibratory contact means being connected to the other side of the direct current source, first circuit connection means including two branches each connecting respectively an oppositely disposed contact means on one side of the vibratory contact means to one end of the primary winding means and second circuit connection means including two branches each connecting respectively an oppositely disposed contact means on the other side of the vibratory contact means to the other end of the primary winding means; the arrangement for preventing the current which is interrupted in an interrupted parallel contact path incident to slight variations in the breaking of the plurality of sets of contact means from suddenly re-establishing itself in a yet uninterrupted parallel contact path and increasing the burden on the set of contacts therein during the short interval involved between the successive openings of the parallel sets of contacts, said arrangement comprising the combination of first current-diverting inductance means connected across the oppositely disposed contact means on one side of the vibratory contact means, second current-diverting inductance means connected across the oppositely disposed contact means on the other side of the vibratory contact means, and balancing inductance means having a first balancing winding with two ends and a center-tap dividing the said first balancing winding into two halves with a half thereof included in each of the branches of the first circuit connection means and having a second balancing winding with two ends and a center-tap dividing the said second balancing winding into two halves with a half thereof included in each of the branches of the second circuit connection means for developing, in series with each of the sets of parallel contact means, an inductive impedance to the flow of the current therein, the inductive impedance in the yet uninterrupted parallel contact path opposing the sudden re-establishment of the current of an interrupted parallel contact path during the short interval involved between the successive openings of the parallel sets of contacts in the yet uninterrupted parallel path, thereby preventing the damaging of the contacts, the said center-tap of the first balancing winding being connected to one end of the primary winding means of the transformer and the two ends of the first balancing winding being connected respectively to the two branches of the first connection means, thus forming a T-connection to balance out the inductive impedance of the said first balancing winding with respect to the current flowing through the primary winding means of the transformer, the said center-tap of the second balancing winding being connected to the other end of the primary winding means of the transformer and the two branches of the second connection means, thus forming a T-connection to balance out the inductive impedance of the said second balancing winding with respect to the current flowing through the primary winding means of the transformer.

4. An electrical system for converting current from a direct current source into alternating current and supplying the latter to a load, said system comprising a vibratory circuit including a transformer and a vibratory interrupter having two sets of parallel contact means with each set comprising oppositely disposed contact means and a vibratory contact means operating therebetween, first current-diverting means connected across the oppositely disposed contact means on one side of the vibratory contact means, second current-diverting means connected across the oppositely disposed contact means on the other side of the vibratory contact means, and balancing inductance means having a first balancing winding with a center-tap connected to the transformer and dividing the said first winding into two halves with a half thereof connected respectively in series with the oppositely disposed contact means on one side of the vibratory contact means and having a second balancing winding with a center-tap connected to the transformer and dividing the said second winding into two halves with a half thereof connected respectively in series with the oppositely disposed contact means on the other side of the vibratory contact means.

5. An electrical system for converting current from a direct current source into alternating current and supplying the latter to a load, said system comprising a vibratory circuit including a transformer and a vibratory interrupter having four sets of parallel contact means with each set comprising oppositely disposed contact means and a vibratory contact means operating therebetween, first current-diverting means connected across the oppositely disposed contact means on one side of the vibratory contact means, second current-diverting means connected across the oppositely disposed contact means on the other side of the vibratory contact means, a first balancing inductance means having a first balancing winding with a center-tap dividing the said first winding into two halves with a half thereof connected respectively in series with oppositely disposed contact means on one side of the vibratory contact means and having a second balancing winding with a center-tap dividing the said second winding into two halves with a half thereof connected respectively in series with two disposed opposite contact means on the other side of the vibratory contact means, a second balancing inductance means having a third balancing winding with a center-tap dividing the said third winding into two halves with a half thereof con-

nected respectively in series with the two remaining oppositely disposed contact means on said one side of the vibratory contact means and having a fourth balancing winding with a center-tap dividing the said fourth winding into two halves with a half thereof connected respectively in series with the two remaining oppositely disposed contact means on said other side of the vibratory contact means, and a third balancing inductance means having a fifth balancing winding with a center-tap connected to the transformer and dividing the said fifth winding into two halves with a half thereof connected respectively in series with the center-taps of the first and third balancing windings and having a sixth balancing winding with a center-tap connected to the transformer and dividing the said sixth winding into two halves with a half thereof connected respectively in series with the center-taps of the second and fourth balancing windings.

