Oct. 31, 1933. R. G. RICHARDSON 1,932,637

VACUUM TUBE

Filed June 18, 1928

Fig. 1

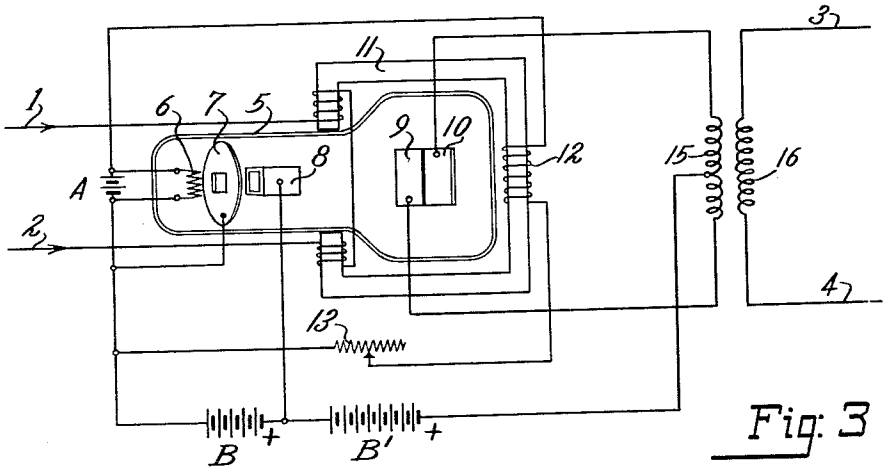


Fig. 3

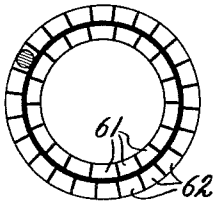
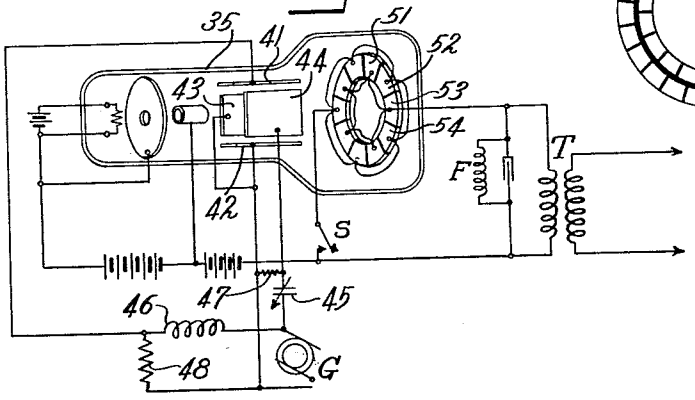


Fig. 2



Inventor
Rodney G. Richardson

Atty:
R. G. Richardson

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VACUUM TUBE

Rodney G. Richardson, Chicago, Ill., assignor, by mesne assignments, to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

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5 Claims. (Cl. 179—171)

This invention relates in general to vacuum tubes; and the object of the invention is to devise new and improved types of tubes, together with apparatus such as telephone repeaters and the like in which tubes of the improved form shown herein may be used.

The invention is illustrated by the accompanying drawing in which Fig. 1 shows a telephone repeater, Fig. 2 shows a frequency changer, while Fig. 3 shows a modified form of segmented target for use in the frequency changer shown in Fig. 2.

Referring to Fig. 1, the reference character 5 indicates what is commonly known in the art as a cathode ray oscillograph tube. This tube may correspond generally to the well-known form of cathode ray oscillograph tube manufactured by the Western Electric Company. It comprises an evacuated vessel, preferably of glass, in which is mounted a filament or cathode 6, a perforated shield 7, and a tubular anode 8. In addition, the tube contains a target comprising the insulated plates 9 and 10, which are disposed at the right-hand end of the tube, as indicated. The cathode 6 is connected in circuit with a battery A by means of which it is heated in the well-known manner. The shield 7 is preferably connected to the cathode as shown, while the anode 8 is connected to the cathode in series with a battery B.

