April 18, 1939. M. KNOBEL 2,154,627

APPARATUS FOR PRODUCING RECIPROCATORY OR VIBRATORY MOTION

Filed June 1, 1938

Fig. 1.

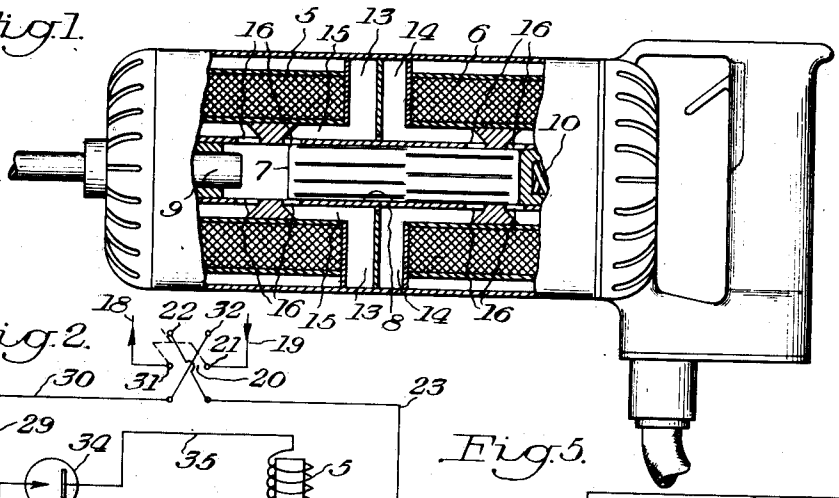


Fig. 2.

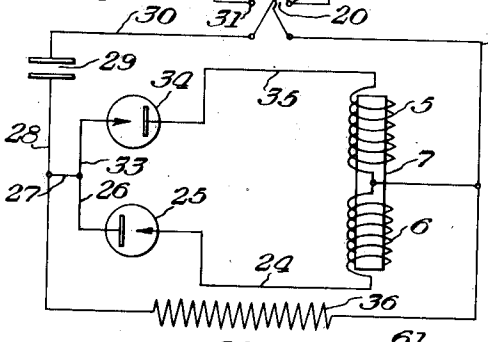


Fig. 5.

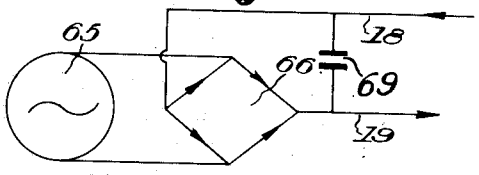


Fig. 3.

