

Jan. 8, 1952

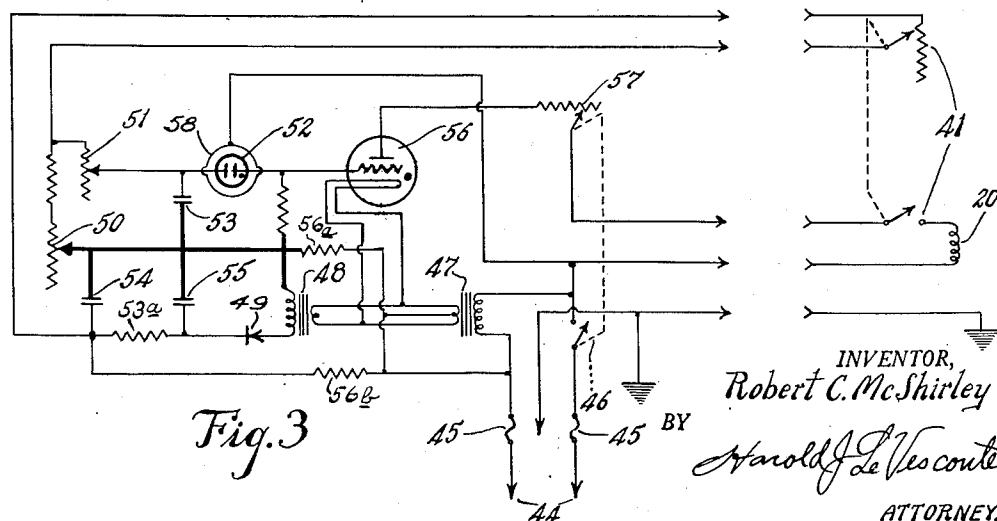
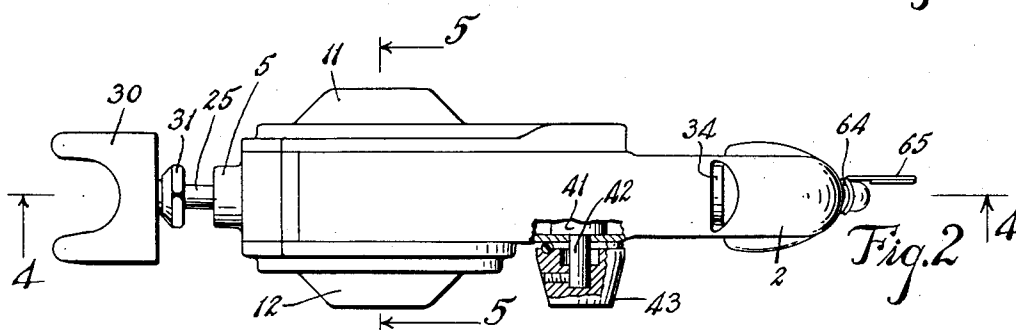
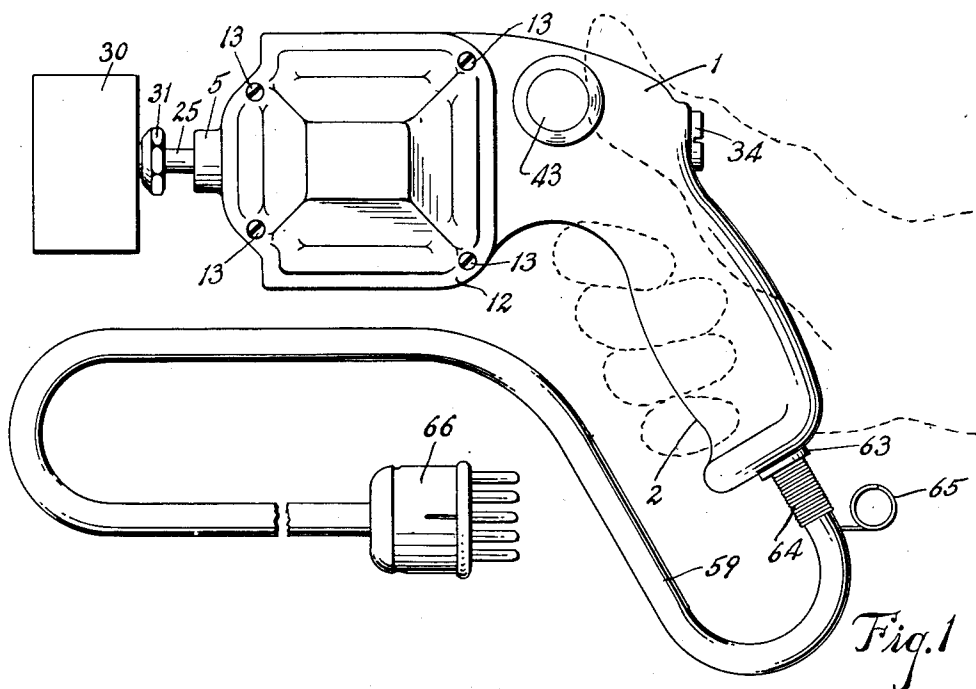
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2,581,806