The reference character 11 indicates a magnetic structure of soft iron, which may be of any desired form, although, as shown in the drawing, the two opposite poles should be disposed one on each side of the tube and substantially in the plane of the cathode ray beam. Separate magnets may be used, if desired. The input circuit including the conductors 1 and 2 is connected to coils wound on the magnet poles. The two plates 9 and 10 are connected to the output circuit comprising conductors 3 and 4 by means of an induction coil having the windings 15 and 16. The middle point of the winding 15 is connected in series with a battery B' to the battery B.

In the operation of the repeater, the cathode 6 is heated by the battery A and emits electrons, part of which are drawn through the opening in the shield 7 and through the opening in the anode 8 by the voltage impressed on the anode 8 by the battery B, aided by the voltage impressed on the plates 9 and 10 by the batteries B and B' in series. In this manner, a so-called cathode ray or beam is produced which impinges on the target comprising plates 9 and 10. The parts may be so disposed in the tube that the beam will normally strike the target at a point somewhat removed from the center thereof. The beam can then be brought to the center of the target by adjusting the rheostat 13, which varies the amount of current flowing through the coil 12. The field produced by the coil 12 will displace the beam more or less so that it can be accurately positioned on the target. It may be stated also that the coil 12 maintains the flux substantially at the point where the maximum change in flux will take place responsive to a given current change in the input circuit, and thus renders the device more sensitive to incoming currents.

It may be explaned at this point that although the various parts correspond generally to the corresponding parts of the well-known cathode ray oscillograph, they are somewhat modified in order to adapt the tube to use as a telephone repeater. The opening in the shield 7 and likewise the opening in the anode 8 should be much larger than is ordinarily used, so as to produce a beam of considerable thickness. It is also desirable to have the tube comparatively short, with the target disposed relatively close to the anode 8. With these modifications, a cathode beam having a fairly high current value can be obtained. The voltage of batteries B and B' should be as low as possible, as the sensitivity of the beam to a deflecting field is inversely proportional to its velocity.

In the operation of the device as a telephone repeater, the incoming voice currents over the circuit including conductors 1 and 2 produce flux changes in the electromagnet 11, which bend the beam back and forth and change the point at which it contacts the target. Thus, at a given instant the major portion of the beam may impinge on the plate 9, while at another instant, due to bending of the beam, it may impinge more on the plate 10. It will be seen that this movement of the beam will produce current changes in the two halves of the induction coil winding 15, which is included in the return path of the beam through batteries B' and B, whereby corresponding fluctuations are induced in the secondary winding 16 of the induction coil which is connected in the output circuit.

Referring now to the frequency changer shown in Fig. 2, the reference character 35 indicates a cathode ray oscillograph tube which is similar to the tube shown in Fig. 1. The target is different, however, and also different

means is employed for bending the cathode ray or beam.

The target is circular in form, as indicated in the drawing, and comprises a number of insulated segments, the number used depending on the desired ratio between the generator frequency available and the frequency which it is desired to produce. The odd-numbered segments such as 51, 53, etc., are all connected together and a common lead extends to the primary winding of the transformer T, from which a return path may be traced through the two batteries to the cathode. The even-numbered segments of the target, such as 52, 54, etc., are also connected together and a common lead is extended to the switch S by means of which the common lead can be connected to the return path through the battery.

The means for causing the cathode beam to trace a circular path so as to follow the target comprises two pairs of plates, 41 and 42, and 43 and 44, together with a generator for charging the plates electrostatically. The generator is indicated by the reference character G and may be any source of alternating current which is to be used as the basic source whose frequency is to be multiplied. Two resistances, 47 and 48, are connected across the terminals of the generator G, resistance 48 having in series with it an inductance 46, while the resistance 47 has in series with it a capacity 45. The plates 41 and 42 are connected across the terminals of the resistance 48, while the plates 43 and 44 are connected across the terminals of the resistance 47. The circuit arrangement shown produces impressed voltages on the two pairs of plates which are out of phase and by suitable adjustment the cathode beam, which is bent by the electrostatic charges on the plates, may be caused to trace a circular path, so as to contact successively with the different segments of the target.

