

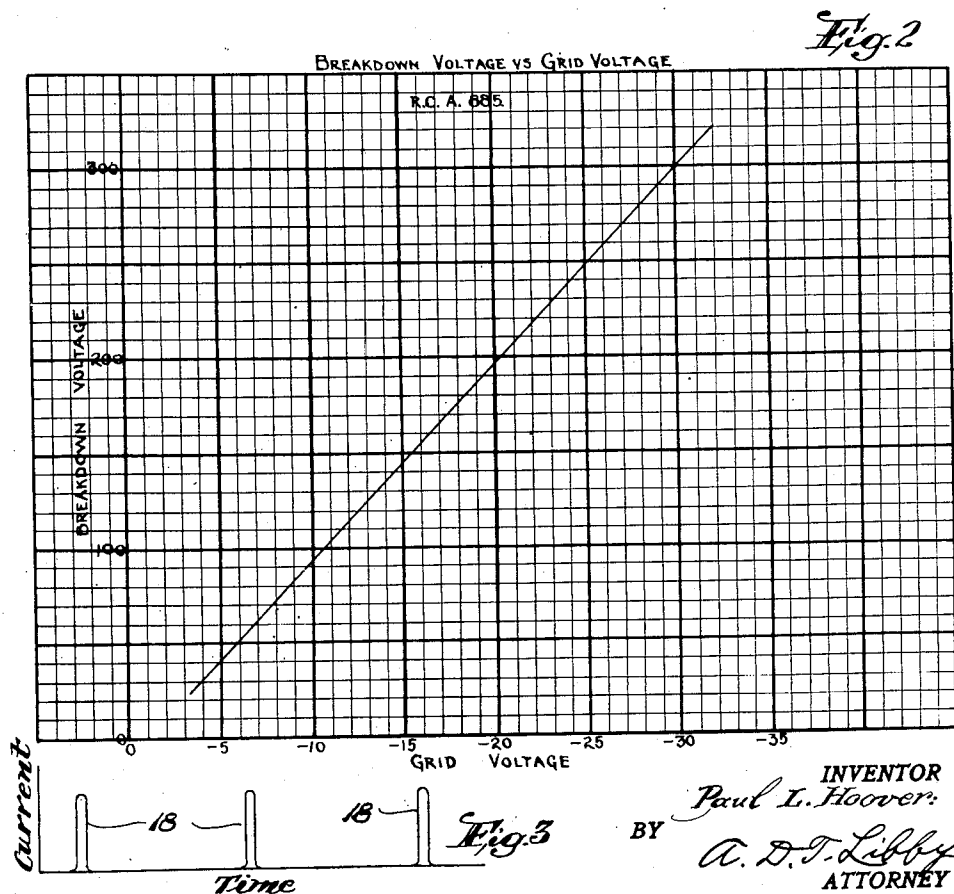
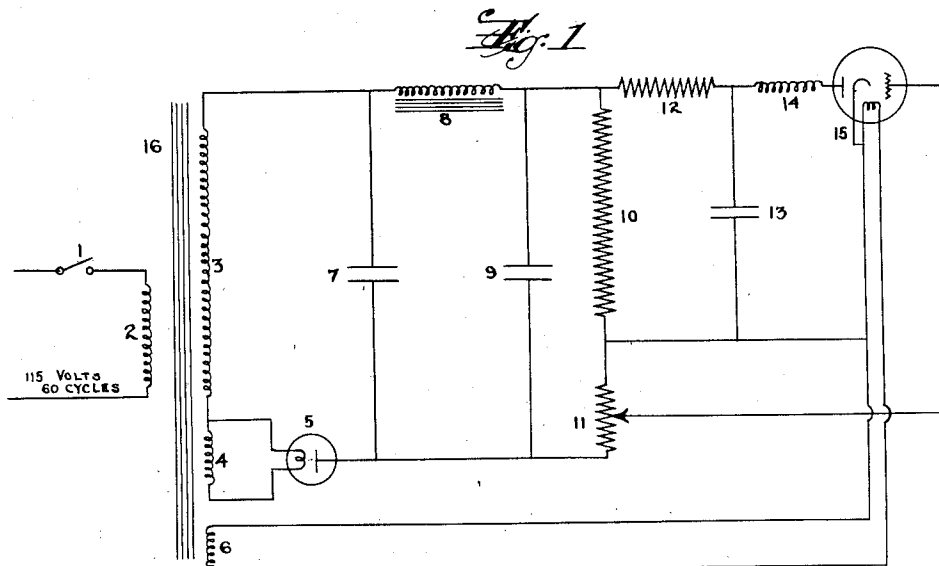
Oct. 26, 1937.

