July 20, 1948. R. M. ELLIS 2,445,390

VIBRATOR CIRCUIT WITH PRIMARY CURRENT DIVISION

Filed Jan. 4, 1944

Fig. 1

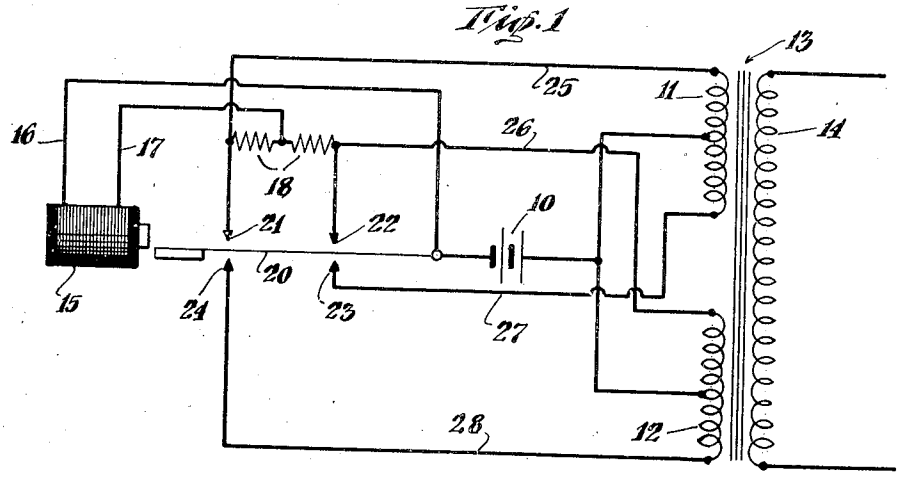
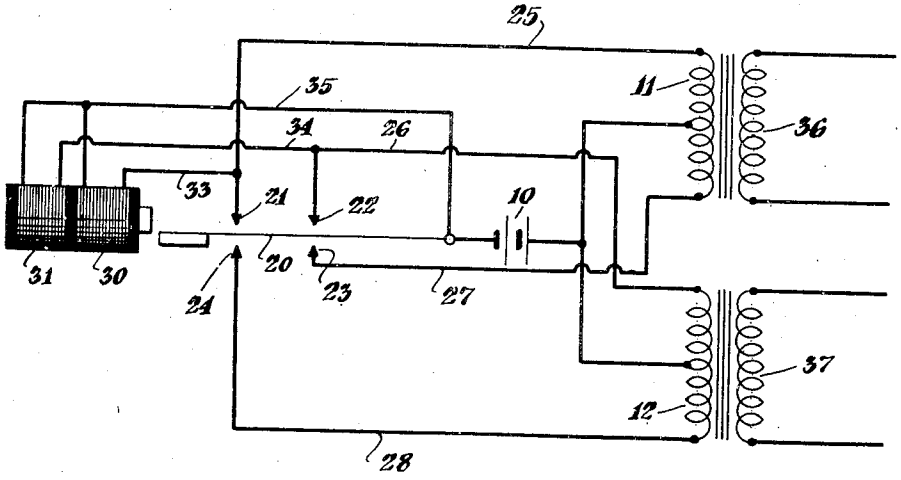


Fig. 2



INVENTOR.
Robert M. Ellis
BY
Robbin & Carlson
ATTORNEYS

Patented July 20, 1948 2,445,390

UNITED STATES PATENT OFFICE

2,445,390

VIBRATOR CIRCUIT WITH PRIMARY CURRENT DIVISION

Robert M. Ellis, Indianapolis, Ind., assignor to P. R. Mallory & Co., Inc., Indianapolis, Ind., a corporation of Delaware

Application January 4, 1944, Serial No. 516,985

6 Claims. (Cl. 175—365)

1

This invention relates to vibrators and has for its object to provide a simple and efficient electrical system employing a vibrator for converting direct current into alternating current. This alternating current can be converted to any desired voltage by the use of an appropriate transformer, and the resultant output voltage or voltages may be utilized directly, or may be reconverted to direct current by suitable rectification.

Another object of the invention is to provide a new and improved system for adapting a shunt driver type vibrator to a primary current division circuit in a manner to insure positive starting of the vibrator, increased load carrying capacity, and longer life by reason of uniform distribution of wear on the vibrator contacts.