As in the case of the device shown in Fig. 1, it is desirable that the parts be so arranged as to produce a cathode beam of considerable thickness. This beam preferably should be large enough to substantially cover one segment of the target in order to produce a fairly good wave form in the output circuit. It may be desirable also in this connection to connect a filter such as is indicated at F in shunt of the primary winding of the transformer T.

The operation of the device will be readily understood in view of the foregoing. The cathode beam is included in a circuit which at a given instant includes a live segment of the target, the primary winding of the transformer T, and the two batteries in series. The current in this circuit will rise to a maximum as the beam becomes centered on the live segment of the target and will decrease to zero when the beam passes on to the adjacent dead segment, rising again to a maximum as the beam reaches the next live segment, etc. The rise and fall of current in the primary winding of the transformer T, of course, induces currents in the secondary winding which may be used for any desired purpose. The frequency of the secondary current generated depends on the number of segments in the target and this, of course, is determined in advance so as to produce the desired frequency. Amplifiers may be used beyond the transformer T in the well-known manner in case large amounts of current have to be supplied.

The modified form of target shown in Fig. 3 is similar to the target shown in Fig. 2 except that it has two rows of segments 61 and 62 instead of only one row. The object of the modification is to make two different frequencies available. There are more segments in one row 61 than there are in row 62, and the beam is made to traverse one row or the other depending on the frequency desired. Control of the beam is effected by any suitable means which will produce changes in the amplitude of the movement of the beam. This can be done conveniently, for example, by adjusting the field of the generator G so as to vary the voltage supplied to the electrostatic plates.

It will be understood that the devices shown herein are illustrative only and that modifications and adaptations can be made without departing from the spirit of the invention. I do not, therefore, wish to be limited to the precise forms of the invention which are shown and described herein, but desire to include and have protected by Letters Patent all forms of my invention which come within the scope of the appended claims.

What is claimed is:

1. In a cathode ray device, means for producing a beam of electrons, a circuit including said beam and having two parallel branches, means for adjusting the beam so that a definite amount thereof is included in each of said branches, and means for deflecting the beam to vary the amount of the beam which is included in said branches, respectively.

2. In a telephone repeater, means for producing a beam of electrons, a target, and means including a source of current and circuit therefor for adjusting the normal position of the beam on the target.

3. In a telephone repeater, a filament for producing a beam of electrons, a target comprising two segments in the path of said beam, an induction coil having the opposite ends of its primary winding connected to said segments, respectively, a battery connected between the said filament and the middle point of said primary winding, and means including a circuit carrying voice currents for modifying the amount of the beam which is intercepted by each of said segments to produce corresponding voice currents in the secondary winding of said coil.

4. In a telephone repeater, an electron emitting element, two return paths both conducting electrons back to said element simultaneously, means including an input circuit carrying voice currents for producing a vibratory motion of the electron stream to vary the amount thereof which is intercepted by each of said paths, and an output circuit in which the varying currents in said return paths cooperate to induce voice currents corresponding to the voice currents in said input circuit.

5. In a telephone repeater, means for producing a beam of electrons, a target comprising two segments each intercepting a portion of said beam, an output circuit, an input circuit carrying voice currents for producing deflections of said beam thereby shifting its contact with the target so that varying amounts of said beam are intercepted by each of said segments while the beam is maintained in contact with both segments, and a local return circuit for said electrons including both said segments and inductively coupled to said output circuit to induce amplified voice currents therein.

RODNEY G. RICHARDSON.