Nov. 8, 1938. H. A. ROSE 2,135,598

IMPULSING DEVICE FOR USE WITH GRID CONTROLLED RECTIFIERS

Filed Sept. 28, 1937 2 Sheets-Sheet 1

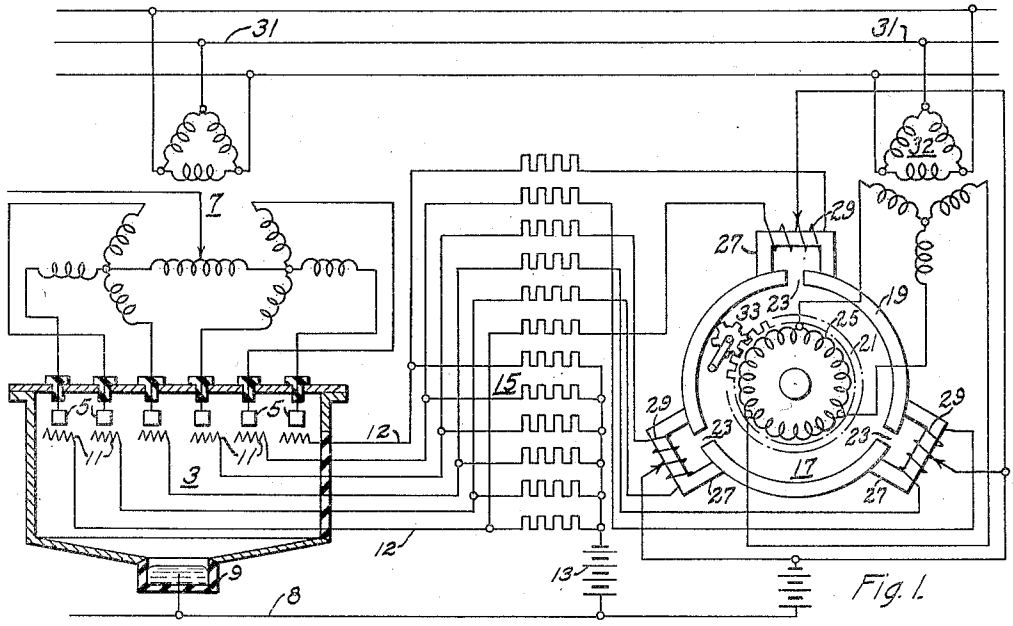


Fig. 1.

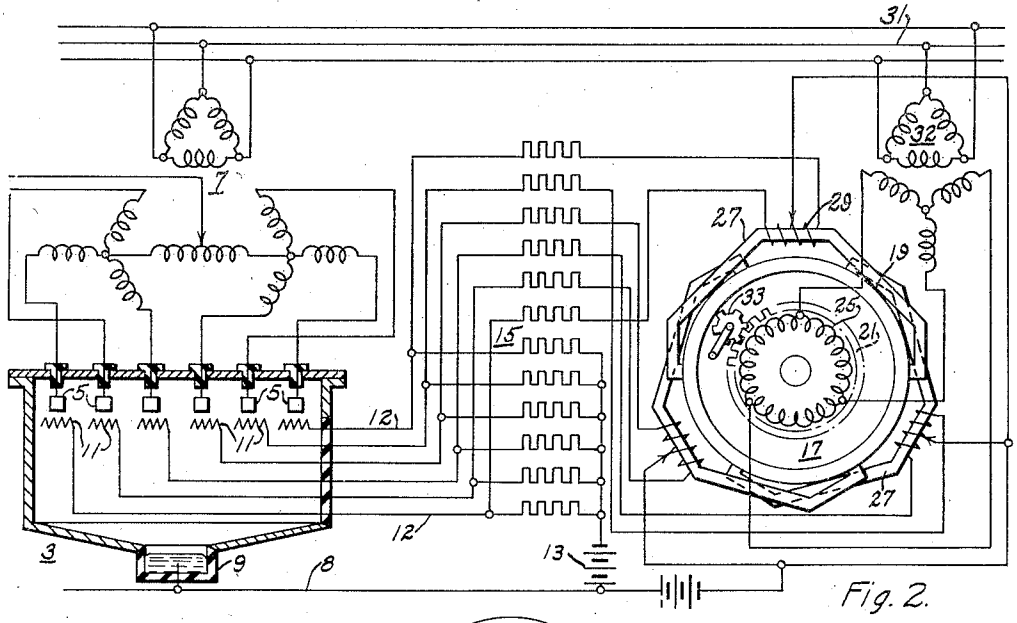


Fig. 2.