6. In a vibratory circuit having two parallel sets of interrupting contacts with each set including oppositely disposed contact means with a vibratory contact means operating therebetween, first current-diverting means connected across the oppositely disposed contact means on one side of the vibratory contact means, second current-diverting means connected across the oppositely disposed contact means on the other side of the vibratory contact means, first balancing inductance means having a first balancing winding with a center-tap included in the load circuit and dividing the said first winding into two halves with a half thereof included respectively in series with the two oppositely disposed contacts on one side of the vibratory contact means, and a second balancing inductance means having a second balancing winding with a center-tap included in the load circuit and dividing the said second winding into two halves with a half thereof included respectively in series with the two oppositely disposed contacts.

7. In a vibratory circuit having two parallel sets of interrupting contacts with each set including oppositely disposed contact means with a vibratory contact means operating therebetween, first current-diverting means connected across the oppositely disposed contact means on one side of the vibratory contact means, second current-diverting means connected across the oppositely disposed contact means on the other side of the vibratory contact means, first balancing inductance means having a first balancing winding with a center-tap included in the load circuit and dividing the said first winding into two halves with a half thereof included respectively in series with the two oppositely disposed contacts on one side of the vibratory contact means, and a second balancing inductance means having a second balancing winding with a center-tap included in the load circuit and dividing the said second winding into two halves with a half thereof included respectively in series with the two oppositely disposed contacts, each of said current-diverting impedances having a value substantially four times the value of the impedance of the vibratory load circuit.

8. In an interrupting system having interrupting means for interrupting a plurality of groups of parallel interrupting paths, the parallel paths of each interrupting groups comprising a plurality of paths and being substantially interrupted by the interrupting means for jointly interrupting the current in the system, current diverting means connected in effective current-diverting relation with the interrupting paths of the said plurality of interrupting groups, and balancing inductance means having a plurality of groups of inductance windings, each group of inductance windings being respectively connected with the interrupting groups of the parallel paths with an inductance winding in series with each of the interrupting parallel paths for developing in series with each of the interrupting parallel paths, an inductance impedance to the flow of the current therein, each group of inductance windings having tap connection means to establish opposing fluxes within each group of inductance windings to minimize the inductance impedance to the flow of the current in the system.

9. In an interrupter system having interrupting means for interrupting a plurality of groups of parallel interrupting paths, the interrupting paths of each interrupting group comprising two parallel paths and being substantially simultaneously interrupted by the interrupting means for jointly interrupting the current in the system; the arrangement for preventing the current which is interrupted in an interrupted parallel path of a group incident to slight variations in the interruption of the parallel paths of the group from suddenly re-establishing itself in a yet uninterrupted parallel path and increasing the burden on the said yet uninterrupted parallel path during the short interval involved between successive interruptions of the parallel paths of a group, said arrangement comprising current-diverting means connected across the two interrupting parallel paths of each group, and balancing inductance means having a plurality of groups of inductance windings with each group of inductance windings being respectively connected to the interrupting groups of parallel paths, each group of inductance windings having a center-tap connection dividing the inductance winding into two halves with a half thereof connected in series with each of the interrupting parallel paths for developing, in series with each of the interrupting parallel paths, an inductance impedance to the flow of the current therein, the inductance impedance in the yet uninterrupted parallel path in combination with the current-diverting means opposing the sudden reestablishment of the current of an interrupted parallel path of a group during the short interval involved between the successive interruptions of the parallel paths of the group in the yet uninterrupted path, thereby preventing the damaging of the interrupting means.

10. In an interrupter system having interrupting means for interrupting a plurality of groups of parallel interrupting paths, the parallel paths of each interrupting group comprising a plurality of paths and being substantially simultaneously interrupted by the interrupting means for jointly interrupting the current in the system; the arrangement for preventing the current which is interrupted in an interrupted parallel path of a group incident to slight variations in the interruption of the parallel paths of the group from suddenly reestablishing itself in a yet uninterrupted parallel path and increasing the burden on the said yet uninterrupted parallel path during the short interval involved between successive interruptions of the parallel paths of a group, said arrangement comprising current-diverting means connected across the interrupting parallel paths of each group, and balancing inductance means having a plurality of groups of inductance windings, each group of inductance windings be-

ing respectively connected with the interrupting groups of parallel paths with an inductance winding in series with each of the interrupting parallel paths for developing, in series with each of the interrupting parallel paths, an inductive impedance to the flow of the current therein, the inductive impedance in the yet uninterrupted parallel path in combination with the current-diverting means opposing the sudden re-establishment of the current of an interrupted parallel path of a group during the short interval involved between the successive interruptions of the parallel paths of the group in the yet uninterrupted path, thereby preventing the damaging of the interrupting means, each group of inductance windings having tap connection means to establish opposing fluxes within each group of inductance windings to minimize the inductive impedance to the flow of the current in the system.

