Sept. 27, 1949. C. F. COAKE 2,483,086

DRIVER CONTACT VIBRATOR

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Fig. 1.

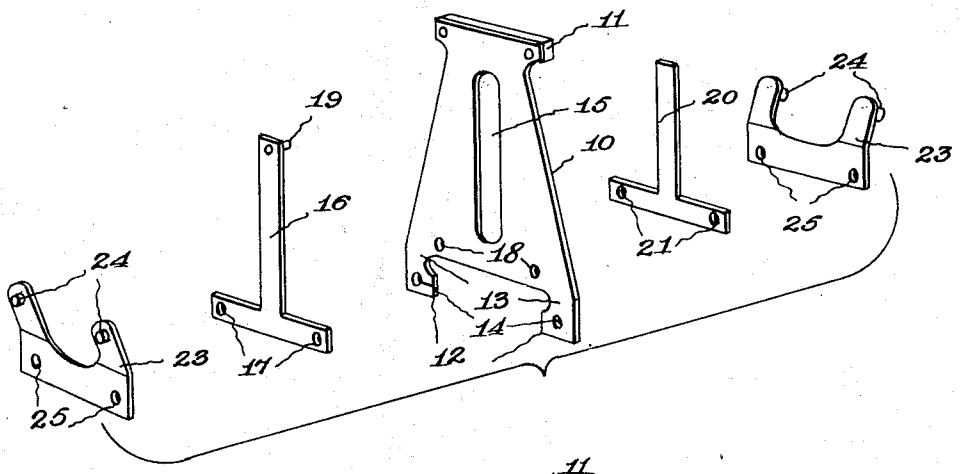


Fig. 2.

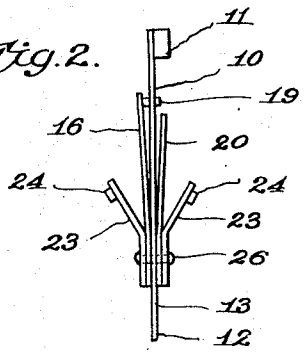
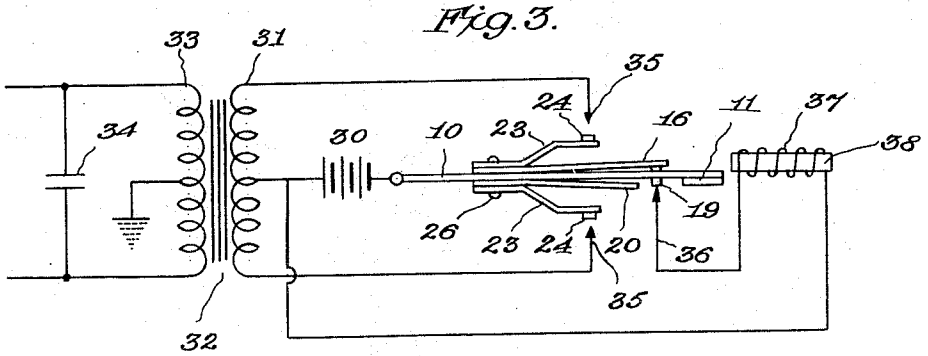


Fig. 3.



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Fig. 4

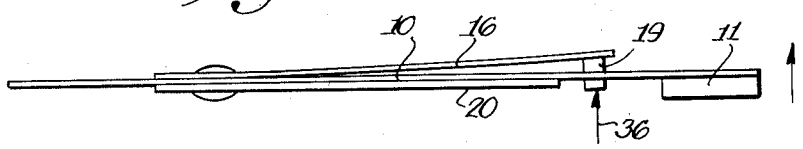


Fig. 5.

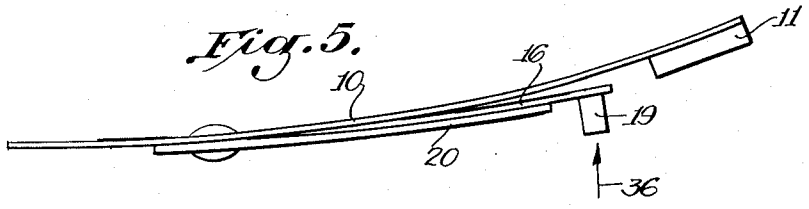


Fig. 6

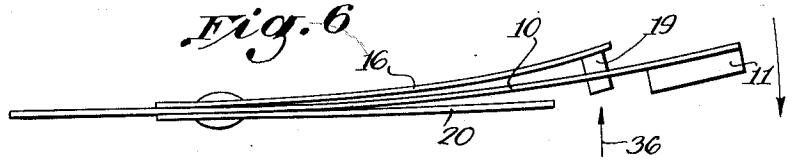


Fig. 7.