P. L. HOOVER

2,097,066

ELECTRICAL TIMING CIRCUIT

Filed April 4, 1936



INVENTOR
Paul L. Hoover.
BY
A. D. T. Libby
ATTORNEY

UNITED STATES PATENT OFFICE

2,097,066

ELECTRICAL TIMING CIRCUIT

Paul L. Hoover, Highland Park, N. J., assignor
to Endowment Foundation, New Brunswick,
N. J., a corporation of New Jersey

Application April 4, 1936, Serial No. 72,743

5 Claims. (Cl. 250—36)

This invention relates to an electrical circuit and means for providing electrical impulses of exact periodicity or frequency which may be used to operate some mechanism directly or indirectly, as will be hereinafter pointed out.

Many different types of mechanical mechanisms have been used in the past to operate contacts and thus send periodic electrical impulses through a circuit. Some of these are even capable of speed regulation over a limited range, but the accuracy of this speed calibration is never very good due to friction and wear on the moving parts of the mechanism.

Certain types of timing mechanisms, including metronomes, have been built in the past to perform a single duty; that is, to either flash lights, send an electrical impulse through a circuit, or produce audible tones or clicks.

My present invention has for its object, a circuit arrangement in which electrical impulses are produced by the devices in the circuit itself, and generally speaking, without any mechanical moving elements.

Another object of my invention is to provide means whereby the periodicity of the impulses may be quickly and conveniently varied to any desired value over a relatively wide range.

Another object of my invention is to provide an electrical timing circuit in which lights may be flashed, impulses sent through a circuit, or other visible and audible tones or clicks may be produced. This dual purpose is very useful in certain classes of work, such as the replacement of metronomes for musical purposes where a combination of flashing light and audible tone is a distinct advantage over the simple audible tone given by a mechanical metronome. Furthermore, in callisthenics the audible tone cannot be heard anyway, and the use of a flashing light, alone, as a metronome is very helpful.

These and other objects will be apparent to one skilled in this particular art, by a reading of the specification, taken in connection with the annexed drawing, wherein:

Figure 1 is a diagram of a circuit arrangement which I have found to be highly useful in connection with the purposes heretofore set forth.

Figure 2 is a curve showing the characteristics of the tube used in the control of the circuit shown in Figure 1.

Figure 3 is a diagram illustrating the kind of signal impulse produced in the circuit for application to the output device.

By reference to Figure 1, it will be seen that when the switch 1 is closed, power is applied to the primary 2 of the transformer 16. Secondary winding 4 supplies power to the cathode of rectifier tube 5. Secondary 6 supplies power to the cathode of the discharge tube 15. Secondary 3 supplies a relatively high voltage, which may be

of the order of 300 volts, to the rest of the circuit. Condensers 7 and 9, along with choke coil 8, constitute a filter circuit to smooth out the half-wave pulses which the rectifier tube 5 passes. The power across the voltage divider, consisting of resistance 10 and potentiometer 11, is thus direct current. If direct current of the correct value were available, the rectifier part of the circuit just described could be omitted as its sole purpose is to convert the ordinary 115-volt, 60-cycle power into direct current power of the required voltage; i. e., 300 volts, in this case to operate tube 15, which is a so-called grid-controlled gas discharge tube such as an RCA885. The particular feature of this type of tube, which makes it useful in this application, is that with the grid potential set at some given value, no plate current will flow at all until the plate voltage reaches a definite value. This plate voltage is known as the breakdown voltage. Figure 2 shows the relation between grid voltage and plate breakdown voltage for the RCA 885 tube. However, once the tube breaks down, and plate current starts to flow, the grid loses control and can no longer influence the flow of current through the plate circuit. When the plate voltage drops below a few volts, however, the tube "goes out" and the grid then regains control.

From Figure 2, it is seen that the breakdown voltage is practically ten times the grid voltage. Therefore resistance 10 of the voltage divider should have ten times the resistance of potentiometer 11. The magnitude of resistance 10 may be of a desired value; preferably, in practice, it may lie between 10,000 and 50,000 ohms.

As soon, then, as direct-current power is applied across resistance 10, current will start to flow through resistance 12 and charge condenser 13. Since no current can flow through the device 14, shown in Figure 1, as a coil, or tube 15 at the start, due to the fact that the voltage is below the breakdown value of tube 15, the charge on condenser 13 will build up until the voltage across it is equal to the breakdown voltage of the tube. At this point, then, tube 15 breaks down and passes current through the plate circuit, with the result that condenser 13 discharges through coil 14 and tube 15, giving a glow-like flash. The time of this discharge is very short, of the order of micro-seconds, so it can be regarded as instantaneous. This is shown in Figure 3, where the signal impulses 18 are plotted against time and current to illustrate the kind of signal impulse which is impressed on the output device connected in series with the plate or equivalent element of the tube. As soon as condenser 13 is discharged, the voltage across it, and hence the voltage on the plate of tube 15, is so low that the tube "goes out" and the grid regains control again. The cycle then repeats.