POWER SUPPLY MEANS FOR PERCUSSOR APPARATUS

Filed March 5, 1948

2 SHEETS—SHEET 1



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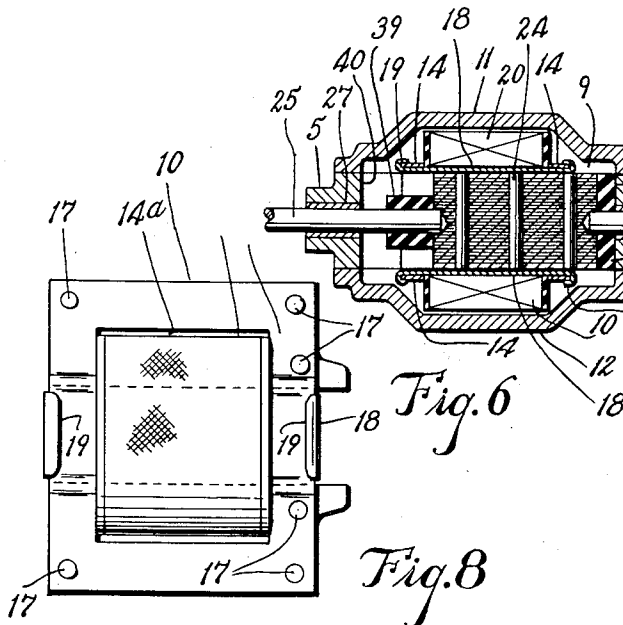
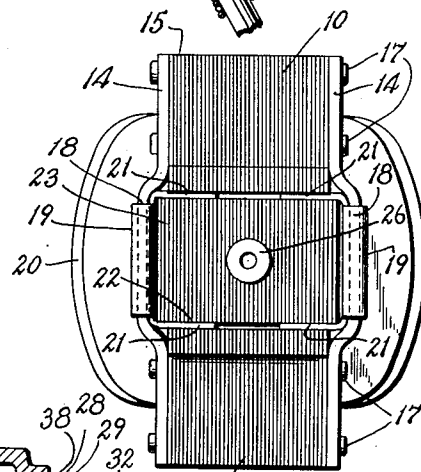
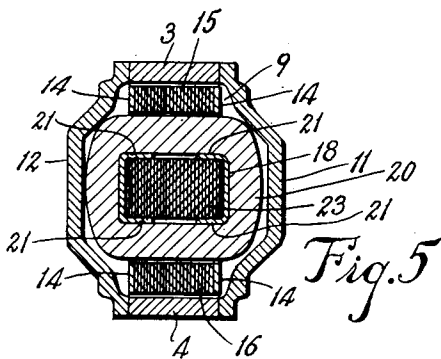
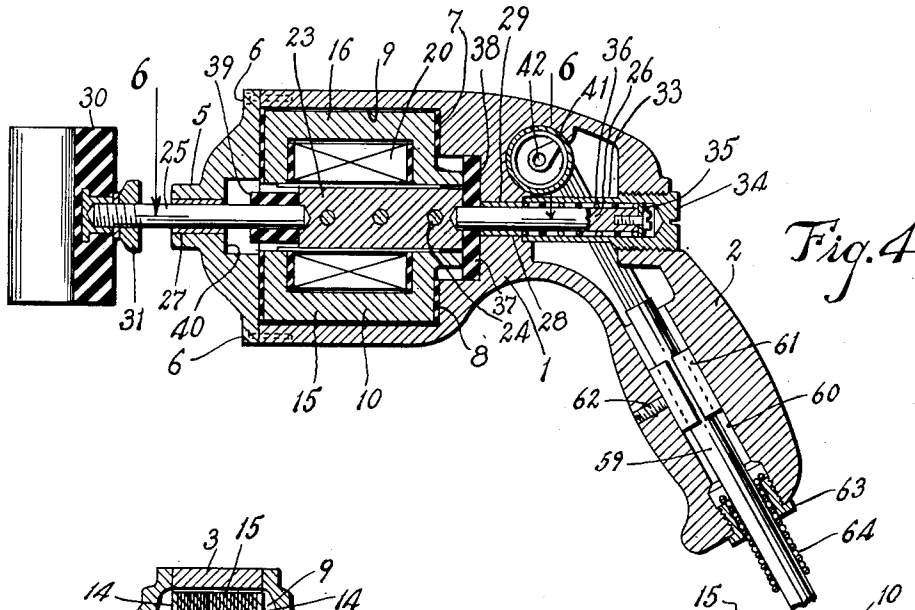
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POWER SUPPLY MEANS FOR PERCUSSOR APPARATUS

