Dec. 24, 1935. P. L. HOOVER ET AL 2,025,208

TIMING AXIS FOR CATHODE RAY OSCILLOGRAPHS

Filed Oct. 19, 1934

Fig. 1

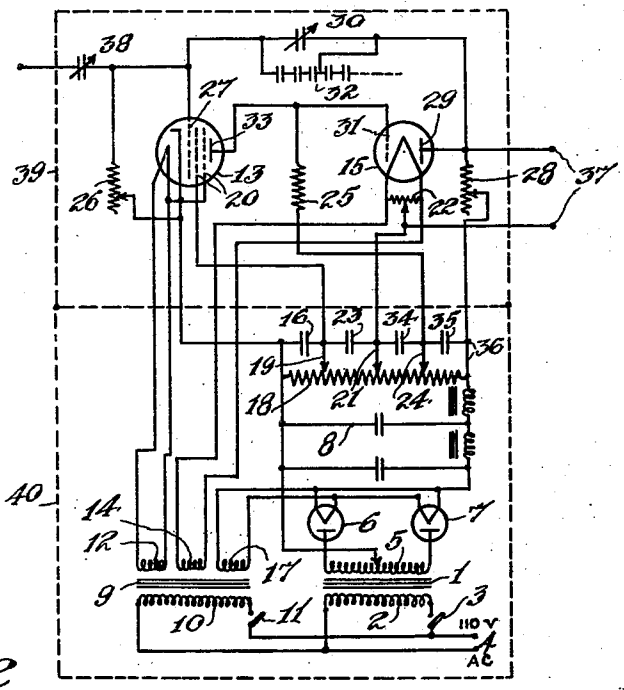


Fig. 2

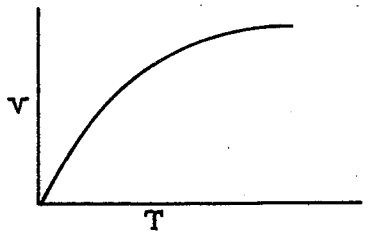


Fig. 3

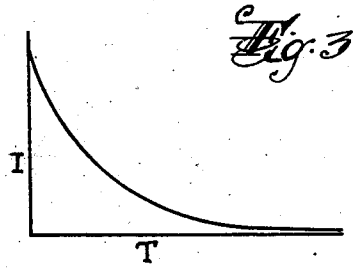
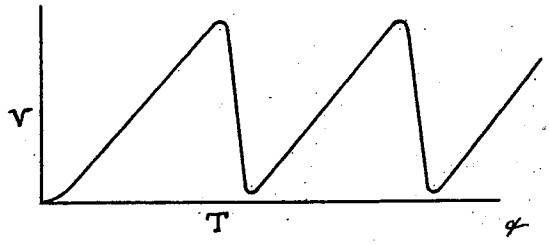


Fig. 4



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Patented Dec. 24, 1935 2,025,208

UNITED STATES PATENT OFFICE

2,025,208

TIMING AXIS FOR CATHODE RAY OSCILLOGRAPHS

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Application October 19, 1934, Serial No. 748,986

10 Claims. (Cl. 171—95)

This invention relates to a circuit arrangement especially adapted for use in connection with a cathode ray oscillograph, whereby a suitable timing axis is provided. Such a circuit is usually referred to as a "sweep" circuit.

Our Patent 1,978,461, issued October 30, 1934, sets forth the limitations of prior art circuits of this type, and then goes on to describe an arrangement which will give a timing axis for a cathode ray oscillograph that will operate at an exceedingly high speed, that is, on the order of one million cycles or more.

In our work with the circuit arrangement set forth in our Patent 1,978,461, we have made the further discovery that by properly proportioning certain of the circuit elements, we can do away entirely with the condenser included in the "sweep" circuit of our patent, together with the means required to charge this condenser at a constant rate, as well as the tube for controlling the charging and discharging of this particular condenser, thereby greatly simplifying and reducing the cost of the apparatus required in such a circuit, without sacrificing the high speed of operation; in fact, our new arrangement to be described herein, is even faster in its operation than the "sweep" circuit of our patent referred to.

It is therefore the principal object of our invention to provide a relatively simple and inexpensive arrangement or combination of parts which will deliver directly from the oscillator per se, a wave form bearing the characteristics that will operate a cathode ray oscillograph at a very high speed of a million cycles or more per second.

In the drawing accompanying this specification;

Figure 1 illustrates a diagrammatic arrangement of our improved form of timing axis or "sweep" circuit.

Figure 2 is a curve showing the charging characteristics of the main control condenser or condensers used in our circuit.

Figure 3 is a characteristic curve of the current flowing into said main control condensers.

Figure 4 is a curve showing the characteristics of the voltage applied to the circuit extending to the oscillograph.