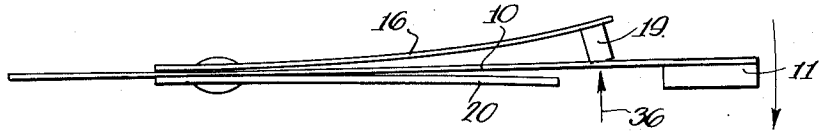
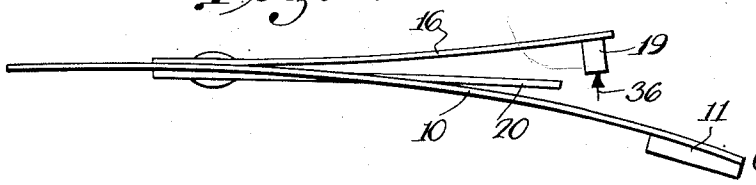


Fig. 8.



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DRIVER CONTACT VIBRATOR

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6 Claims. (Cl. 172—126)

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The present invention relates to vibrators, and, more particularly, to a driver contact vibrator of novel and improved character.

At the present time vibratory electromagnetic interrupters are employed on a substantial scale particularly in mobile and portable installations for converting direct current drawn from a storage battery or from some similar low voltage source into high voltage which after subsequent rectification and filtering may provide plate and biasing voltages for vacuum tubes of a radio transmitter to receiver. The trend of the development of the art was in the direction of providing vibratory interrupters of increasing power handling ability and efficiency in order to convert relatively heavy low voltage currents into high voltage currents with negligible power losses. In vibrators of this type it was found desirable to keep the driver circuit distinct and independent from the power circuit and to assign a separate driver contact for controlling the circuit of the driver electromagnet and thereby to obtain continuous vibratory motion of the reed.

In prior driver contact vibrators the driver contact was generally carried by an auxiliary reed secured to the principal reed. This driver contact was so associated with the circuit of the driver electromagnet that in the normal position of rest the circuit of the electromagnet was closed, thereby energizing the electromagnet and deflecting the reed. This in turn interrupted the driver circuit and would cause the reed to return to its original position and in fact to swing beyond the same, thereby restoring continuity of the driver circuit. Broadly stated, the driver circuit was closed for about one-half cycle and was open for about one-half cycle during a full operative period. Obviously, the current flowing in the driver circuit was drawn from the low voltage source in addition to the current flow in the primary winding of the step-up transformer and represented a power loss cutting down the overall efficiency of the system. For this reason, it was conventional practice to employ a driver electromagnet of relatively high resistance and thereby to keep the driver circuit current at a minimum. This however, was only possible to a very limited extent because the low amount of energy which might have been sufficient to maintain the reed in continuous vibration during the steady-state operation was frequently insufficient to positively assure quick starting of the vibrator and was a frequent source of operating difficulties. Moreover, at least a portion of the period during which the driver electromagnet was energized coincided with the time during which the reed swinging back from one extreme position has already passed beyond the midpoint of its travel and was moving away from the pole of the driver electromagnet. In this period the energized condition of the driver circuit has actually hindered the swing of the reed into its other extreme position and has represented a total loss of energy. Although these difficulties were well known to those skilled in the art and from time to time various suggestions and proposals were made to eliminate the same, none of these suggestions and proposals was completely satisfactory and successful on a practical and commercial scale.

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It is an object of the present invention to provide a novel vibrator organization which completely eliminates the foregoing difficulties and inconveniences connected with the design and the operation of prior driver contact vibrators.

It is another object of the present invention to provide a driver contact vibrator of novel and improved character in which the period during which the driver circuit is closed and consumes energy is substantially reduced.