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2 SHEETS—SHEET 2



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UNITED STATES PATENT OFFICE

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POWER SUPPLY MEANS FOR PERCUSSOR APPARATUS

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3 Claims. (Cl. 318-130)

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This invention relates to percussors for use in physiotherapy and particularly to a form thereof in which the percussions are produced by a reciprocating motor means energized by an electric current controlled by electronic means.

Heretofore, percussors (also known in the art as "concussors") have been used in which a rotary motor delivered mechanical impulses to an applicator held in contact with the body of the patient, but such devices employ a crank or cam to convert the rotations into the movement imparted to the applicator; such movement being more like a vibratory movement than a true percussive movement. Such devices have not been as satisfactory as might be due to the fact that the mechanical linkage that converts the rotary motion into linear motion produces a slowing up of the rate of linear motion as the crank or cam passes over center and begin its retractive movement. As a result, the applicator does not impart the sharp, quick blow or stroke which is essential to the realization of maximum benefits from percussion techniques. Additionally, such devices have lacked the optimum range of speeds or the ability to deliver true percussive strokes at both high and low frequencies as well as the capacity for independent variation of the force with which percussive strokes are delivered and of the rate of percussion.

With the foregoing considerations in mind, it is an object of the present invention to provide an electrically operated percussor for therapeutic purposes in which the body-contacting implement (hereinafter designated as "applicator") is moved at a substantially uniform rate of speed throughout the extent of any length or frequency of percussive stroke.

Another object of the invention is to provide an electrically operated therapeutic percussor in which both the frequency of percussive strokes and the force applied at each stroke can be independently varied.

Still another object of the invention is to provide an electrically operated percussor for therapeutic purposes in which the percussive strokes are produced by a reciprocating motor mechanism energized by an electrical system employing a thermionic tube.

A still further object of the invention is to provide an electrically operated percussor for therapeutic purposes in which the applicator and its actuating motor are carried by a freely dirigible hand piece electrically connected to a power source and in which a single control on said hand piece controls both a power circuit and a control circuit.

A still further object of the invention is to provide a percussion producing instrumentality for therapeutic purposes in which the individual strokes of the body-contacting element are derived from electrical impulses of less duration in time than the time required for each stroke and in which each stroke is completed by the kinetic energy imparted to the element by the said impulses.

A still further object of the invention is to provide an electrically operated percussion apparatus having the above desirable characteristics composed of few parts and which is so constructed and arranged as to be of small size and, consequently, is readily portable and, further, is reliable in operation and economical to manufacture.

With the above objects in view together with such additional objects and advantages as may hereinafter appear, the invention resides in the parts, and in the construction, combination, and arrangement of parts, which, by way of example, is hereinafter described and illustrated in the accompanying drawings, in which:

Fig. 1 is a side elevation of the hand piece of the apparatus carrying one form of commonly used applicator,

Fig. 2 is a top plan view of the hand piece shown in Fig. 1,

Fig. 3 is a circuit diagram of an electric circuit which is adapted to serve as a source of power for the motor means carried by the hand piece,

Fig. 4 is a longitudinal, sectional, side elevation of the hand piece taken on the line 4-4 of Fig. 2,

Fig. 5 is a transverse sectional view taken on the line 5-5 of Fig. 2,

Fig. 6 is a fragmentary, longitudinal, sectional view taken on the line 6-6 of Fig. 4,

Fig. 7 is an enlarged front elevation of the reciprocating motor means carried by the hand piece of the apparatus, and

Fig. 8 is a side elevation of the field assembly of the motor means.