In the drawing, 1 is a transformer having its primary 2 connected by a switch 3 to a source of power 4 which may be 110 volts A. C. The secondary 5 of the transformer 1 is connected to rectifier tubes 6 and 7 which furnish current to the filter arrangement generally referred to by the numeral 8. The second transformer 9 has its primary 10 also connected to the power leads 4 by means of a switch 11. One of the secondaries 12 of the transformer 9 supplies current to the filament or heater of tube 13, while the secondary 14 of the transformer 9 supplies current to the filament of tube 15, the other remaining winding 17 of the transformer 9 being connected to the filaments of rectifiers 6 and 7.

Associated with the filter 8, is a voltage divider 18 having a tap 19 extending to the grid-plate-screens 20 of the tube 13. Another tap 21 extends to the balancing resistance 22 of the tube 15. A further tap 24 extends to a rather high resistance 25, of approximately 50,000 ohms. Interposed between these various taps and the terminals of the voltage divider 18 are the condensers 16, 23, 34 and 35.

An adjustable resistance 26 is connected across the grid 27 of the tube 13 and one end of the voltage divider 18. The resistance 26 is relatively low, being of the order of 1,000 ohms. An adjustable resistance 28 of the order of 10,000 ohms is connected to one extremity of the voltage divider 18 at 36, and to the plate 29 of the tube 15, and also to one side of a variable condenser 30, the other side of which is connected to the grid 27 of the tube 13. In order to get a considerable range of capacity, the condenser 30 may be bridged by a fixed adjustable condenser 32, but in the claims we refer to one or both as a condenser. The grid 31 of the tube 15 is coupled to the plate 33 of the tube 13 and the resistance 25.

In the operation of our circuit, when the source of alternating current is supplied to the transformer 9, by closing the switch 11, the current is sent through the filaments or heaters of the tubes 13 and 15. On closing the switch 3, power is applied to the transformer 1, the output of which, at approximately 750 volts, passes through the rectifier tubes 6 and 7 and the filter circuit 8, impressing on the voltage divider 18 a smooth direct current.

From the various voltage taps 19, 21, 24 and 36 on the voltage divider, current will flow through the resistance 25 into the plate 33 of tube 13. Current also starts flowing through resistance 28 into condensers 30 and 32, through the resistance 26, back to the potential divider. The condensers 30 and 32 thus start uncharged, but due to the current flowing into them, they become charged and a voltage is developed across their terminals. If the tube 15 draws no current through its plate circuit, the condensers 30 and 32 will merely be charged through resistances 26 and 28, and the rate of charge, as a function of time, will be shown as in Figure 2. The maximum value of

the voltage on the condensers 30 and 32, will be the voltage on the potential divider, and current into the condensers 30 and 32 and through resistances 26 and 28, will be substantially as shown in Figure 3.

At the instant of starting, the voltage on the plate 29 of the tube 15 is practically zero, but this starts to build up with time in a manner quite similar to Figure 2. However, due to the fact that the charging current into condensers 30 and 32 flows through resistance 26, the grid 27 of tube 13 starts in with a positive bias, and this also decreases with time according to Figure 3 in the same manner as the current.

The tube 13 and resistance 25 constitute merely a direct connected amplifier, and thus the output impressed on the grid 31 of tube 15 is of the same form, except for a reversal of sign; that is, as the grid voltage of tube 13 decreases with time, the grid voltage of tube 15 increases with time, and vice versa. The net result then is that immediately after the power is applied to the circuit, condensers 30 and 32 are charged through resistances 26 and 28. The tube 15 passes very little current at the start, but rapidly begins to pass more and more, since both plate and grid voltages are becoming more positive. The condition is soon reached where tube 15 passes more current than the resistance 28. This is possible, since the current into the condensers 30 and 32 reverses and discharges these condensers. This reversal of current into condensers 30 and 32 also reverses the direction of flow through the resistance 26, which in turn drives the grid of tube 13 negative and consequently the grid of the tube 15 still more positive. As a result, this discharge current will flow until the condensers 30 and 32 are substantially completely discharged. In this discharged state, the voltage across the condensers is practically zero, as is also the voltage on the plate 29 of the tube 15, and conditions are the same as when the voltage was first applied. The cycle is then repeated.

The voltage on the plate 29 of the tube 15 across the terminals 37, which are connected to a cathode ray oscillograph, thus increases from a low value to a relatively high one, several hundred volts, and then rapidly drops to a low value, this cycle repeating as long as power is applied to the circuit. We have found, even with ordinary commercial tubes, that by suitably adjusting the taps on the voltage divider 18, it is possible to get a voltage delivered to the terminals 37, that is, to an oscillograph, which is a linear function of time during the charging interval, and the return time is small compared with the charging time, all as depicted in Figure 4.

The description of the mode of operation of this sweep circuit as given above is from the point of view of oscillator action. It is important to note, however, that in this oscillator a non-linear charging current to the condensers 30 and 32 is combined with another non-linear tube current in order to produce a linear voltage rise with time across the terminals 37. In other words, two different non-linear currents are used to produce a linear voltage rise across a part of the circuit.