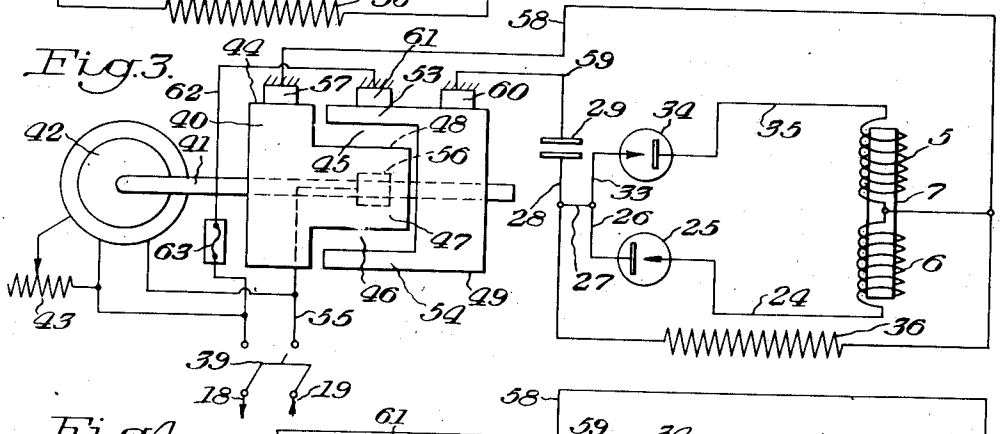
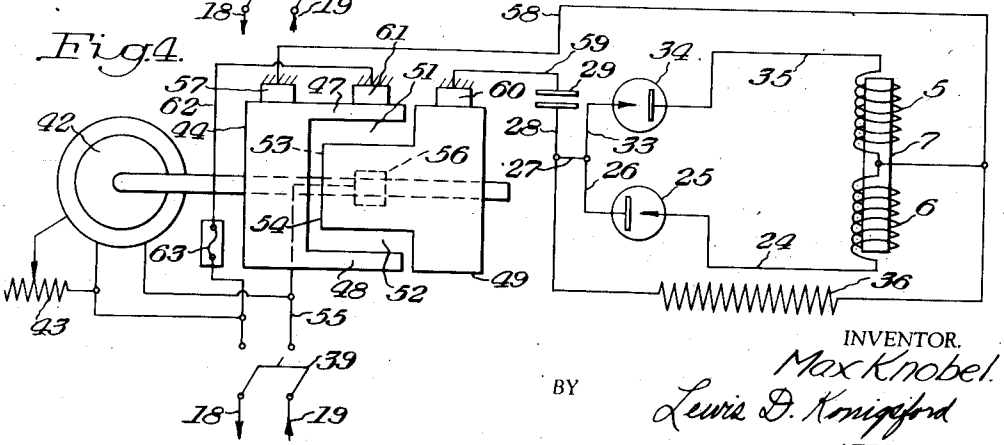


Fig. 4.



INVENTOR.
Max Knobel.

BY
Lewis D. Konigsford
ATTORNEY.

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APPARATUS FOR PRODUCING RECIPROCATORY OR VIBRATORY MOTION

Max Knobel, Arlington, Mass., assignor to Syntron Company, Homer City, Pa., a corporation of Delaware

Application June 1, 1938, Serial No. 211,169

5 Claims. (Cl. 172—240)

This invention relates to a control system for two coil reciprocating motors such as are utilized for operating electric hammers, screens, conveyors or the like, and relates particularly to a system in which electric current from any suitable source is converted into current pulsations of desired frequency separated by zero intervals for alternately energizing the coils of the motor. The invention will be described particularly with relation to an electric hammer, but it will be understood that the invention is not limited thereto.

It is an object of this invention to control the rate of reciprocation or vibration of an electrically operated vibratory reciprocatory or oscillatory apparatus having two coils by supplying alternately to said coils current impulses of desired frequency obtained from a unidirectional current source or from an alternating current source of different frequency.

A further object is the provision of a reciprocating or vibrating motor operating system which is highly efficient in producing divided current impulses of any desired frequency separated by zero intervals, and in which destructive sparking is obviated.

A further object is the production of a reciprocating or oscillating magnetic field from a source of unidirectional current.

Figure 1 is a view partly in section showing a preferred type of reciprocating motor,

Figure 2 is a wiring diagram illustrating the principle of the present invention,

Figure 3 is a schematic view illustrating a preferred modification,

Figure 4 is a view similar to Figure 3, showing the reversing switch in its reversed position, and

Figure 5 is a diagrammatic view showing the manner of applying the invention to a source of alternating current.

Referring to the drawing, Figure 1, there is shown an electric hammer comprising two operating coils 5 and 6, a movable piston or core 7, a barrel or guide 8 for the coil and a tool 9 that is struck by the core to do useful work, a shock absorbing spring 10 being provided to reduce the shock on the returned stroke. The coils 5 and 6 may be provided with magnetic circuits including soft iron end laminations 13 and 14 and middle laminations 15. The laminations are provided with pole tips 16 that extend into openings in the barrel 8 to within a few thousandths of an inch from the inner surface thereof which guides the movement of the core 7. The magnetic flux passing between the pole tips in the magnetic circuit of each coil acts upon the core to effect its actuation in each direction.