Another object of the invention is to provide a vibrator system of the above type having novel and improved details of construction and features of operation.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

There are certain definite limits to the amount of power which can be handled by any given vibrator mechanism such as is employed in converter systems of the type referred to above. Therefore, if the load current exceeds the carrying capacity of a 4-contact vibrator, it is customary to employ an 8-contact vibrator which may have two paralleled pairs of contacts on each side of the vibrator reed for the purpose of increasing the load carrying capacity of the unit.

Such paralleled contacts will increase the life of the vibrator in situations where the circuit is loaded to the point where contact wears occurs at a rapid rate. Since two sets of contacts will provide twice as great a volume of tungsten or other contact metal as a single set, the life of the vibrator is theoretically doubled. However, it is impossible to adjust paralleled contacts so that each pair of contacts will "make" at precisely the same instant, and it is equally impossible to insure that two paralleled contacts will "break" at exactly the same instant. The contacts with the closest spacing will "make" first and "break" last, and thus will assume all the load. This condition will continue until the tungsten or other contact metal has been eroded on the active contacts to a point where their spacing is greater than that of the other pair of contacts, at which instant the circuit load will be transferred to the other pair of contacts. From then on, operation will be alternately with one pair of contacts active, and then with the other pair active.

2

Because contact wear increases rapidly and non-linearly with increasing current density, it will be seen that if the primary load current could be divided evenly between two paralleled contacts, the life of the vibrator would be greatly increased; or conversely the vibrator could handle more power for a given life.

One method heretofore proposed for achieving the division of the current load between two sets of contacts is to operate each pair of contacts through a current limiting resistor, but this method is open to the objection that there is always some resistance in the main load circuit which results in lowered efficiency.

Another method proposed for achieving the desired effect is to use consecutively closing contacts, wherein the first pair of contacts are closed through a resistor which limits the flow of current to a safe value for the contacts, this resistor being shorted out of the circuit by a second pair of contacts which close later in the cycle. The practical objection to this method is the difficulty of adjusting two sets of contact points for different time sequences or spacings, and the further difficulty of balancing the electric circuit so that relative spacings will be maintained during the life of the vibrator as the contacts wear.

A third method proposed for dividing the primary current is to use two separate transformers, with each transformer carrying half the load, or alternately a single transformer with two primary windings. With these arrangements the primary load is divided evenly between each pair of contacts, since the pairs of contacts connect to separate primary windings. Such an arrangement is efficient from electrical standpoint because no resistance is connected in the main load circuit, and also because all contacts can be adjusted to the same spacing. Furthermore, the tendency is for the contacts to wear uniformly and maintain constant relative spacing since the load current is the same for both sets of contacts.

This third-mentioned method of primary current division in the past has been used exclusively with separate driver type vibrators. In this form of construction, the action of making and breaking the electrical circuit actuating the electromagnet is obtained by means of a separate pair of contacts which are divorced from the load circuit. In actual practice the result is a complex vibrator mechanism having five pairs, or a total of ten contacts.

My invention provides a new and improved vibrator system in which a primary current divi-

sion circuit, employing either twin transformers or a transformer having twin primaries, can be operated from a vibrator having four pairs of contacts. My system includes a center-tapped resistor which is connected in series with the driver coil circuit where the current is relatively low, and where the power requirements are relatively small. This center-tapped resistor enables the driver coil to actuate from two sets of contacts, and distributes the driver coil load to two contacts to provide a symmetrical circuit for the driver coil load. My system results in a symmetrical circuit so that the driver coil load is equally distributed on both contacts, thus resulting in uniform contact wear.

Although the novel features which are characteristic of the invention are set forth more in detail in the claims appended hereto, the nature and scope of the invention may be better understood by referring to the following description, taken in connection with the accompanying drawing forming a part thereof, in which certain specific embodiments have been set forth for purposes of illustration.

In the drawing:

Fig. 1 is a schematic diagram of a system embodying the invention and employing a single transformer with twin primary windings; and

Fig. 2 is a similar diagram illustrating a modification of the invention employing a driver magnet with twin windings.

In the following description certain specific terms are used for convenience in referring to the various details of the invention. These terms, however, are to be given an interpretation commensurate with the state of the art.