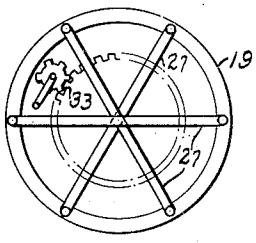


Fig. 3.

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IMPULSING DEVICE FOR USE WITH GRID CONTROLLED RECTIFIERS

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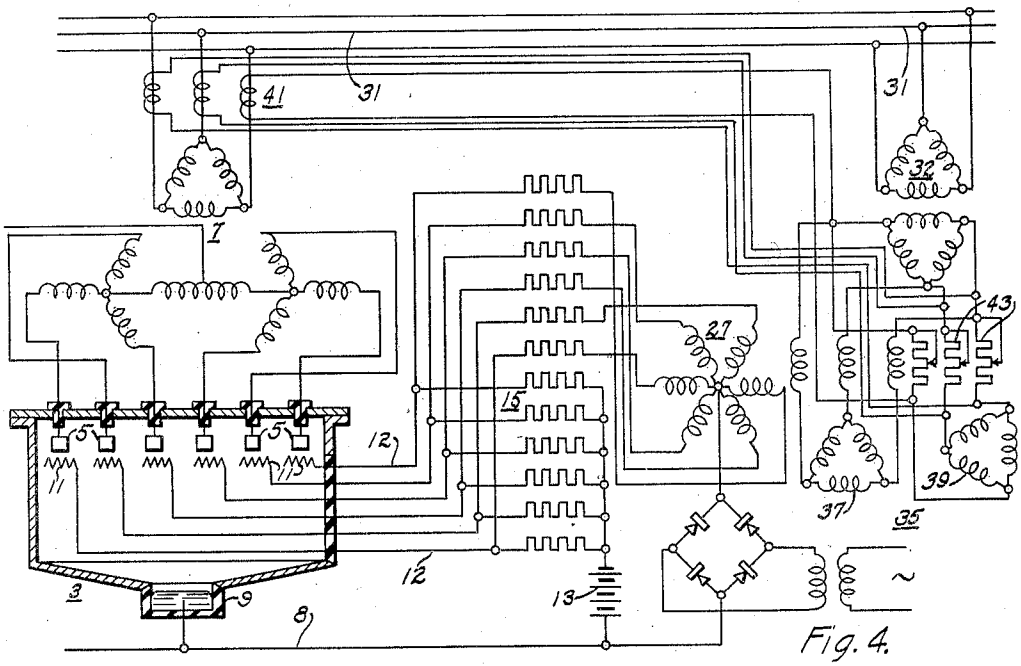


Fig. 4.

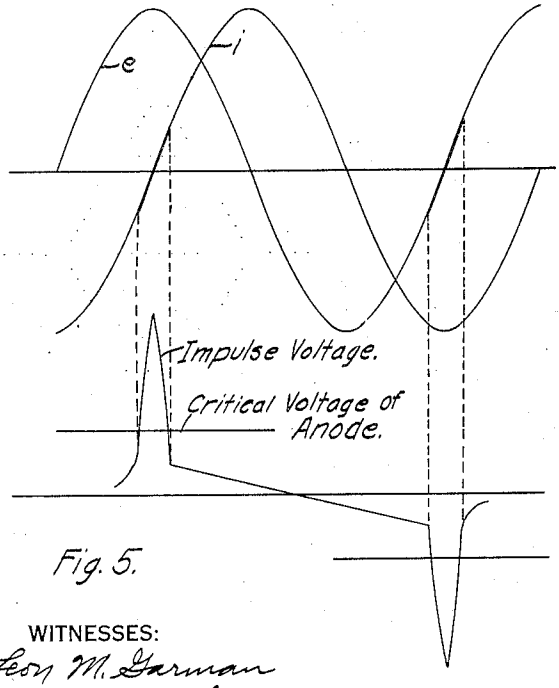


Fig. 5.