Referring to Figure 2, there is diagrammatically shown a circuit for operating the hammer from a source of direct current in accordance with the present invention. Direct current is supplied from any suitable source by lead mains 18 and 19 to the reversing switch indicated generally by the numeral 20. In one position of the switch current passes between the terminals 21 and 22 and by wire 23 to the coil 6 of the hammer, then by wire 24 through the rectifier 25 and by wires 26, 27 and 28 to charge the condenser 29, the opposite charge on the condenser passing off through wire 30 and terminals 31 and 32 of the switch 20. The current flowing through coil 6 produces a magnetic impulse that moves the hammer piston 7 in one direction. When condenser 29 is fully charged the current ceases to flow through coil 6 and after a predetermined time interval the switch 20 is reversed by connecting terminal 22 with terminal 31 and terminal 32 with terminal 21. The condenser 29 is then discharged through wires 28, 27 and 33, rectifier 34, wire 35, coil 5 and wire 23, and is simultaneously oppositely charged through wire 30, the current ceasing when the condenser is charged. The condenser discharging current through coil 5 produces a magnetic impulse that moves the hammer piston 7 in the opposite direction. Shunt resistance 36 is provided to assist commutation.

It will be apparent that the reversing switch 20 is reversed after each charging operation of the condenser during the period that the current is zero so that sparking is substantially eliminated. One current impulse, for example, the condenser charging current passing through coil 6, moves the piston 7 in one direction while the other current impulse passing through the coil 5 moves the piston in the opposite direction. Hence, there is one stroke for each current impulse. Any suitable type of rectifier may be used, such as copper sulphide or copper oxide disks, mercury vapor or thermionic tubes, suitable exciting or heating circuits being provided for the rectifiers where required.

In Figures 3 and 4 I have diagrammatically shown a preferred system employing a rotary reversing switch which is automatically operated to produce current impulses through the coils separated by predetermined zero intervals. The commutator or reversing switch 40 on shaft 41 is driven by a motor 42 which is operated at constant speed by current supplied from mains 18 and 19 through switch 39, a resistor 43 being provided to control or vary the speed of the motor as desired. The commutator 40 comprises a cylindrical conductor 44 which is cut out at 45 and 46 to provide conductor strips 47 and 48 connected to cylindrical portion 44. A similar member on the shaft 41 has a cylindrical conductor 49 having ample cutout portions 51 and 52 to provide conductor strips 53 and 54 connected to cylindrical conductor 49. One lead 39 from the direct current source connects by a wire 55 with a brush 56 in the commutator case which

is in contact with conducting strip 48 (concealed by conductor strip 47 in Figure 3, and the current is conducted by strip 48 and cylinder 44, brush 57 and wire 58 to the coil 6 and by wire 24 to rectifier 25, thence by wires 26, 27, and 28 to the condenser 29 to charge the same, any opposite charge on the condenser passing off by wire 59, brush 60, cylindrical conductor 49, strip conductor 53, brush 61, wire 62, through fuse 63 to the main 18. The rotation of the commutator is timed to disconnect brushes 56 and 57 and connect brushes 56 and 60 through conductor strip 53 and cylindrical conductor 49 at a predetermined interval after condenser 29 is charged as shown in Figure 4. This allows the condenser 29 to discharge through wires 28, 27 and 33, rectifier 34, wire 35, coil 5, wire 58, brush 57, conductors 44 and 47, brush 61, wire 62 and fuse 63, and at the same time condenser 29 receives an opposite charge from wires 19 and 55, brush 56, conductors 53 and 49, brush 60 and wire 59.

In the system herein described it is desirable that the timing be such that the current falls to zero at the time of commutation in order to eliminate sparking. The arcuate spacing of conductor strips 47 and 48 and of 53 and 54 should be sufficiently wider than the brushes to prevent sparking. If the condenser 29 is too small the efficiency drops off sharply. The condenser value is not very critical and by employing a larger condenser the peak current does not increase as rapidly as with a smaller condenser and therefore a condenser is employed which is large enough to produce a current of sufficient duration to obtain the desired energy in the armature. With a condenser producing the desired duration of current, sparking can be eliminated by reducing the number of turns in the coils 5 and 6 of the motor.

