April 19, 1932. W. C. ROE 1,854,863

REED CONVERTER

Filed June 7, 1930

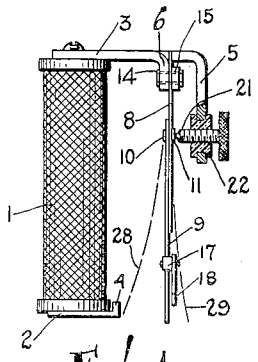

Fig. 1.

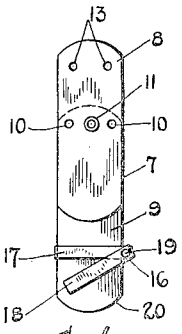

Fig. 2.

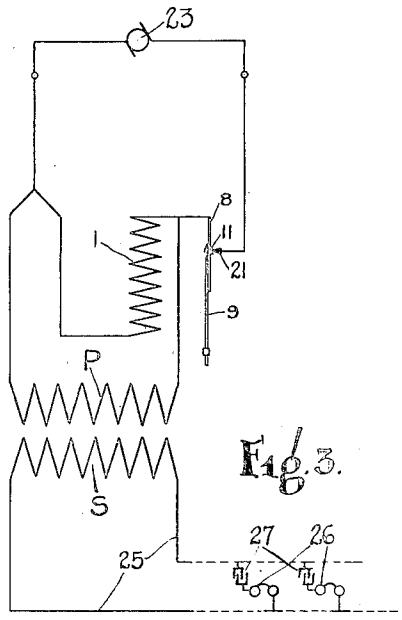

Fig. 3.

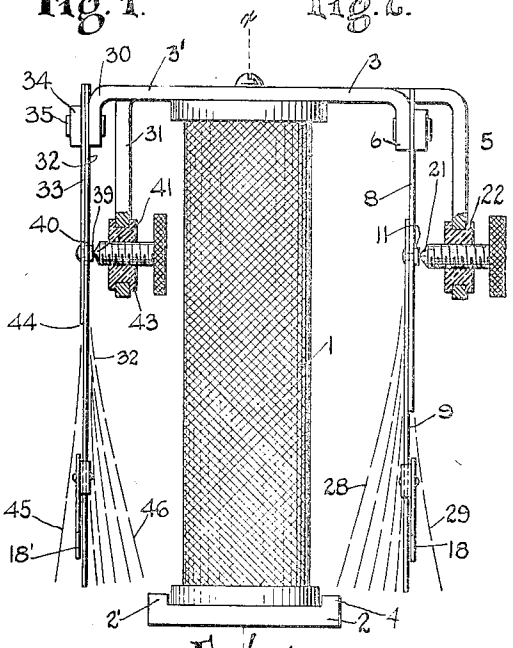

Fig. 4.

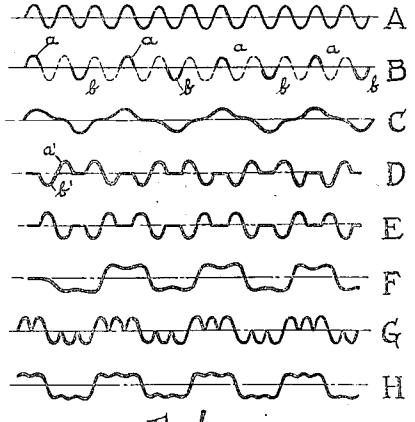

Fig. 9.

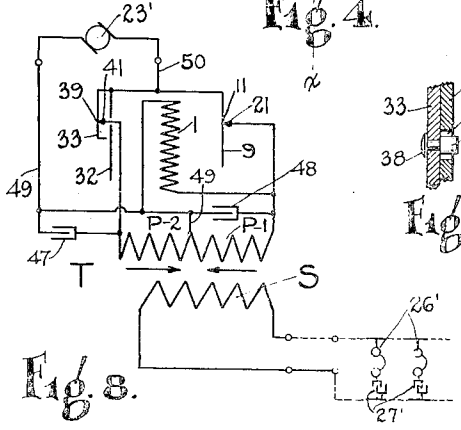

Fig. 8.

