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CONTROL SYSTEM FOR INDUSTRIAL VIBRATING MACHINERY

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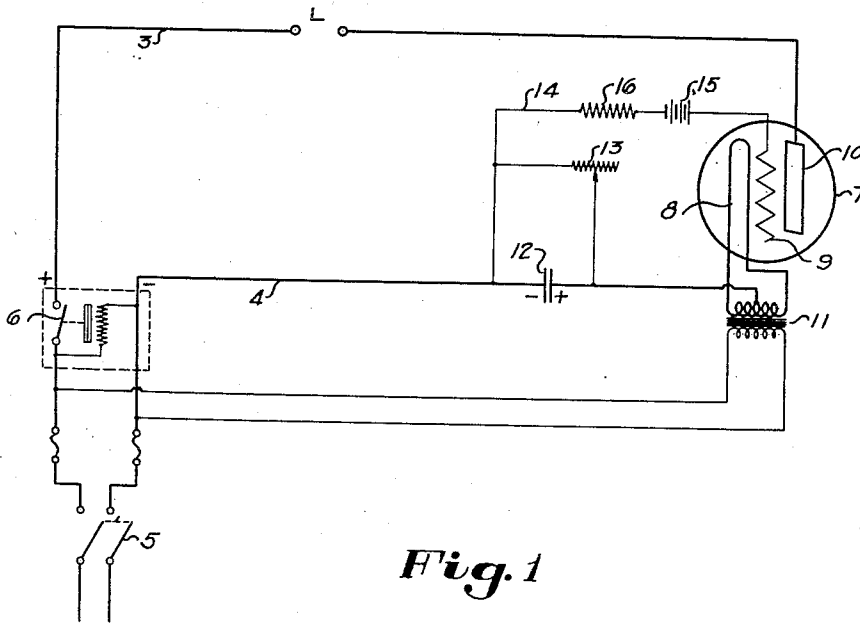


Fig. 1

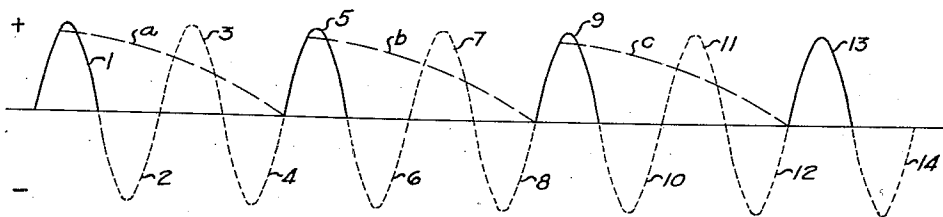


Fig. 2

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CONTROL SYSTEM FOR INDUSTRIAL
VIBRATING MACHINERYDudley B. Clark, Palm Springs, Calif., assignor of
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2 Claims. (Cl. 250—27)

This invention relates to a control system for industrial vibrating machinery.

In an effort to secure a power supply of low frequency, from commercial lines, for the purpose of operating heavy vibrating screens, conveyors, barrel packers, electric hammers, etc., control systems have heretofore been devised which reduce the number of electrical impulses taken from an alternating current source of public utility frequencies.

These systems fail to take into consideration the fact that they must be maintained under other than laboratory conditions, and by persons who are not accustomed to the adjustment of electron tubes, which form the principal parts of these control systems.

It is a primary object of the present invention, accordingly, to provide a control system which is of a simple, rugged, easily operable design, and from which parts of complicated and delicate construction are eliminated.

A further object of the invention is to provide a control system which is of inexpensive construction, and consists of a minimum number of parts.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully pointed out in the claims; the annexed drawing and the following description setting forth in detail certain means for carrying out the invention, such disclosed means illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a schematic diagram of an electrical circuit embodying the novel features of the invention; and

Fig. 2 is an oscillogram of the voltage waves supplied to the load in the circuit illustrated in Fig. 1.

Referring more particularly to the drawing, the circuit includes a source of alternating current, represented by the power lines 1, 2, the main lines 3 and 4 of the control system, and a switch 5, which interconnects the lines 1 and 2 with the lines 3 and 4 respectively. The line 3 is provided with a thermally-controlled switch 6, and also includes the load L, which may be the magnet of a vibrating screen, or other load.

The circuit further includes a power tube 7 containing a cathode 8, a grid 9 and an anode 10, the anode being connected directly to the line 3 through the load L. The cathode 8 is heated by the secondary coil of a transformer 11, which derives its energy from the lines 3 and 4. The

line 4 is connected to the center tap of the secondary coil of the transformer 11.

A condenser 12 is inserted in the line 4, and an adjustable rheostat 13 is placed in parallel with the condenser.

The grid 9 is connected to the line 4, as by means of a connection 14, a bias 15 being inserted in the grid circuit, as well as a resistance 16.

Having thus described the general make-up of the electrical circuits, the action which occurs therein will now be described.