Referring to Figs. 1, 2, and 4 to 7 inclusive of the drawings, the hand piece of the apparatus comprises a pistol-shaped frame member 1 having a hand grip portion 2, said frame member being formed of non magnetic metal or from a suitable plastic material. The distal end of the frame is formed of spaced, forwardly projecting, members 3 and 4, the free ends of which are connected by an end plate 5 secured thereto by screws 6. The opposed inner surfaces of the members 3 and 4, the inner face of the end plate 5, and the shoulders 7 and 8 at the rear ends of the members 3 and 4 combine to define a cavity

or space 9 in which the motor field assembly 10 is mounted. Cover plates 11 and 12 secured to the sides of the frame 1 by screws 13 serve to complete the enclosure of the motor field assembly 10 within the space or cavity 9.

The field assembly 10 comprises rectangular side plates 14 having rectangular openings 14a and two opposed pole pieces 15 and 16 formed of shallow U-shaped laminations of soft iron extending between said side plates and having their extremities facing each other as best shown in Fig. 4; the side plates and pole laminations being secured together by a series of rivets 17 passing therethrough. Extending between the portions of each side member between the opposed free ends of the pole pieces are coil supporting plates 18 secured to the side members 14, 14 by tabs 19 bent over the edges of the side members. A coil 20 is carried by these members and extends outwardly through the openings 14a as best shown in Figs. 5, 6, and 8 and the inturned flanges 21 and the ends of the pole pieces 15 and 16 serve to define a passageway 22 in which the motor armature 23 reciprocates.

The armature 23 comprises a series of laminations of rectangular soft iron plates disposed in planes parallel to the planes of the pole laminations and secured together by rivets 24. Brazed or similarly secured to one end of the armature 24 is a bearing rod 25 of stainless steel or other non-magnetic material and similarly secured to the opposite end of the armature is a second bearing rod 26 formed of magnetic material; both of said rods being disposed on the same axial line. The rod 25 is mounted for reciprocation in and extends through a bearing bushing 27 mounted in the end plate 5 and the rod 26 is similarly mounted in a bearing bushing 28 mounted in a bore 29 in the frame 1; both of said bushings being so located that the armature is free to reciprocate in the passageway 22 closely adjacent to but without touching the coil supports 18, 18. The rod 25 at its distal end is threaded to receive an applicator 30 and a lock nut 31. The applicator may be any one of several forms; the form illustrated being formed of resilient rubber and being U-shaped in cross section as best shown in Fig. 2. As is common practice, different forms of applicators may be interchanged for various types of treatment.

The bore 29 extends from the rear side of the frame member 1 and the rear portion is counter-bored as at 32 to provide clearance for a spring guiding sleeve 33 surrounding the bar 26 and terminating in a screw portion 34 threaded into the outer end of the counterbore 32. Surrounding the bar 26 and bearing against the end of the bushing 28 and the head of a screw 35 carried by the end of the bar 26 is a compression spring 36 tending normally to hold the armature 23 and its supporting bars 24 and 26 moved to one end of its stroke partly out of the magnetic field of the field assembly against a resilient buffer pad 37 seated on a surface 38 of the frame member 1 normal to the axis of the bar 26 and forming the rear end of the cavity 9. The extent of forward movement of the armature and the supporting bars under the influence of the magnetic field created by energization of the field assembly is limited by a buffer in the form of a resilient collar 39 mounted on the bar 25 adjacent the armature and adapted to engage the bottom 40 of a recess formed in the inner face of the end plate 5.

Also mounted in the frame member 1 adjacent the motor-containing cavity 9 is a combined

switch and rheostat assembly 41 actuated by a shaft 42 projecting through the side wall of the frame member and carrying a control knob 43 so located as to be readily accessible to the thumb of the user as best shown in Fig. 1. The switch controls the flow of actuating current to the field coil 20 and the rheostat assists in varying the voltage in the control circuit in a manner hereinafter to be described. As is usual in such constructions, the rheostat, preferably, is ineffective until the knob and shaft have been rotated sufficiently to close the switch.