Fig. 5.

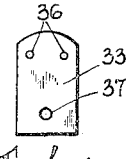

Fig. 7.

Fig. 6.

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UNITED STATES PATENT OFFICE

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REED CONVERTER

Application filed June 7, 1930. Serial No. 459,674.

My invention relates to electrical circuit controllers and relates particularly to improvements in vibratile reed circuit controllers.

My invention relates to that general type of vibratile reed circuit controllers disclosed in my prior Patent No. 1,646,662, dated October 25, 1927, the present application disclosing improvements to the method and apparatus shown in my aforesaid prior patent.

An object of my present invention is to provide an improved controller for translating a periodically varying current into periodically varying current impulses of a different effective frequency.

Another object of my invention is to provide an improved reed operated circuit controller adapted to more continuously utilize the supplied current impulses in the translation of said impulses into current impulses which periodically vary at a relatively fractional rate.

Another object of my invention is to provide an improved synchronous reed controlled current flow modifier.

Another object of my invention is an improved electrical system.

Another object of my invention is to provide a novel method of modifying electrical current flows.

Other objects of my invention and the invention itself will become apparent by reference to the following description of an embodiment of my invention illustrated more or less diagrammatically in the accompanying figures of drawings, wherein:

Fig. 1 is a side elevational view of an electromagnetic reed controller employed in an embodiment of my invention.

Fig. 2 is an elevational view of the reed for the controller of Fig. 1;

Fig. 3 is a diagrammatic view of a system employing the controller of Fig. 1;

Fig. 4 is a side elevational view of a controller employing in combination the structure of Figs. 1 and 2, together with an additional reed and circuit controlling contacts.

Fig. 5 is a medial longitudinal section relatively enlarged of a fragment of the controller of Fig. 4;

Fig. 6 is an elevational view of a reed for the controller of Figs. 4 and 5.

Fig. 7 is an elevational view of a supplemental reed therefor.

Fig. 8 is a diagrammatic view of an electrical system employing the controller of Fig. 4;

Fig. 9 is a diagrammatic view of the supplied current wave and successively disposed therebelow, impressed and resultant current waves resulting from the operation in electrical systems of the apparatus of the foregoing figures.

Referring now first to the apparatus of Figs. 1 and 2 and the system of Fig. 3, in which the said apparatus is employed, at 1 I show an electromagnet having a core terminating magnetically in laterally extending pole pieces 2 and 3 at its respective two ends.

The pole piece 2 terminates in a pole flange 4 and the pole piece 3 terminating in a pair of inturned forks 5 and 6.

At 7 I show a compound reed element comprising a pair of leaf springs 8 and 9 secured together by a pair of rivets 10 and an intermediate rivet 11 forming an electrical contact point as will later appear. The two springs are preferably of very thin spring steel strips and are relatively so superposed by end portions so that when secured together the effect of the spring 9 is to form a resilient extension for the spring 8 whose end 12 extends toward the free end of the spring 9 to a point approximately mid-way of the ends of said spring. The spring 8 is provided with a pair of perforations 13 adapted to admit the shanks of rivets 14 projected therethrough, and through aligned perforations of a metallic block 15 and of the fork 6 of said electromagnet pole piece, whereby the compound reed 7 is rigidly mounted on said fork.

The spring 9 carries an inertia weight element 16 which, in the form of a looped strip of metal 17, embraces the spring 9 and to which there is rotatably secured an adjustable arm 18 pivoted to the free ends of the loop 17 by a rivet 19 securing the free ends of

the loop and an end of the arm together in such a manner as to clamp the loop onto the spring and to form a pinion on which the arm 18 may frictionally rotate in order to adjustably disposed its free end more or less remote from the tip 20 of the spring 9.