It is a further object of the invention to provide a driver contact vibrator in which a principal reed is combined with a pair of auxiliary reeds into a unitary vibratory structure, one of said auxiliary reeds bearing a driver contact, while the other auxiliary reed acts as a stop finger causing interruption of the driver circuit at a determined time with respect to the vibratory displacement of the principal reed, thereby reducing the period during which the driver circuit is maintained closed.

It is also within contemplation of the invention to provide a driver contact vibrator in which the natural or fundamental frequency of the principal and of the auxiliary reeds and the mass of the armature and of the driver contact are so adjusted with respect to each other and to the driver circuit constants that a very high starting ability is combined with a low steady-state current, thereby realizing a heretofore unobtainable efficiency of current conversion.

The invention also contemplates a driver contact vibrator of high efficiency which is simple in structure, positive in operation, and which may be readily manufactured and sold on a practical and commercial scale at a low cost.

Other and further objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawing; in which

Fig. 1 illustrates an expanded perspective view of a vibratory reed embodying the principles of the present invention;

Fig. 2 depicts a side elevational view of the reed structure shown in Fig. 1 in its assembled condition;

Fig. 3 shows a circuit diagram of the novel vibratory interrupter organization; and

Figs. 4 to 8 illustrate the relative positions of the principal reed and auxiliary reeds during successive stages of the operation cycle.

Referring now more particularly to Figs. 1 and 2 of the drawing, reference character 10 denotes a principal reed having an armature 11 mounted at the upper or free end thereof and having a pair of downwardly depending ears 12 at the lower or clamped end thereof. These depending portions are connected to the body of the reed by means of weakened portions 13 and have clamping holes 14 provided therein. An elongated slot 15 extends throughout the major portion of the length of the reed. Auxiliary reed 16 is of an inverted T-shape and has two mounting holes 17 in the transverse portion thereof conforming to correspondingly spaced holes 18 in the body of the principal reed. The upper end of auxiliary reed 16 bears a driver contact 19. The second auxiliary reed 20 is similar in shape to auxiliary reed 16 and has a pair of similar mounting holes 21 in its transverse portion. Auxiliary reed 20, however, ends short of auxiliary reed 16 and constitutes a stop finger adapted to cooperate with corresponding portions of auxiliary reed 16 below driver contact 19, as it will be explained more fully hereinafter. The reed structure is completed by a pair of U-shaped side arms 23 bearing two power contacts 24 each and having mounting holes 25. The principal reed, the auxiliary reeds and the side arms are held together by means of bolts or rivets 26 in the position illustrated in Fig. 2.

The cooperation of the novel reed structure with an electro-magnetic vibratory interrupter will be best understood by referring to Fig. 3 showing a preferred form of circuit organization. A source of low voltage 30 has one of its terminals connected to reed 10 and its other terminal connected to the midpoint of the primary winding 31 of a step-up transformer 32. The high voltage alternating current is taken off at the terminal points of secondary winding 33 of the transformer, grounded at its midpoint and having a buffer condenser 34 connected across the same in conventional manner. This alternating current may be rectified by means of a vacuum tube rectifier or by means of synchronous contacts (not shown) provided on the vibratory reed. Vibratory power contacts 24 carried by side arms 23 cooperate with relatively fixed contacts 35, respectively connected to the ends of primary winding 31 of the transformer.

The driver circuit of the vibrator comprises a relatively fixed contact 36 cooperating with driver contact 19 on auxiliary reed 16 and connected with winding 37 of the driver electromagnet having an iron core 38 one end of which is arranged in close proximity to armature 11 of principal reed 10. The other end of winding 37 is connected to one terminal of the low voltage source 30.