The power supply apparatus, illustrated diagrammatically in Fig. 3, includes a connection to a source of alternating current 44 with interposed fuses 45, 45. This circuit is opened and closed by a switch 46 and the primary side of a step down transformer is connected in series with the switch 46 and the power source 44. The secondary side of the transformer 47 is connected in series with the primary side of a step up transformer 48 and the secondary winding of the transformer 48 is connected to the input side of a half wave rectifier 49; the output side of which is filtered by condensers 54 and 55 and resistance unit 53a to provide direct current to a voltage dividing circuit controlled in varying degrees by the rheostat 41 in the hand piece and the rheostat 50 in the power supply unit. The rheostat 51 is connected in series with one side of a gas filled diode 52 across which current will not flow until a predetermined voltage is built up in the condenser 53. The other side of the tube 52 is connected to the grid of a gas filled rectifier tube 56, the plate of which is connected in series with the motor field coil 20 with the interposed rheostat 57 which is mechanically connected to the switch 46. Resistance units 56a and 56b connected across the power source 44 are provided to impose a bias on the cathode of the tube 56. Additionally, a lead connected to one side of the power source terminates in a loop 58 surrounding the exterior of the tube 52.

The effect of this loop is to create an electrostatic field in the vicinity of the electrodes of the tube 52 with incident concentration of the lines of force within the tube and thus operating at each cycle to lower, momentarily, the voltage at which the tube will allow current to flow; such momentary or periodic lowering reaching its greatest effect at the top of the cycle when the voltage in the power source 44 is greatest. As the voltage across the tube 52 increases due to the gradual charging of condenser 53 the breakdown point of the tube 52 is being momentarily lowered at the same instants that the voltage peaks in the power source occur. Thus, the time at which current will flow across the electrodes of the tube 52 to the grid of the tube 56 is reached at the instant of maximum voltage in the power source 44, "firing" the tube 56 with resultant flow of current from the power source across the tube 56 and through the rheostat 57 to the field coil 20 and thence back to the power source until the cycle reverses at which time the current will cease to flow across the tube 56 until it is "fired" again.

The hand piece is connected to the power supply unit by a multiple wire flexible cable 59 containing five wires, one of which is a ground connection, two of which are connected to opposite sides of the switch operated by the knob 43 and complete the circuit to the field coil 20 and the other two of which are connected to opposite sides of the rheostat 41 operated by the knob 43.

The cable extends up through a bore 60 in the hand grip and midway of the length of the bore and cable carries a split clamp collar 61 adapted to be compressed and caused to grip the cable by a set screw 62 threaded into the hand grip 2. The bore 60 at the end of the hand grip is threaded to receive a nut 63 and an associated coil spring 64 surrounding the cable and the spring is provided with a loop 65 formed by bending one of the coils thereof out of the axial line of the spring whereby the hand piece may be suspended from a hook when not in use. At its other end, the cable is provided with a conventional multiple contact plug 66 adapted to be inserted into a corresponding receptacle carried by the power supply unit with incident completion of the circuits extending between the power supply and the hand piece. This is desirable to facilitate the packing of the units for transport, but it is not absolutely necessary, since the cable may be permanently connected to the power supply, if desired.

The energizing current is applied to the coil 20 at the instant that the maximum power source voltage occurs, and is applied only during the remainder of the half cycle in which the tube 56 is fired. Thus it will be realized that the power impulses delivered to the coil 20 are of extremely short duration; being little if any more than a quarter cycle in extent and in the case of 60 cycle current, this would amount to about $1/240$ of a second.

By adjustment of the rheostats 41, 50 and 51, the rate of charging of the condenser and of the resultant firing of the tube can be varied from 3600 times per minute to rates which may be as low as 60 times per minute, and in each instance, the maximum voltage available will be applied to the coil 20. The location of the switch and rheostat unit in the hand piece permits the operator to start and stop the motor means and to vary the frequency of percussion at will during the treatment of a patient without the necessity of turning away to the power supply for that purpose.

As above explained, at each impulse, the armature and the applicator are moved suddenly forward, but the impulse is terminated before the movement is completed. However, the mass of the armature and the applicator provide the necessary kinetic energy to continue the forward movement initiated by the impulse until it is stopped by contact with the patient or with the buffer 39 at which time the spring 36 will start the return movement. At such adjustment of the control circuit that the tube 56 is fired at the higher frequencies, the successive impulses may be delivered before the preceding return movements are completed and, in effect, reduce the length of stroke.

While, visually, these high frequency movements may seem to resemble simple vibration, they are in fact true percussive movements in that the forward movement is at a more rapid rate than the return movement. Regardless of the frequency, the nature of the movement is much like that which would be obtained if the rear end of the rod 26 were to be repeatedly struck with a hammer to produce the forward movement.