For example, one satisfactory set of operating conditions for operating a hammer supplies 160 volts direct current and using an average current of 1.05 amperes, a 16 microfarad condenser may be employed, the commutator being operated to give 60 cycles per second. The hammer will provide 3600 impacts per minute. The motor 42 need be large enough only to operate the commutator, which may be of conventional design with the usual brushes. Any suitable type of rectifier may be employed, for example, a thermionic vacuum tube rectifier, dry disk copper oxide or copper sulphide rectifiers, or any other suitable type. Any desired condenser may be employed for a relatively large range of operating conditions.

The invention may be used for converting an alternating current of any frequency into a pulsating current of any predetermined frequency. A modification by which this is accomplished is shown in Figure 5. Alternating current from any suitable source 65 passes through a bridge rectifier 66 to provide direct current in wires 18 and 19, which are connected to switch 39 in Figures 3 and 4. A filter condenser 69 may be connected across wires 18 and 19. Preferably, the motor 42 is replaced by a synchronous motor operating from the alternating current source and the commutator 40 may be geared to the motor to rotate at any desired speed. Thus, for example, current from a 60 cycle source may be converted into 25, 30, 50 or any other desired number of pulsations per second, the number of the blows of the hammer being two times the revolutions per minute of the reversing switch.

What I claim and desire to secure by Letters Patent is:

1. A reciprocatory motor comprising two coils, a condenser associated with said coils, an armature adapted to be moved in one direction by the magnetic field produced by one of said coils, and moved in the opposite direction by the magnetic field produced by the other of said coils, two oppositely arranged rectifiers, each in series with the condenser and a coil, a source of direct current and means for reversely connecting said source with the condenser through one of said coils and rectifiers.

2. A reciprocatory motor comprising two coils, a condenser associated with said coils, an armature adapted to be moved in one direction by the magnetic field produced by one of said coils and moved in the opposite direction by the magnetic field produced by the other of said coils, two oppositely arranged rectifiers each in series with the condenser and a coil, a source of direct current, a reversing switch connecting said source with the condenser through one of said coils and rectifiers, and automatic means for reversing said switch connections to discharge said condenser through the other of said coils and rectifiers.

3. A reciprocatory motor comprising two coils, a condenser associated with said coils, an armature adapted to be moved in one direction by the magnetic field produced by one of said coils and moved in the opposite direction by the magnetic field produced by the other of said coils, two oppositely arranged rectifiers each in series with the condenser and a coil, a source of direct current, a reversing switch connecting said source with the condenser through one of said coils and rectifiers, and automatic means for reversing said switch connections to discharge and recharge said condenser to opposite polarity through the other of said coils and rectifiers.

4. A reciprocatory motor comprising two coils, a condenser in series with each of said coils, an armature adapted to be moved in one direction by the magnetic field produced by the other of said coils and moved in the opposite direction by the magnetic field produced by the other of said coils, two oppositely arranged rectifiers each in series with the condenser and a coil, a source of direct current, a rotary reversing switch connecting said source with the condenser through one of said coils and rectifiers, and a motor for operating said switch for reversing the switch connections to discharge and recharge said condenser to opposite polarity through the other of said coils and rectifiers.

5. A reciprocatory motor comprising two coils, a condenser in series with each of said coils, an armature adapted to be moved in one direction by the magnetic field produced by one of said coils and moved in the opposite direction by the magnetic field produced by the other of said coils, two oppositely arranged rectifiers each in series with the condenser and a coil, a source of alternating current, a full wave rectifier system for converting the alternating current into unidirectional current, a rotary reversing switch connecting said direct current source with the condenser through one of said coils and rectifiers, and a motor for operating said switch at a predetermined speed to disconnect one coil from the source of direct current and discharge and recharge said condenser to opposite polarity through the other of said coils and rectifiers.

MAX KNOBEL.