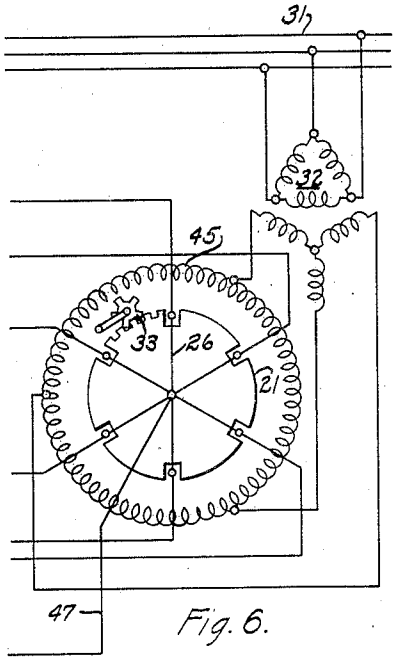


Fig. 6.

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UNITED STATES PATENT OFFICE

2,135,598

IMPULSING DEVICE FOR USE WITH GRID-CONTROLLED RECTIFIERS

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13 Claims. (Cl. 175—363)

My invention relates to grid-controlled rectifying systems, and particularly, to new and improved apparatus for exciting the control grids of such rectifying systems.

In the operation of electric valve converting systems for transmitting energy between direct and alternating-current circuits, it is customary to provide a suitable biasing potential to the control elements of such valves. The impression on the control elements of a suitable potential, which is preferably above the potential of the cathode, will prevent the cooperating anodes from picking up an arc produced in such rectifiers, as is well known to those acquainted with the art.

Heretofore, mechanical distributing apparatus and relaying means have been employed to impress a negative potential on the grids. However, it is desirable to eliminate moving contacts and other disadvantages inherent in such prior art systems in order to reduce maintenance and to improve the operating efficiency of such systems.

According to my invention, I provide a static means for obtaining a periodic control potential. Briefly, my apparatus consists of an impulsing device having an inductive member and an exciting member cooperating with it. The exciting or inducting member is like a blocked rotor of an induction motor, and hereinafter I shall use these terms interchangeably to describe my invention. Preferably the inductive member is made up of laminated silicon steel cores with a number of air gaps provided. A material having high permeability and provided with an inductive winding shunts the air gaps. A suitable source of potential is applied to the exciting winding for producing a rotating magnetic field, which results in rapid cyclic flux reversals through the various shunts. A voltage is induced, as a result, and is impressed on the control elements in a predetermined sequence.

It is, therefore, among the objects of my invention to provide an impulsing device having no moving contacts or other means liable to wear in service.

It is a further object of my invention to provide an impulsing device capable of producing voltage impulses of steep wave fronts.

Another object of my invention is to provide an impulse device in which the phase of the impulse may be shifted to produce any desired linkage.

Still further, it is an object of my invention to provide an improved electric current converting system and excitation apparatus for impressing a biasing potential on the grids of such devices in a predetermined sequence.

Other objects and advantages of my invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic illustration of a rectifying system embodying my invention;

Fig. 2 is a similar view of a modification thereof;

Fig. 3 is a plan view showing the relative position of the magnetic paths to the exciting member according to my invention;

Fig. 4 is a modification of a phase-shift winding in accordance with my invention;

Fig. 5 is a graphic illustration of the form of an impulse voltage desired; and,

Fig. 6 is a modified view of an impulsing device.