The time required for a complete cycle is, then, practically the time taken to charge the condenser to the proper voltage. This, of course, depends on the resistance 12, the condenser 13, and the setting of potentiometer 11 which is the variable that controls the breakdown voltage of tube 15. By keeping resistance 12 and condenser 13 fixed in value and changing only potentiometer 11, a range of almost ten-to-one may be had for the period of the charging cycles when using the 885 tube. If a wider range is required, either resistance 12 or condenser 13, or both, may be varied.

A very important feature of this circuit is that an increase or decrease in either line voltage or frequency will not change the periodicity of the charge and discharge cycles of condenser 13. This is because of the fact that any change in the supply line voltage or frequency would only change the magnitude of the direct-current voltage across the voltage divider elements 10 and 11. Thus, if the voltage across resistance 10 increases, then condenser 13 will be charged at a faster rate, but the voltage across potentiometer 11 also increases proportionately so that the grid voltage, and consequently the plate breakdown voltage or tube 15, also increases proportionately. This would not be the case if the relation as shown in Figure 2 were not linear.

The output device of this electrical timing means or metronome is shown in Figure 1 in the form of a coil 14, but it may be any one or a multiplicity of numerous types of translation devices. For instance, coil 14 may be the operating coil which moves or controls the recording mechanism of a chronograph. It may be a loud speaker, in which case, the electrical pulses are converted into sound pulses or clicks. It may be the primary of a transformer, in which case, the induced voltage in the secondary may be used to control either high voltage or high current devices, depending on the turns ratio of this output transformer. Output coil 14 may also be the operating coil of a relay which controls a multiplicity of contacts, which in turn controls the flow of power in a number of external circuits. In case it is desired, several output coils may be put in series and thus several output devices operated simultaneously. The dual character of this output device may be utilized by having coil 14 the operating coil of a relay, and this relay so designed that when the relay armature operates, it closes a pair of contacts in an external circuit, flashing a light, and at the same time, the relay armature may strike a member to produce an audible sound or tone. Where only the flash from the tube is wanted as a signal, the device 14 may be a plain resistance, or it may even be dispensed with.

This type of instrument, utilizing the circuit of Figure 1, has been found very useful for musicians, but as heretofore indicated, the instrument in which the apparatus of the circuit is used, may take any desired shape and serve other purposes.

Furthermore, the circuit shown in Figure 1 is to be considered as the preferred form of circuit and not as the only circuit or means whereby electrical pulses of exact periodicity may be made to function as a metronome.

What I claim is:

1. An electrical timing circuit for producing spaced short-time impulses including a voltage

divider, a condenser, a resistance, one terminal of said condenser being connected to an intermediate point on said divider and the other terminal of said condenser being connected to a terminal of said divider through said resistance, a gas-filled tube having at least a cathode, anode and grid and having a ratio of plate voltage to grid voltage at break-down which is substantially a constant, an output device connected in series between said plate and the juncture of said condenser and resistance, a connection from said cathode to said intermediate point on said voltage divider, and a connection between said grid and a point on said voltage divider on the other side of said intermediate point from said first-named terminal.

2. An electrical timing circuit for producing spaced short-time impulses including a two-section voltage divider composed of two series-connected resistances, a condenser and a third resistance connected in series across one section of said divider, one terminal of said condenser being connected to the point between said two sections, a grid controlled gas-filled discharge tube having at least grid, cathode and anode and having a substantially straight line relation between its grid and plate voltages at breakdown, a connection between said grid and an adjustable point on the second of said voltage divider resistors, an output device connected in series between the anode and the junction of said condenser and the third resistance and a connection between said cathode and said point between said two sections.

3. An electrical timing circuit as defined in claim 2, in which the first said voltage divider resistance is larger than said second resistance and in which the ratio of said two resistances is of the order of the ratio of the anode voltage to the grid voltage at breakdown.

4. An electrical metronome having a circuit for producing and utilizing spaced short-time impulses including a trigger-action tube having elements comprising at least a grid, a cathode and a plate, a source of direct current, a condenser and means for charging the condenser from said source, an output device in series with the plate of the tube for utilizing said impulses, said condenser being connected to at least two of said tube elements, in series with the output device, whereby the discharge of the condenser will be through said output device, and means connected to said source of current and also between the grid and cathode to vary the speed of the impulses produced, said condenser and translating means being connected in series in the anode-cathode circuit.

5. A timing circuit utilizing devices which will electrically produce spaced short-time impulses of exact periodicity and use the same through a translating means, with means for adjusting the periodicity over a wide range, said devices including a grid-controlled breakdown tube with at least a cathode, and a plate, and having substantially straight-line characteristics between its grid and plate breakdown voltages, and a condenser, with means for charging the condenser from a source of direct current, said condenser and translating means being connected in series in the anode-cathode circuit, and means for applying a voltage to said grid with respect to said anode.

PAUL L. HOOVER.