The reed as mounted on the electromagnet structure of Fig. 1 is disposed with the spring 9 innermost, that is, towards the electromagnet 1, and the contact 11, heretofore referred to as a rivet, projects outwardly to engage the contacting end of a contact screw 21 which is adjustably screw-threaded in an insulating bushing 22 carried by an end of the fork 5 of the pole piece 3.

When the screw 21 is turned in the bushing to advance its point into contact with the contact 11, an electrical circuit is completed between said screw and said contact and when the electrical circuit of Fig. 3 is complete, including said contact screw 21 and contact 11, the compound reed is thrown into vibration under the control of the contacts 11—21 at a rate dependent upon the inherent properties of the reed, the electrical and mechanical effect of the engagement of the contacts and the strength of the magnetic field in which the steel compound reed is oscillated, but under the dominant control of the impulses of electrical current supplies from a source such as the alternating current generator 23 over the circuit conductors, as illustrated in Fig. 3, the circuit of which will now be explained.

Referring now particularly to Fig. 3, at 24 an alternating current transformer is illustrated comprising a primary winding P and a secondary winding S of any desired transformation ratio, such as for instance 1 to 1. The secondary winding S is extended by circuit conductors 25 to any desired electro-responsive devices adaptable for operation by the current derived from the mechanism and circuit described, such as the telephone, polarized bells 26, shown as being connected across the conductors 25, each in series with an appropriate electrical condenser 27.

The winding of the electromagnet 1 is connected in serial circuit with the source of alternating current 23 and the contacts 21 and 22, and the primary winding 1, in the embodiment illustrated, is shown as connected in multiple with the winding of the electromagnet 1.

The system of Fig. 3 operates as follows: Alternating current having the approximate wave form of that indicated at A in Fig. 8, being supplied from the source 23 to the winding of the electromagnet 1 through the contacts 21—11, Fig. 3, will energize the electromagnet to cause the end of the reed 7 to approach the pole piece flange 4, as indicated by the dotted lines 28, Fig. 1, at the same time effecting breaking of the circuit by separation of the contacts 21—11. The contacts being broken, the reed by the power of its own inherent resiliency will retract to again close the contacts with the foregoing result repeated.

When so oscillated, the reed constructed as illustrated in Figs. 1 and 2 will oscillate within the limits relatively substantially as shown by the dotted lines 28 and 29 to periodically make and break the contacts 21—11. Due to the compound nature of the reed, the relative positioning of its parts 8 and 9 and mechanical engagement on the back stroke between the contact 11 carried by the reed and the fixed contact 21, the reed will take a longer excursion toward the pole flange 4 than in the opposite direction, and by suitable adjustment of the screw 21 while the reed is vibrated, each forward excursion of the reed will be caused to take just twice as long as each rearward excursion thereof. When this result is obtained, the fact will be visually evident to the one making the adjustment by noting that at such time the substantially complete absence of electrical sparking at the contacts.

When this condition is secured, it is found that the reed is vibrating by impulses of current taken from the wave such as shown at A, Fig. 9, and indicated in solid lines by the portions thereof shown at a', Fig. 9. In other words, as shown at B, the current impulses through the electromagnet 1 are of alternate polarity and spaced from the next succeeding impulses of current by a full cycle of omitted impulses of alternating current indicated by dotted lines at b. The solid line impulses a and a' of successively opposite polarity passing through the electromagnet 1 also pass through the primary winding P of the transformer 24 with the result that an alternating current is supplied by the secondary winding thereof having a periodicity one-third that of the periodicity of current supplies by the source 23 as shown by the compound reed of my present invention are similar to those previously described in my prior Patent No. 1,646,662, dated October 25, 1927, and to which reference may be had.