Apparatus, according to my invention, comprises an arc discharge device 3 such as a mercury-arc rectifier having a plurality of anodes 5 supplied with potential by a suitable transformer 7 and a load circuit 8 connected between the transformer 7 and the cathode 9 of the rectifier 3. Each of the anodes 5 is provided with a suitable control grid 11. Each grid 11 is, in turn, connected to a control circuit 12 having a biasing potential supplied from any desired source such as a battery 13. Suitable resistances 15 are included in the circuit to limit the flow of current.

The impulsing device 17 consists of two principal sections, the inductive or stator member 19 and the inducing or blocked rotor 21. The core of the inductive member 19 is preferably made up of laminated silicon steel provided with non-magnetic sections or air gaps 23. The number of air gaps 23 would ordinarily be one-half the number of impulse phases. In my illustration, I show three air gaps 23 and six impulse phases. The inductive member 19 has no exciting windings, as shown. Nevertheless, it is to be understood that the excited member 19 may have suitable windings to cooperate with the blocked rotor windings 25 in producing the desired phase shift and voltage changes, as I shall later point out in more detail. A saturable magnetic bridge 27 of high permeability forms a shunt path for each air gap 23 and contains an inductive winding 29. I prefer to use a material having high permeability such as "Hypernik" or "Permalloy" which saturates on low

magnetomotive forces per centimeter for the bridges 27.

The blocked rotor 21 consists of a polyphase exciting winding 25, which, when energized from a separate supply source 31, through a suitable transformer 32, sets up a revolving magntomotive force of essentially fixed value and which revolves at synchronous speed with essentially sinusoidal space distribution. The rotating magnetic field traverses the inductive winding 29 so that periodic impulses of short duration are impressed on the control grids 11.

The revolving magnetomotive force in the blocked rotor winding 25 results in a cyclic flux reversal through the various magnetic bridges 27. At the instant the direction of the magnetomotive force acting on the shunt winding 29 reverses, a rapid flux change occurs from a saturated condition of one polarity to a similar condition of opposite polarity. It can be readily understood that the magnetomotive force drop across the air gap 23 is sufficient to saturate the shunts 27 except for low values of current. The back E. M. F. of the blocked rotor 21 is supplied mainly by leakage flux changes in the air gaps 23 of both the blocked rotor 21 and the inductive member 19. For a few electrical degrees per cycle, near zero magnetomotive force at the shunts 27, a rapid flux change occurs through the magnetic shunts 27 due to its natural characteristics at low flux densities. As a consequence, a voltage impulse of steep wave front is generated in the impulse windings 29 of the inductive member 19 and impressed on the grids 11 of the rectifier 3 in a predetermined sequence.

In the modification shown in Fig. 2, I show a similar impulsing device 3. The magnetic bridges 27 are spaced 120° apart on the core of the inductive member 19. No air gaps 23 are provided in the stator core 19 as the three shunt circuits 27 are connected at opposite sides to the excited member 19 at points diametrically opposite each other. Such an arrangement is an additional improvement in that air gaps 23 are eliminated in the core of the inductive member 19. A suitable means 33 is used to adjust the position of the inducting winding 25 in order to shift the impulse voltage phase and obtain proper voltage relations for the control electrodes 11.

It is possible to place inductive windings (not shown) on the stator 19 as well as on the blocked rotor 21. However, I prefer to place the excitation winding 25 on the blocked rotor 21 and the phase shift winding (not shown) on either the stator 19 or the blocked rotor 21. Zero adjustments by manual manipulation of the blocked rotor 21 by a hand screw 33 are thus made possible, which changes the relative position of the blocked rotor 21 in respect to the stator 19 in cases where both the blocked rotor 21 and the stator 19 carry windings 25. Such an adjustment permits changes in the space phase of the resultant magnetomotive force when both or all windings 25 are placed on the blocked rotor 21. In some applications, zero adjustments are desirable especially when the equipment is first installed. In other cases, the output characteristics of the converter 3 may be readily changed.