11. In an interrupter system having a common circuit and interrupting means for interruptingly connecting a plurality of groups of parallel interrupting paths to the common circuit, the parallel paths of each interrupting group comprising a plurality of paths and being substantially simultaneously interrupted by the interrupting means for jointly interrupting the current in the system; the arrangement for preventing the current which is interrupted in an interrupted parallel path of a group incident to slight variations in the interruption of the parallel paths of the group from suddenly re-establishing itself in a yet uninterrupted parallel path and increasing the burden on the said yet uninterrupted parallel path during the short interval involved between successive interruptions of the parallel paths of a group, said arrangement comprising current-diverting means connected across the interrupting parallel paths of each group, and balancing inductance means having a plurality of groups of inductance windings, each group of inductance windings being respectively connected with the interrupting groups of parallel paths with an inductance winding in series with each of the interrupting parallel paths for developing, in series with each of the interrupting parallel paths, an inductive impedance to the flow of the current therein, the inductive impedance in the yet uninterrupted parallel path in combination with the current-diverting means opposing the sudden re-establishment of the current of an interrupted parallel path of a group during the short interval involved between the successive interruptions of the parallel paths of the group in the yet uninterrupted path, thereby preventing the damaging of the interrupting means, each group of inductance windings having tap connection means to establish opposing fluxes within each group of inductance windings to minimize the inductive impedance to the flow of the current in the system.

12. In an interrupter system having first and second electrical circuit connections and interrupting means for interrupting two groups of parallel interrupting paths, the interrupting paths of each interrupting group comprising two parallel paths, each being substantially simultaneously interrupted by the interrupting means for interrupting the current in the system, first current-diverting means connected across the two interrupting parallel paths of the first group, second current-diverting means connected across the two interrupting parallel paths of the second group, and balancing inductance means having a first balancing winding with a center tap connected to said first electrical circuit connection and dividing the said first winding into two halves with a half thereof connected respectively in series with each of the two interrupting paths of said first group and having a second balancing winding with a center tap connected to said second electrical circuit connection and dividing the said second winding into two halves with a half thereof connected respectively in series with each of two interrupting paths of said second group.

13. In an interrupter system comprising a transformer having a first and second circuit connection, and interrupting means for interrupting four groups of parallel interrupting paths, the interrupting paths of each interrupting group comprising two parallel paths and being substantially simultaneously interrupted by the interrupting means for interrupting the current, current-diverting means connected across the two interrupting parallel paths of each group, a first balancing inductance means having a first balancing winding with a center-tap dividing the first winding into two halves with a half thereof connected respectively in series with the two parallel paths of the first group and having a second balancing winding with a center-tap dividing the said second winding into two halves with a half thereof connected in series with the two parallel paths of the second group, a second balancing inductance means having a third balancing winding with a center-tap dividing the said third winding into two halves with a half thereof connected respectively in series with the two parallel paths of the third group and having a fourth balancing winding with a center-tap dividing the fourth winding into two halves with a half thereof connected respectively in series with the two parallel paths of the fourth group, and a third balancing inductance means having a fifth balancing winding with a center-tap connected to said first circuit connection on the transformer and dividing the said fifth winding into two halves with a half thereof connected respectively in series with the center-taps of the first and third balancing windings and having a sixth balancing winding with a center-tap connected to the said second circuit connection on the transformer and dividing the said sixth winding into two halves with a half thereof connected respectively with the center-taps of the second and fourth balancing windings.

14. In an interrupter system having interrupting means for interrupting a plurality of groups of parallel interrupting paths, the interrupting paths of each interrupting group comprising two parallel paths and being substantially simultaneously interrupted by the interrupting means for jointly interrupting the current in the system, current-diverting means connected in effective current-diverting relation with the interrupting paths of the said plurality of interrupting groups, and balancing inductance means each having a plurality of groups of inductance windings, each group of inductance windings being respectively connected with the interrupting groups of parallel paths and having a center tap connection dividing the said inductance winding into two halves with a half thereof connected in series with each of the interrupting parallel paths for developing, in series with each of the said interrupting parallel paths an inductive impedance to the flow of the current therein.

HAROLD J. BROWN.