From the foregoing description, the operation of the novel vibratory reed and its circuit organization will be readily understood by those skilled in the art. In the normal position of rest the driver circuit is closed between driver contact 19 and fixed contact 36 and current will flow from

the negative terminal of the current source through auxiliary reed 16, driver contact 19, fixed contact 36, electromagnet winding 37 and back to the positive terminal of the source. Winding 37 being energized, the end of iron core 38 will attract armature 11 and will deflect the principal reed and the auxiliary reeds mounted thereon. It will be noted that the combination of the two auxiliary reeds 16 and 20 will provide a reed structure and support for driver contact 19 which is relatively rigidly connected to the principal reed 10 during the upward travel thereof and is relatively yielding with respect to said principal reed during the downward travel thereof. Therefore, during the upward displacement of the principal reed the driver contact will closely follow the principal reed and will break the driver circuit between 19 and 36 at approximately the time when the principal reed reaches the midpoint of its displacement and possibly before such position. Due to its inertia the principal reed and also the driver contact will swing beyond the midpoint and will reach its greatest upward deflection. During its return travel, however, driver contact 19 will lag behind the principal reed and will not catch up with it until the principal reed has practically reached the lower point where its direction is reversed. This lagging of the driver contact is the result of the cooperation of various factors. First, the mass of the driver contact 19 loads the free end of auxiliary reed 16 and introduces a sufficient amount of inertia which prevents this auxiliary reed from instantaneously following any change in the direction or speed of the displacement of the principal reed. In addition to this, during this downward travel, auxiliary reed 16 is substantially disconnected from the other auxiliary reed, or stop finger 20, so that its flexibility and its freedom of displacement with respect to the principal reed are greatly increased. The result will be that the driver circuit will be closed only during the relatively short period while armature 11 is under the influence of the energized electromagnet 37 and is traveling from its lowest point up to its midpoint. Generally speaking, this period of closed driver circuit does not exceed one-quarter cycle and may be even less, in contrast to the conventional mode of operation where the driver circuit is closed for a period greatly exceeding one-quarter cycle and is of the order of one-half cycle.

It has been found that this highly desirable and novel operating condition is further supplemented and assured by providing predetermined and definite frequency relations between the frequency of the driver contact and that of the principal reed. Thus, it is preferred to so adjust this frequency relation that the fundamental frequency of the driver contact is less than that of the principal reed, preferably equaling one-half to one times the principal reed frequency. As a modification of this concept, the frequency of the driver contact may be made higher than the fundamental frequency of the principal reed by an odd ratio, such as for example two and one-half to one. In this case the driver circuit will not be closed until the principal reed has reached the lower terminal point of its swing.

It will be noted that the principles of the invention provide various important advantages. Thus, first of all, due to the greatly reduced period during which the driver contacts and the driver circuit are closed, the amount of heat generated in the driver coil is greatly reduced. Since the driver coil does not hinder the downward travel

of the reed structure, much less energy is required for maintaining the reeds in vibratory motion whereby the overall efficiency of conversion is substantially increased.

It is also to be observed that the lower amount of heat generated in the driver coil permits provision for higher ampere turns of the driver electromagnet, this considerably aiding in starting. At the same time such higher starting power is obtained without the necessity of employing higher steady-state amplitudes of the driver current, which is an ideal condition of operation heretofore unobtainable with conventional reed structures.

Moreover, the novel reed structure is extremely simple in construction and in fact is much safer and more positive in operation than any one of the prior reed organizations.

Figures 4 to 8 illustrate the relative positions of the principal reed 10 and auxiliary reeds 16, 20 during successive stages of the operating cycle. In the structure shown by these figures, the fundamental frequency of the auxiliary reed 16 is substantially less than that of the principal reed 10. In the initial position shown by Figure 4, the reeds 16 and 20 are in engagement and the contacts 19, 36 are closed. As the principal reed travels upwardly in the direction indicated by the arrow, Figure 4, in response to energization of the driver coil, the three reeds move as a unit until an upper extreme position is reached which is shown in Figure 5, the reed 20 lifting the auxiliary reed 16 along with the contact 19. Thereupon, the principal reed 10 and reed 20 move downwardly, the successive positions thereof being indicated in Figures 6 to 8. The auxiliary reed 16 lags behind the principal reed during this downward motion since, as stated, the fundamental frequency of the auxiliary reed is substantially less than that of the principal reed. At or shortly after the time the principal reed reaches its lowermost position, Figure 8, the auxiliary reed reaches a position where the contact 19 engages the contact 36 and these contacts remain in engagement while the principal reed moves upwardly to the initial position shown by Figure 4. Thereupon, the reed member 20 again engages the auxiliary reed 16 and the three reeds move upwardly as a unit to initiate another cycle of operation.