In the modification shown in Fig. 4, I show another type of construction capable of producing similar results. The exciting member 35 has two windings 37 and 39 electrically displaced in phase relationship. One of the windings 37 is supplied with a constant potential from a suitable source of supply 31. The other winding 39, a phase shift winding, is connected to a supply source of potential 31 through suitable current transformers 41. In series with each phase of the phase shift winding 39 is placed a suitable resistance 43. With an increase in load current, the excitation on the phase shift winding 39 increases, causing the resultant magnetomotive force to vary in function of the load current. Thus, the impulse voltage characteristics of the rectifier 3 can be compounded as well as compensated for fluctations in the load.

Likewise, the phase of the resultant induced peak voltages is automatically shifted corresponding to load conditions as a result of the "compounding" characteristic.

According to the modification in Fig. 6 of my invention, the stator winding 45 is supplied with a source of potential through a suitable transformer 32. The blocked rotor 21, having a magnetic circuit of non-uniform reluctance, contains a polyphase winding 26 with proper connections to the control electrodes 11 of the rectifier 3. A connection 47 is made from the junction of the blocked motor windings 26 to the cathode 9.

When the rectifier 3 is ready to be placed in operation, a source of suitable exciting electrical energy is connected to the stator windings 45 in order to produce a revolving magnetic field. Peak voltages or periodic impulses are induced in the blocked rotor winding 26 by the narrow flux bands set up by the magnetic field and applied to the control grids 11 in a predetermined sequence. A suitable device 33, manual or semi-automatic, permits adjustment in the space phase of the resultant magnetomotive force.

While for purposes of illustration I have shown certain specific embodiments of my invention, it will be apparent that changes and modifications can be made therein without departing from the true spirit of my invention or the scope of the appended claims.

I claim as my invention:

1. In an electric current converter system comprising an electric current rectifier of the arcing type including a plurality of anodes, a cathode, control electrodes for said anodes, means for impressing a negative bias on said control electrodes, an impulsing means comprising a stator member and an exciting member, said stator member provided with a plurality of open magnetic cores, a plurality of magnetic bridges connected in shunt with adjacent stator core members, an inductive winding on said bridges, a source of potential for said exciting member, means for producing a rotating flux interlinking said stator member and said exciting member and control means for impressing voltage impulses induced in said stator winding in a predetermined sequence upon said control electrodes.

2. In an electric current converter system comprising an electric current rectifier of the arcing type, a plurality of anodes, control electrodes associated with said anodes, a cathode, means for impressing a bias on said control electrodes, apparatus for exciting said control electrodes in a predetermined sequence comprising a plurality of magnetic core members, a plurality of magnetic bridges cooperating therewith, said bridges being each provided with an inductive winding, an inducing member supplied with a source of potential, said inducing member capable of being rotated relative to said inductive windings on said bridges, and control means for

impressing induced voltages upon said control electrodes.

3. In an electric current converter system comprising an electric current rectifier of the arcing type, a plurality of anodes, control electrodes associated with said anodes, a cathode, means for impressing a bias on said control electrodes, apparatus for exciting said control electrodes in a predetermined sequence comprising a magnetic core member, a plurality of magnetic bridges placed 120° apart on said core member, said bridges provided with an inductive winding, an inducing member supplied with a source of potential, said inducing member capable of being adjusted relative to said inductive winding and control means for applying induced voltages to said control electrodes.

4. In an electric current converter system comprising, in combination, an alternating-current supply circuit, a direct-current load circuit, a vapor electric device provided with a plurality of anodes and associated control electrodes therein, a cathode, means for impressing a negative bias on said control electrodes, means for exciting said control electrodes in a predetermined sequence, said exciting means comprising a stator member, a plurality of magnetic bridges connected diametrically opposite to said stator members, said bridges provided with an inductive winding, an inducing member supplied with a source of potential, means for rotating said inducing member to shift the voltage phase and obtain proper voltage changes for said control electrodes.

5. In an electric current converter system comprising an electric current converter of the arcing type, a plurality of anodes, control electrodes associated with said anodes, a cathode, apparatus for exciting said control electrodes in a predetermined sequence comprising a plurality of magnetic core members, a plurality of magnetic bridges being each cooperating therewith, said bridges provided with an inductive winding, an inducing member supplied with a constant source of potential, a second inducing member supplied with a variable source of potential, and control means for applying induced voltages to said control electrodes.