In the apparatus of Fig. 1, the reenforcing portion of the spring 8, overlapping the spring 9 causes a resistance to be resiliently applied to retractive movements of the spring 9, and particularly this is true when the contact screw 21 engages the contact 11 affixed to the reed 7 at a point spaced from its support 6. On the forward excursion toward the position 28, however, the overlapping portion of the spring 8 has no such function and the spring 9 and the supporting portion of the spring 8 swings freely inwardly, in a manner similar to that which would occur, were the springs 8 and 9 one continual spring with no overlapping portion.

In effecting vibration of the compound reed at a rate which is exactly two-thirds that of the periodicity of the supplied alter-

nating current, the arm 8 of the element 16 may be adjusted to varying positions by rotating it on the pin 19 until its periodicity corresponds to the fractional periodicity of the alternating current desired.

It will be understood that the tuning of the compound reed is to be accomplished with a view to the frequency of alternating current desired to be obtained by the operation of the system and that the reed vibration rate above given is that which would be required to be had where it is desired to obtain an alternating current whose periodicity is one-third that of the periodicity of current from the source, as described herein.

In the embodiment of my invention illustrated in Fig. 4, the apparatus shown to the right of the longitudinal middle line x—x is like that previously shown and described in connection with Figs. 1, 2, 3 and 9, and therefore this part of the apparatus of Fig. 4 will be referred to but briefly in connection with the description of the operation of the apparatus shown to the left of the medial line x—x of Fig. 4, wherein the pole pieces 2 and 3 of Fig. 1 are integrally prolonged toward the left to provide the pole tip 2′ and the pole piece 3′ bifurcated at its end to provide the reed supporting arm 30 and the fixed contact supporting arm 31. An elongated main reed 32 and a short contact-carrying supplemental reed 33 are supported by an end of each, in relatively superposed relation on the arm 30 being clamped thereto by a plate 34 and rivets 35 projected through aligned apertures of said plate, said superposed reeds and said arm 30. The main and supplemental reeds, per se, are respectively illustrated in elevation in Figs. 6 and 7, wherein the rivet receiving apertures are shown and also are shown at 36, and also an aperture 37 is shown provided in the supplemental reed 33 for the reception of the reduced neck 38, Fig. 5, of an electrical contact element 39 in the form of a rivet and having a contact portion projected from a flat side of the supplemental reed.

Also, an enlarged aperture 40, Figs. 5 and 6, is provided through which the projecting portion of the contact 39 may extend for engagement by the contact point of the fixed contact screw 41, which is adjustably mounted in the insulating block or bushing 43 carried by the arm 31.

The supplemental reed 33 being substantially shorter, less than one-half the length, than the reed 32, terminates at a point 44 which lies but slightly beyond the contact 39 carried by it and being disposed on the outer side of the main reed 32, and engageable therewith on all outward excursions, such as indicated at 45 of the reed 32, restrains the main reed in outward movements, that is, when moving in directions away from the pole tip 2″.

However, the presence of the reed 33 at first accelerates the inward movement toward the position 46 of the reed 32 and the inward swing of the reed 32, like the inward swing of the reed 9 is of much greater amplitude than the outward swing, as at 29, referring again to the reed 9.

It is to be noted, however, that the positioning and relationship of the contacts 39—41 is different from that of the contacts 11—21, and the adjustment of the contact screws is previously made so that when there is engagement between the contacts 11 and 21, the contacts 40 and 39 are disengaged and the contrary is also true, namely, that upon engagement of the contacts 39 and 41, there will be disengagement of the contacts 11 and 21.

The electrical circuit preferably employed for the embodiment of Fig. 4 is illustrated in Fig. 8 and by reference thereto, it will be noted that current flow through the electromagnet 1 is directly controlled by the contacts 11—21, whereas the contacts 39 and 41 are employed in the circuit merely to control the flow of current through one of two primary windings P—2 of a transformer T having a secondary winding S and a second primary winding P—1.