If desired, for the purpose of stabilization, a small coupling condenser 38 may be connected to the circuit under investigation. Such a condenser connected as shown serves to keep the "sweep" circuit exactly in step with the wave form under examination. Preferably the apparatus is enclosed in suitable separate metal shields as indicated by the dotted lines 39 and 40.

We have found that by properly mounting the various tubes and resistances, and by proper adjustment of the other elements—such as the taps on the potential divider and the main control condensers—we can get an oscillator which will deliver directly a suitable wave form for a cathode ray oscillograph, which is much faster in its operation than other circuits heretofore used. This is undoubtedly due at least in part to the simplicity of the arrangement with the minimum number of elements therein, which acts to reduce stray capacities and other disturbances.

What we claim is:

1. Means for supplying electrical energy of suitable wave form for the deflection plates of a cathode ray oscillograph; said means including a pair of electron tubes having a resistance coupling including a source of voltage between the plate of one tube and the grid of the other, a second coupling between the grid of the one tube and the plate of the other tube; said second coupling including, an adjustable resistance in each of the said grid and plate circuits and a source of voltage; and an adjustable condenser connected between said last-mentioned grid and plate, the plate output terminals of said other tube adapted to be directly connected to the oscillograph.

2. Means for supplying electrical energy of suitable wave form for the deflection plates of a cathode ray oscillograph; said means comprising an oscillator circuit including a pair of electron tubes having the plate of one coupled to the grid of the other, also the grid of the one coupled through a condenser to the plate of the other, the first coupling being supplied with an adjustable voltage through a high resistance, while the other coupling is supplied on opposite sides of said condenser with voltages through adjustable resistances, the plate output terminals of said other tube adapted to be directly connected to the oscillograph.

3. Means for supplying electrical energy of suitable wave form for the deflection plates of a cathode ray oscillograph; said means comprising, a source of selectable voltages, a pair of electron tubes having the plate circuit of one of the tubes adapted to be connected to the oscillograph, while the output side of the second tube is coupled through a resistance type coupling to the input side of the first tube with means for supplying a variable voltage thereto from said source of voltages, while the input side of the second tube is connected to the output side of the first tube through an adjustable condenser, voltages being applied from said source to said last-mentioned input and output sides of the tubes through suitable adjustable resistances.

4. Means for supplying electrical energy of suitable wave form for the deflection plates of a cathode ray oscillograph; said means comprising an oscillator circuit including a pair of electron tubes resistance-coupled together with a source of adjustable voltage connected to the resistance, said source of voltage being connected to the input and output circuits of the tubes through adjustable resistances with an adjustable condenser bridging said input and output circuits, the output terminals of the oscillator circuit adapted to be connected to the oscillograph.

5. Means for supplying electrical energy of suitable wave form for the deflection plates of a cathode ray oscillograph; said means comprising an oscillator including two electron tubes coupled in part by a resistance coupling so that one of the tubes acts as an amplifier to the other, said tubes

being further coupled through an adjustable condenser with a source of voltage applied through adjustable resistances to opposite sides of the condenser, the plate output terminals of said second tube adapted to be connected to the oscillograph.

6. A "sweep" circuit arrangement as set forth in claim 5, further characterized in that said amplifier tube includes a grid-plate screen and a voltage divider having taps thereto which supplies energy to the whole circuit arrangement, said grid-plate screen being connected to a tap on said voltage divider.

7. Means for supplying ultra-high frequency energy to a cathode ray oscillograph; including a condenser, a pair of electron tubes coupled by the condenser, the grid of one tube to the plate of the other tube, a source of unidirectional voltage, adjustable resistances connected between said source of voltage and said grid and plate, and a further coupling between the plate and grid of said respective tubes, said coupling including a resistance connected also to a variable tap on said source of voltage, the plate output terminal of one of the tubes adapted to be connected to the oscillator.

8. Means for supplying electrical energy of suitable wave form for the deflection plates of a cathode ray oscillograph; said means comprising an oscillator including two electron tubes coupled in part by a resistance coupling so that one of the tubes acts as an amplifier to the other, said tubes being further coupled through a condenser, the opposite terminals of which are connected through suitable resistors to a source of uni-directional current, whereby the condenser charge has a non-linear characteristic and the non-amplifier tube of the oscillator also has a non-linear characteristic, the combination of the two non-linear characteristics producing substantially a straight line voltage characteristic which is supplied to the circuit leading to the oscillograph.

9. Means for supplying ultra-high frequency electrical energy to the deflection plates of a cathode ray oscillograph directly from the plate circuit of an electron tube; said means including, a second electron tube coupled as an amplifier to the grid of the first mentioned tube, a condenser coupling the grid of the amplifier tube to the plate of the first-mentioned tube and a source of uni-directional current connected through suitable impedances to the opposite sides of the condenser as well as to the amplifier coupling between said tubes.

10. Means for supplying electrical energy of suitable wave form for the deflection plates of a cathode ray oscillograph; said means including a circuit wherein a plurality of non-linear voltages of different character are produced in an element of the circuit and then combined thereto to give a linear voltage rise with time across said element of the circuit.

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