It will be apparent that the contacts 19, 36 are closed for approximately one-fourth of the operating cycle and that the length of the closed contact period may be varied by adjusting the fundamental frequencies of the principal reed 10 and auxiliary reed 16.

While the present invention, as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. A vibratory interrupter comprising in combination a principal reed having an elongated longitudinal slot therein, a pair of auxiliary reeds of inverted T-shape having their transverse portions respectively mounted on said principal reed and having their longitudinal portions extending into and displaceable through said slot, one of said auxiliary reeds bearing a driver contact and the other ending short of said contact, and electromagnetic means under the control of said driver contact for maintaining said principal reed in vibratory motion, the shorter one of said auxiliary reeds constituting a stop finger substantially preventing vibration of the other auxiliary reed when the principal reed moves in driver circuit-opening direction but being substantially ineffective to prevent vibration of the longer auxiliary reed when the principal reed is moving in the opposite direction whereby the driver contact will lag behind the principal reed during the return swing thereof and will reduce the period during which the driver circuit is closed below one-half cycle.

2. A vibratory interrupter comprising in combination a principal reed having an elongated longitudinal slot therein, a pair of auxiliary reeds having a transverse portion respectively secured to the two sides of said principal reed and having longitudinal portions of unequal length extending into and flexible within said slot in substantially aligned position, the longer one of said auxiliary reeds bearing a driver contact and the shorter one forming a stop finger therefor, and a relatively fixed contact for said driver contact, electromagnetic means under the control of said driver contact to maintain said principal reed in vibratory motion, the mass of said driver contact and the resiliency of the auxiliary reeds being so determined that the driver contact will lag behind the principal reed during its swing toward driver contact-closing position whereby the period during which the driver circuit is closed is reduced to the order of one-quarter cycle.

3. A vibratory interrupter comprising in combination a principal reed having an aperture therein, a pair of auxiliary reeds having one of their ends mounted on said principal reed and having their other end relatively displaceable thereto, said auxiliary reeds being adapted for engagement with each other through said aperture during a portion of each operating cycle, a driver contact on one of said auxiliary reeds, a fixed contact adapted to cooperate with said driver contact, and electromagnetic means controlled by said driver contact to maintain said reeds in vibratory motion, the fundamental frequency of said driver contact reed being adjusted to a value lower than that of said principal reed.

4. A vibratory interrupter comprising in combination an apertured principal reed clamped at one end thereof, an auxiliary reed structure including a pair of auxiliary reeds of different lengths, each having one end fixed to said principal reed near the clamped end thereof and having the other end relatively displaceable thereto, said auxiliary reeds being adapted for engagement with each other during a portion of each operating cycle, a driver contact on one of said auxiliary reeds, a relatively fixed contact adapted to cooperate with said driver contact, and electromagnetic means under the control of said driver contact to maintain said reeds in vibratory motion, the fundamental frequency of said driver contact reed being higher by an odd ratio than that of said principal reed whereby said electromagnetic means will be energized for a period of the order of one-quarter cycle for each cycle of the principal reed.

5. In a driver contact vibrator having a vibratory principal reed adapted to control a power circuit and an electromagnetic driver circuit therefor, the improvement which comprises a composite auxiliary reed bearing a driver contact, the components of said auxiliary reed having asymmetrical flexibility characteristics for flexure in two opposite directions, the relative fundamental frequencies of principal and auxiliary reed

being so adjusted that in-phase operation of said reeds will result in driver contact-breaking direction and out-of-phase operation of said reeds will result in driver contact-making direction whereby the driver circuit will be energized for about one-quarter cycle for each cycle of the principal reed.

6. In a driver contact vibrator having a vibratory principal reed adapted to control a power circuit and an electromagnetic driver circuit therefor, the improvement which comprises a composite auxiliary reed constituted of a pair of aligned reeds of unequal length mounted on said principal reed, and a driver contact on the longer one of said auxiliary reeds, the relative fundamental frequencies of said principal and auxiliary reeds being so adjusted that in-phase operation of said reeds will result in the driver circuit-breaking direction and out-of-phase operation of said reeds will result in the driver circuit-closing

direction whereby said driver contact will lag behind the principal reed and will close the driver circuit only when the principal reed has practically reached its extreme position during its return swing.

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