When the switch 5 is closed, the cathode 8 of the tube 7 becomes heated. This is followed, in about 60 seconds, by the automatic closing of the switch 6, which starts the machine or load, represented by the reference character L, and which is usually of an inductive character, vibrating.

After the switch 6 closes, the first positive impulse to pass the tube 7, charges the condenser 12 with the polarity shown, and puts the first impulse designated by reference character 1, into the load L. Due to the rectifier action in the power tube 7, impulse #2 (Fig. 2) from the line supply, is omitted. At the end of impulse #1, the condenser 12 starts to discharge through the rheostat 13, which is set to maintain this discharge as long as desired. If it is set, for example, to completely discharge somewhere during impulse #4 (Fig. 2), it would omit impulses Nos. 3 and 4, and permit impulse #5 to be impressed upon the load, as was impulse #1.

At any time that the condenser 12 is discharging through the rheostat 13, a negative bias on the grid 9 is increased, making it non-conducting. The charge on the condenser 12 cannot leak off through the tube, because the positively charged side of the condenser is connected to the cathode 8 of the tube, which cathode only passes current when negatively charged with reference to the anode 10. Neither can such charge leak off through its grid circuit, as the grid 9 is always negative to some degree, during most of the condenser discharge. During the first impulse, which has already been referred to, there is no negative difference of potential between the grid and cathode, and the tube will always conduct on the first impulse, with usual commercial voltage on the plate or anode, as can be seen from Fig. 1. Even if a bias is used, this first impulse will conduct and start the operation, with either a negative or positive grid type of tube. On impulse #4, the tube 7 is again rectifying, and when impulse #5 appears, the charge on the condenser

12 has been absorbed at the correct time, due to the setting of the rheostat 13, and impulse #5 is imparted to the load. The E. M. F. across the condenser need not be high, allowing the use of an inexpensive condenser.

The action is repeated indefinitely, the system operating at one half the frequency of the rectifier circuit. If the resistance 13 is increased, a greater delay is caused, and the number of impulses is lowered to a point which would eventually approach the time in which the condenser 12 would discharge through insulation leakage.

It is also within the scope of the invention to place the condenser 12 in the anode side of the tube, but the location shown in Fig. 1 is preferred, due to the more economical cathode return connection and resistor arrangement. In other words, placing the condenser in the anode side would require a resistor completely across the tube, which would draw some current, no matter how high the value of resistance.

It is to be further understood that while a simple battery bias 15 is shown, in the grid circuit, that any of the well-known bias arrangements may be used instead, such as a transformer, capacitor grid leaks, potentiometers, etc.

The oscillogram shown in Fig. 2, shows how the condenser 12 charges and discharges, the condenser voltage being represented by the curves *a*, *b* and *c*. The condenser charges to a maximum potential of the peak line voltage, minus the tube drop and other losses, and discharges in a manner represented by the exponential curves *a*, *b* and *c*, the tube being maintained in a non-conducting condition for practically the entire length of these curves.

The amount of charge reaching the condenser, during the time allowed by the positive impulse that reaches the load, is in proportion to the impedance value of the load and resistance 13. If the condenser is so chosen that it is of the proper size to absorb the full impulse in the time allotted, the strength of the impulse reaching the load will be greatest.

If, for example, the curve *a* (Fig. 2) intersects impulse #5, voltage control by phase shift is added to the control of frequency, in a more direct manner than in my co-pending application Serial No. 356,863, filed September 14, 1940.

It is thus seen that I have provided means for effectively producing a rectifying impulse power supply for vibrating machinery operating at a frequency of half or less than the frequency of the normal supply line, and have accomplished

this with a lesser number of tubes than has heretofore been used for this purpose.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the means herein disclosed provided the elements stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A control system for industrial vibrating machines comprising a source of alternating current, an electron tube including plate, grid and filament electrodes, circuit means directly connecting a load to one side of said source and to said plate electrode, a condenser, means directly connecting the condenser to the other side of said source and to said filament electrode, means for heating the filament electrode, a source of substantially constant grid bias potential for rendering the tube normally conducting to pass positive current impulses from the plate to the filament electrodes to thereby energize the load and charge said condenser, a discharging circuit in shunt with said condenser and means for controlling the relative grid-filament potential by the discharge current of the condenser to render the tube non-conducting for a predetermined number of cycles of said alternating current source following the passage of a positive current impulse through the tube.

2. A control system for industrial vibrating machines comprising a source of alternating current, an electron tube including plate, grid and filament electrodes, circuit means directly connecting a load to one side of said source and to said plate electrode, a condenser, means directly connecting the condenser to the other side of said source and to said filament electrode, means for heating the filament electrode, a discharge circuit for the condenser connected in shunt therewith and including an adjustable resistor, circuit means connecting said discharge circuit with said grid electrode, substantially constant potential biasing means in said grid connection for rendering the tube normally conducting to pass positive impulses of current between the plate and filament electrodes to thereby charge the condenser and energize said load, the discharge of said condenser overcoming the normal potential bias on said grid to render the tube non-conducting throughout the discharge period of the condenser as determined by the value of said adjustable resistor.

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