The advantages of manual percussion massage techniques to stimulate the flow of blood and lymph and for other therapeutic purposes are well known but, heretofore, no device has been available that would closely approximate the effect of

manual percussion with its capacity for variation of both force and frequency of stroke. The present invention not only achieves this desirable result, but also, can continue these movements over periods of time and at frequencies that would be impossible to continue or to achieve manually.

It will be understood that the particular form of operating circuit illustrated is by way of example only, and that any other circuit which will deliver equivalent impulses to the operating motor means and which can be controlled from a freely dirigible hand piece carrying the motor and the applicator shall be considered as the equivalent of the above illustrated and described circuit in the combinations hereinafter claimed.

It will also be appreciated that while the power supply circuit above described may find its greatest usefulness in the actuation of therapeutic instruments, it is also capable of use as a power supply for any device in which an electrically derived, percussive movement is desired.

While I have shown and described one form of execution of my invention, I do not limit myself to the exact combination disclosed, and the invention includes such modifications of the parts and their equivalents, and of the construction, combination, and arrangement thereof, as come within the purview of the appended claims.

I claim:

1. A power supply unit for a percussion apparatus having a reciprocable, solenoid actuated element; said unit comprising an input lead attachable to a source of alternating current, an output lead attachable to the actuating coil of a percussion apparatus, and means electrically interconnecting said leads and operative to convert input alternating current into an output current comprising a succession of separate, unidirectional, electrical impulses; said means comprising a thermionic rectifier tube having a grid, a cathode, and an anode; said cathode being connected to said input lead and said anode being connected to said output lead, a half wave rectifier interposed between said input lead and said grid, a diode comprising a pair of spaced electrodes in a gas filled envelope connected in series between said half wave rectifier and said grid, and means for intermittently reducing the resistance of said diode comprising a conductor having one end thereof connected to said input lead and having the other end thereof terminating in a loop spaced from and surrounding said diode in the region of said electrodes and effective at the instants of peak voltages of input alternating current to create an electrostatic field in the region of said electrodes with resultant reduction of the resistance between said electrodes and initiation of current flow from said half wave rectifier to said grid at such peak voltage instants.

2. A power supply unit for actuation of a percussion apparatus of the type having a reciprocable, solenoid actuated element; said power supply unit including means for converting input alternating current into a succession of separate, unidirectional electrical power impulses and comprising an input lead attachable to a source of alternating current, an output lead attachable to the solenoid coil of a percussor apparatus, a thermionic rectifier tube having a grid, a cathode and an anode; said anode being electrically connected to said output lead and said cathode being electrically connected to said input lead, a half wave rectifier including a condenser electrically interconnected between said

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input lead and said grid, a diode including a pair of electrodes enclosed within a gas filled envelope connected in series between said half wave rectifier and said grid, and means electrically connected to said input lead and having a portion thereof positioned adjacent to said diode effective to create an intermittent electrostatic field in the region of said electrodes which field reaches its maximum intensities at the peak voltages of input current with resultant momentary reductions of the resistance of said diode to values below the capacitance of said condenser and consequent initiation of current flow to said grid only at the instants of peak voltages of input current.

3. A power supply unit for actuation of a percussion apparatus of the type having a reciprocable, solenoid actuated element; said power supply unit including means for converting input alternating current into a succession of separate, unidirectional electrical power impulses and comprising an input lead attachable to a source of alternating current, an output lead attachable to a percussor apparatus, a thermionic rectifier tube having a grid, a cathode connected to said input lead and an anode connected to said output lead, a half wave rectifier including a condenser electrically connected between said input lead and said grid; said condenser being connected to be charged by successive positive half cycles of input current passing through said half wave rectifier, a diode comprising a pair of spaced electrodes enclosed in a gas filled envelope connected in series between said half wave rectifier and said grid; said diode normally having a resistance greater than the potential of said condenser when fully charged, and means for mo-

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mentarily reducing the resistance of said diode to a value slightly less than the maximum potential of said condenser; said resistance reducing means comprising a lead connected at one end to said input lead and terminating at its other end in a loop surrounding the envelope of said diode and effective to create an intermittent electrostatic field about said diode; said field reaching its maximum intensities at the peak voltages of input current with consequent momentary reductions of the resistance of said diode at such peak voltages and initiation of current flow from said condenser across said diode to said grid only at or near such peak voltages and resultant firing of said tube and flow of current from said cathode to said anode during the remainder only of such positive half cycle of input current.

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