The said second primary winding is connected across the terminals of the electromagnet 1 and therefore both the electro-magnet and the primary winding P—1 is always exposed to the same varying electro-motive force. The two contact sets may be differentiated in that the contact set 11—21 is both a motor controlling contact set and a current commutating contact set for the primary winding P—1, whereas the contact set 39—41 is intended principally for the purpose of commutating the current through the primary winding P—2. A pair of condensers 47 and 48 may be employed connected as shown in the circuit of Fig. 8 to more completely eliminate the tendency toward sparking, which may occur at the two sets of contacts where precise adjustments thereof and of the adjustable weighting elements 18 and 18′ for the reeds 9 and 32 respectively are not had.

In the electrical system of Fig. 8, the alternating current generator is shown at 23′. The electro-magnet coil 1 is that of the apparatus of Fig. 4, as are also the reeds 9, 32, and 33, and the respective contact sets therefor. The transformer is provided with two like primary windings joined together at an end of each from which an electrical circuit conductor 49 extends to a pole of the source 23′ of alternating current. The other pole of the source of current leads by a conductor 50 to branching circuit conductors which are electrically connected to the reeds 8, 9 and 33, the carried contacts of which are inter-

mittently engaged, as before described by the fixed contacts 21 and 41, respectively.

When the respective circuits served by these contacts are closed thereby, alternately, as before related, current is alternately directed through the primary windings P—1 and P—2 in the opposite directions, as indicated by the arrows shown between the primary and secondary windings.

Referring now to Fig. 9, the effect of the operation of the apparatus, as previously described, and the electrical system of Fig. 8 in which such apparatus is graphically shown therein. Fig. 9 is provided with eight representations of alternating current waves, there being shown both impressed and resultant current waves and of these the uppermost wave A will be assumed to be the current wave ordinarily supplied from a generator, such as that shown at 23 when a fixed load is applied to the generator. It also represents the current wave supplied from the generator 23′ to the electrical system illustrated in Fig. 8.

The current impulses which pass from the generator 23 through the contacts 11—21, to the transformer having the primary winding P, are those shown in solid lines at *a* and *b* at B, Fig. 9, those at *a* being, we will assume, positive impulses, and those at *b* being assumed to be negative impulses. It is noted that the positive and negative impulses are alternated with respect to time, which is taken as running from left to right, Fig. 9, and that between each positive and each negative successive impulse, there is omitted a complete cycle comprising two immediately adjacent negative and positive waves.

The effect of periodically omitting a cycle of current on the wave form of resultant current is approximately diagrammatically shown at C, the magnetic lag in the transformer of the system and the inductance of the system itself, prolonging the impulses *a* somewhat.

Now the commutating contacts 39—41 of Figs. 4 and 8 effect periodic impulses of current each consisting of the dotted line, omitted cycles of alternating current shown at B. Each of these cycles comprise, as shown at D, a negative impulse *b′* and a positive impulse *a′*, immediately succeeding it, and between each cycle of impressed current supplied through the contacts 39—41, as shown at D, there is omitted, successively, negative impulses *b* and positive impulses *a* at the times as shown by the impulses *b* and *a* at B when such impulses are permitted to flow by the contacts 11—21.

The impressed current, shown at D, provided by the contacts 39—41 may be considered as being reversed in polarity, when supplied to the transformer having the secondary winding S, with respect to such secondary winding, since current flow through the contacts 39—41 passes through the primary winding P—2 (see D) in a direction which is exactly opposite to the direction of flow of impulses through the contacts 11—21 (see B), so that when considering such impressed current in connection with the impressed current through the primary winding P—1, and both in relation to the effect on the secondary winding S, it is easier to consider the impulses as being in the reversed direction, as shown by E.

By analogy to the curve shown at C, relative to the impressed current, as shown at B, the wave form of the resulting current through the winding P—2 is probably much like that shown at F, since insufficient time is provided between successive positive impulses and between successive negative impulses for the current to decay to nullity.

Considering now the resultant wave forms C and F and the impressed wave forms B and E, respectively, the impressed wave forms of B and E being combined, provide a wave, as shown at G, wherein three immediately connected positive impulses are immediately succeeded by three immediately connected negative impulses ad infinitum. Also the combination of the resultant wave forms C and F provides a wave which may be more or less like that shown at H, although this showing is exaggerated to accentuate the triple ripples at the crest of each positive and negative wave.