6. In an electric current converter system comprising an electric current rectifier of the arcing type, a plurality of anodes, control electrodes associated with said anodes, a cathode, apparatus for exciting said control electrodes in a predetermined sequence comprising a stator member provided with a source of potential, a secondary member provided with a plurality of windings and control means for applying the secondary potential of peaked wave form to the control electrodes of said converter.

7. In an electric current converter system comprising an electric current rectifier of the arcing type, a plurality of anodes, control electrodes associated with said anodes, a cathode, means for impressing a bias on said control electrodes, apparatus for exciting said control electrodes in a predetermined sequence comprising a plurality of magnetic core members, a plurality of magnetic bridges cooperating therewith, said bridges provided with an inductive winding, a plurality of inducing windings electrically displaced in phase relationship, one of said exciting windings supplied with current depending on load conditions on said conversion system whereby the phase of the resultant induced peak voltages in said inducing windings is automatically varied.

8. In an electric current converter system comprising an electric current converter including a plurality of anodes, control electrodes cooperating with said anodes, a cathode, means for impressing a blocking potential on said control electrodes, apparatus for exciting said control electrodes comprising a stator member and an exciting member, said stator member provided with a plurality of open magnetic cores, a plurality of magnetic bridges shunting adjacent stator core members, an inductive winding on said bridges, said windings connected to said control electrodes in proper phase relationship, a source of potential applied to said exciting member for producing a rotating magnetic field, said exciting member capable of rotation relative to said stator member whereby a phase shift of the resultant impulse voltage is obtained.

9. In an electric current converter system comprising an electric current converter including a plurality of anodes, a cathode, control electrodes for said anodes, means for impressing a bias on said control electrodes, means for exciting said control electrodes including a transformer comprising a primary and a secondary member, said secondary member provided with a plurality of open magnetic cores, a plurality of magnetic bridges of high permeable material connected in shunt with adjacent stator core members, an inductive winding on said bridges, a source of potential for said primary member, means for shifting said primary relative to said secondary member whereby the rapid flux reversals in said secondary results in a potential of high peak wave form.

10. In a conversion system comprising an alternating-current circuit, a direct-current circuit, a plurality of electric valves interconnecting said circuits, control electrodes cooperating with said valves, an impulsing device for impressing control potential on said control electrodes, including a magnetic member having a plurality of non-magnetic sections, saturable magnetic bridges of high permeability in shunt with said non-magnetic sections, a winding for inducing a rotating magnetic field traversing said magnetic members, and inductive windings associated with said saturable bridges so that periodic impulses of short duration are impressed on said control electrodes.

11. A conversion system for transferring electric energy between an alternating-current system and a direct-current system comprising a plurality of electric valves, control electrodes in said valves, an impulsing device for impressing periodic impulses on said control electrodes, a magnetic member for said impulsing device, a plurality of phase displaced exciting windings for creating a rotating magnetic flux in said magnetic member, and means responsive to load conditions on said conversion system for varying the effective current in at least one of said exciting windings, a magnetic bridge of high permeability associated with said magnetic member in such manner as to secure periodic flux reversals therein and inductive windings interlinked with said magnetic bridges.

12. A conversion system transferring electric energy between an alternating-current system and a direct-current system comprising a plurality of electric valves, control electrodes in said valves, an impulsing device for impressing periodic impulses on said control electrodes, a magnetic member for said impulsing device, a plurality of phase displaced exciting windings for creating a rotating magnetic flux in said magnetic

member, means responsive to load conditions on said conversion system including a current transforming device whereby the effective current of said exciting windings is varied in such manner as to secure periodic flux reversals therein.

13. An electric impulse generating device consisting of a primary member and a secondary member, a winding on said primary member excited from a source of alternating current and arranged to produce a rotating magnetomotive force, said secondary member having a magnetic circuit of non-uniform reluctance including a plurality of core members, a plurality of bridges connected in shunt with adjacent core members, and a winding on each of said bridges whereby voltages of peak wave form are produced by said rotating magnetomotive force.

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