The system shown in Fig. 1 includes a source of current **10**, such as a storage battery, which is connected to the mid-points of the twin primary windings **11** and **12** of a transformer **13** having a secondary winding **14**.

The vibrator mechanism comprises a driver coil **15** which is connected by conductor **16** to the source of current **10** and by return conductor **17** to the center-tap of a resistor **18**; vibrator reed **20** which is connected to said source of current; and two sets of contacts **21**, **22** and **23**, **24**, respectively, which are mounted on opposite sides of the reed **20**.

Vibrator contacts **21** and **22** are connected to opposite ends of the resistor **18**, and they are likewise connected by conductors **25** and **26**, respectively, to the upper ends of the respective primary windings **11** and **12** of the transformer. The contacts **23** and **24** on the opposite side of vibrator reed **20** are connected by conductors **27** and **28**, respectively, to the lower ends of the respective primary windings **11** and **12** of the transformer.

Assuming that the contacts **21** and **22** at the upper side of reed **20** are open, current will flow through the driver coil **15** over a circuit extending from one pole of battery **10**, through the upper half of primary winding **11**, the left half of resistor **18**, conductor **17**, winding of coil **15**, and conductor **16** to the other pole of battery **10**; and the driver coil **15** will also be energized over a parallel circuit extending from the one side of battery **10**, through the upper half of primary winding **12**, the right half of resistor **18**, conductor **17**, winding of coil **15** and conductor **16** to the other side of battery **10**.

The vibrator magnet **15**, thus energized over the parallel circuits described above, will attract the reed **20** and cause same to close both of the contacts **21** and **22**. When both of the contacts **21** and **22** are closed, current will flow momentarily from one side of battery **10**, through the upper halves of primary windings **11** and **12**, contacts **21** and **22** respectively, and reed **20** to the other side of battery **10**. The driver coil will thus be deenergized, releasing the reed **20** and causing same to close the contacts **23** and **24**.

Closing of contact **23** causes current to flow momentarily, in a direction opposite to that previously described, from one side of battery **10**, through the lower half of primary winding **11**, contact **23**, and reed **20** to the other side of battery **10**; while closing of contact **24** completes a similar circuit extending from one side of battery **10**, through the lower half of primary winding **12**, contact **24**, and reed **20** to the other side of battery **10**. Thus the alternate interruption and reversal of the current flow through the primary windings **11** and **12** induces an alternating current of increased voltage in the secondary winding **14** of the transformer.

It will be observed that in the system described above the flow of current to the driver coil is shunted by closing either contact, but the driver coil energizing current will not be completely cut off until both of the contacts **21** and **22** are closed. It will be evident from the description and drawing that both vibrator contacts participate equally in the driver coil action.

Fig. 2 shows a modification of the invention employing a driver coil with twin windings **30** and **31**. These windings each have one terminal connected to one of the vibrator contacts **21** and **22** by conductors **33** and **34**, respectively, while the other terminals are connected to the negative side of battery **10** by conductor **35**. In this embodiment the primary transformer windings **11** and **12** are shown on separate transformer cores, each having its own secondary **36** and **37**. However, it is to be understood that twin driver coil arrangement **30**, **31** may be used with a single transformer having two primary windings as shown in Fig. 1. This transformer may have one or more secondary windings as required by the circuit application.

Likewise, the system illustrated in Fig. 1, wherein a single driver coil **15** is connected to two contacts **21** and **22** by a center-tapped resistor **18** is equally adapted for use with primary windings on two separate transformers, as shown in Fig. 2.

The operation of the system of Fig. 2 is the same as that previously described in connection with Fig. 1. The flow of current to the driver magnet is shunted by either contact **21** or **22**, and this magnet will not be deenergized until the current to both of its windings **30** and **31** is cut off by the closing of both of the contacts **21** and **22** by the vibrator reed **20**.

Although certain specific embodiments of the invention have been shown for purposes of illustration, it is to be understood that the invention is capable of various modifications and adaptations which will be readily apparent to a person skilled in the art. The invention is only to be limited in accordance with the scope of the appended claims.