The wave H is that which is delivered by the secondary winding S, Fig. 8, to the electro-responsive devices such as telephone bells 26′, which are serially connected across circuit conductors leading from the said secondary winding, each bell preferably being a series with an associated condenser 27′ in accordance with common standard practice.

Having thus described my invention in certain embodiments thereof, I am aware that numerous and extensive departures may be made from the embodiments herein illustrated and described, but without departing from the spirit of my invention.

I claim:

1. In an electrical system, the combination with a source of current, a transformer, a pair of primary transformer coils and a secondary coil therefor, a pair of vibratile reeds associated therewith, current commutating means for each reed operable thereby, electro-magnetic means for actuating said reeds, both of said reeds tuned to vibrate at the same periodic rate, each of said commutating means under the control of a different reed adapted to complete a circuit to a different one of said primary coils, during a fraction of the period of each complete vibration which is different, in point of time, then the period of circuit closure effected by the other commutating means, during the remaining fraction of said period.

2. In an electrical system, the combination with a source of alternating current, a transformer having a secondary coil and a pair of primary coils inductively related thereto, a current commutator and electrical circuit conductors independently associated with each of said primary coils adapted to communicate current from the source to the associated primary coil to effect communication of impulses of current therethrough and vibratile reed means including an electromagnet receiving current from said source, and a tuned reed mechanism, for controlling the operation of the two commutators to effect communication of current from the source through one of said commutators to its associated primary coil for a fractional part of each alternating current wave and communication of current by the other commutator to its associated primary coil for the rest of each said current wave.

3. In an electrical system, the combination with a source of alternating current, a transformer having a secondary coil and a pair of primary coils inductively related thereto, a current commutator and electrical circuit conductors independently associated with each of said primary coils adapted to communicate current from the source to the associated primary coil to effect communication of impulses of current therethrough and vibratile reed means including an electromagnet receiving current from said source, and a tuned reed mechanism, for controlling the operation of the two commutators to effect communication of current from the source through one of said commutators to its associated primary coil for a fractional part of each alternating current wave and communication of current by the other commutator to its associated primary coil for the rest of each said current wave, one of said primary coils being reversed relative to its inductive effect communicated to the secondary coil by current communicated thereto from said source, relative to that communicated to the other coil therefrom.

4. In an electrical system, a source of alternating current, a primary circuit, a secondary circuit, a pair of commutators each in a separate branch of the primary circuit both leading from the source, tuned reed means to alternately cause said commutators to periodically divert current from the source to said branches, and means to relatively oppositely communicate with respect to direction of current flow the commutated current from the branches to the secondary circuit.

5. In an electrical system, a source of electrical alternating current, a pair of reeds each tuned to vibrate synchronously with the impulses of current from said source, a current supply circuit, a set of electrical contacts operable by each reed synchronously therewith independently controlling the flow of current from the source to the supply circuit, each of said reeds periodically closing a different circuit from the source to the supply circuit during alternate successive periods.

6. In an electrical system, a source of electrical alternating current, a pair of reeds each tuned to vibrate synchronously with the impulses of current from said source, a current supply circuit, a set of electrical contacts operable by each reed synchronously therewith independently controlling the flow of current from the source to the supply circuit, each of said reeds periodically modifying the current flowing from the source to the supply circuit during alternate successive periods.

7. In an electrical system, a source of periodically variable current, a pair of reeds adapted to vibrate synchronously with the impulses of current from said source, means receiving current from said source effecting vibration of said reeds, current commutating means under the control of both said reeds, a discharge circuit and an electrical circuit including said source and said commutating means for supplying modified current impulses to said discharge circuit.

In testimony whereof I hereunto affix my signature this 10th day of April, 1930.

WILLIAM C. ROE.