What is claimed is:

1. A vibrator system comprising in combination a pair of primary transformer windings, a source of current having one of its terminals connected to the midpoints of said windings, a vibratory reed connected to the other terminal of said source, a pair of contacts on opposite sides

of said reed for each winding connected to the ends of the respective windings and adapted to cooperate with the reed during vibrations thereof to alternately pass current in opposite directions through the respective halves of said windings, a driver coil adapted when energized to displace the reed into a deflected position, a resistor connected between the contacts closed in said deflected position, and leads connecting the ends of said coil between said reed and the midpoint of said resistor whereby the driver coil will be alternately energized in the open contact position and disabled in the said deflected position by the bypassing effect of said contacts and will maintain the reed in continuous vibration.

2. In a vibrator system, the combination of a vibratory reed, a pair of primary transformer windings each having two half sections, twin pairs of stationary contacts electrically connected to the ends of said windings wherein said reed cooperates with said pairs of contacts to alternately pass current in opposite directions through respective sections of said windings during vibrations of the reed, a driver coil, and dual resistive path, each including a resistor and a section of one of said primary windings, through which said coil is normally energized to deflect the reed into contact-closing position, the closure of one of said contacts as the reed moves to deflected position being effective to shunt the resistor and the driver coil out of the first of said paths, the closure of another of said contacts as the reed moves to deflected position being effective to shunt the resistor and the driver coil out of the other of said paths.

3. A vibrator system comprising in combination a pair of primary transformer windings, a source of current having one of its terminals connected to the midpoints of said windings, a vibratory reed connected to the other terminal of said source, a pair of contacts on opposite sides of said reed for each winding and connected to the ends of the respective winding adapted to cooperate with the reed during vibrations thereof to alternately pass current in opposite directions through the respective halves of said windings, and a pair of driver coils having one of their ends connected to said reed and having their other ends respectively connected to the two contacts on one side of the reed, said coils being energized in the open contact position to deflect the reed into one of its contact-closing positions and being shunted and de-energized in the said contact-closing position whereby the reed will be maintained in continuous vibration.

4. In a vibrator system, the combination of a vibratory reed, a pair of primary transformer windings each having two halves, twin pairs of stationary contacts electrically connected to the ends of said windings wherein said reed cooperates with said pairs of contacts to alternately pass current in opposite directions through respective halves of the said two primary transformer windings, a pair of driver coils each being serially connected with one-half of one of the respective primary windings and energized to deflect the reed into one of its contact-closing positions, and connections between said coils and the contacts on one side of the reed to shunt and

to disable the coils in the said position of the reed thereby maintaining the reed in continuous vibration.

5. A vibrator system comprising, in combination, a pair of transformer primary windings, a source of current having one of its terminals connected to the midpoints of said windings, a vibratory reed connected to the other terminal of said source, a driver coil for said reed, a pair of contacts for each winding, said contacts being connected to the respective ends of the associated winding and being adapted to cooperate with the reed during vibration thereof to alternately pass current in opposite directions through the respective sections of said windings, each pair of contacts including one contact on the driver coil side of the reed and a second contact on the other side of the reed, a lead connecting one end of the driver coil to the reed, the other end of said driver coil being connected through individual resistive paths to the respective driver coil side contacts whereby, when one of said driver side contacts is open, current passes through the associated section of said primary winding and one of said resistive paths to the driver coil, the driver coil and the resistive path being shunted from the circuit when said one driver side contact is closed with the result that the coil is energized when either of said driver side contacts is opened and deenergized whenever both of said driver side contacts are closed.

6. A vibrator system comprising, in combination, a pair of center-tapped primary windings, a source of current having one terminal thereof connected to both of said center taps, a vibratory reed connected to the other terminal of said source, a driver coil for said reed, a pair of contacts connected, respectively, to the terminals of the first primary winding, a pair of contacts connected, respectively, to the terminals of the second primary winding, each pair including a contact on the driver coil side of the reed and a contact on the other side of the reed, and a dual branch circuit for energizing said driver coil, one branch of said circuit being connected between the first driver coil side contact and the reed, another branch of said circuit being connected between the second driver coil side contact and the reed, each branch circuit being disabled when the contact associated therewith is engaged by the reed, whereby current flows through the driver coil when either of said driver coil side contacts is not engaged by the reed and no current flows through the driver coil when both of said driver coil side contacts are engaged by the reed.

ROBERT M. ELLIS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,020,681	Garstang	Nov. 12, 1935
2,265,717	Bedford	Dec. 9, 1941
2,286,842	Brown	June 16, 1942
2,327,579	Brown	Aug. 24, 1943