

Aug. 11, 1931.

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1,818,760

PROCESS AND APPARATUS FOR DRAWING ELECTRICAL PICTURES

Filed Jan. 18, 1929

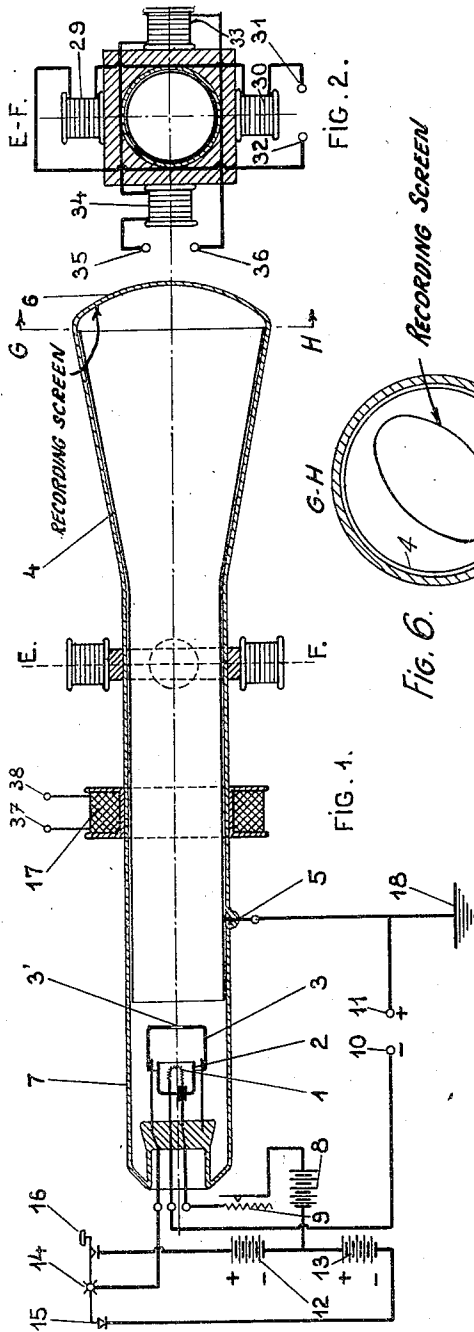


FIG. 2.

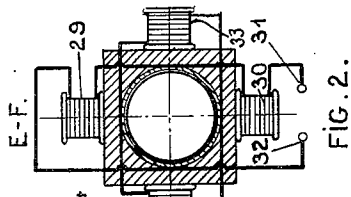
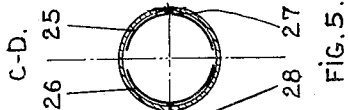
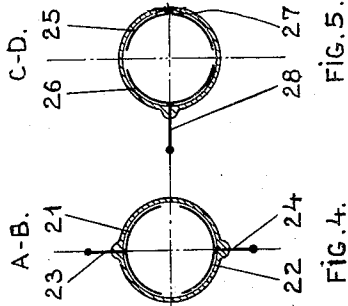
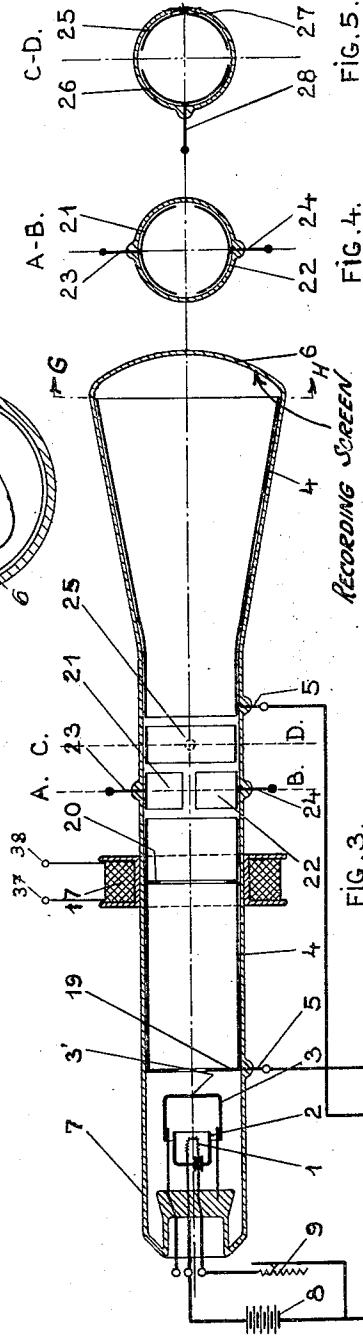
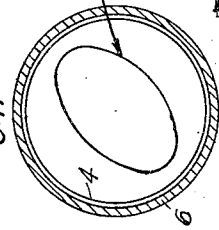


FIG. 6.



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PROCESS AND APPARATUS FOR DRAWING ELECTRICAL PICTURES

Application filed January 18, 1929, Serial No. 333,462, and in Hungary and Austria February 1, 1928.

It is known, that cathode rays consist of rapidly moving electrons, and it has also been noticed, that the glass parts of discharge vessels, for instance of Braun tubes, acquire a negative charge on the spots hit by the cathode rays. These charges of the wall are in most cases apt to cause disturbances in the functioning of the tube, and therefore in most cases measures must be taken for avoiding the possibility of existence of such wall charges.

According to the invention, I am utilizing this effect of the cathode rays, regarded mostly as disturbing heretofore, for producing permanent electrical pictures or drawings. According to my invention a strong, sharply defined bundle of cathode rays, a so-called "pencil" of rays, generated in a Braun-tube instead of the usual fluorescent screen, of highly insulating material disposed in the tube instead of the usual fluorescent screen, and this "pencil" of rays is set in motion by known means, i. e. variable electrical or magnetic fields generated by condensers or magnetic coils disposed in or about the tube.

The path of the moving rays on the screen leaves a permanent but invisible mark on it, in the shape of a line drawn with electrical charges. This process is in a way similar to the functioning of a fountain pen filled with a kind of ink the writing of which is invisible and must be "developed" afterwards, for instance by heating, and may be compared with it by way of explanation. In the same manner, as the ink constantly flowing from the fountain pen leaves and traces its, as yet invisible, mark on the paper along the lines of travel of the pen, the negative charges constantly conveyed by the cathode rays mark the path of travel of the pencil of rays on the spots of the screen hit by them, by getting fixed on the highly insulating material of the screen, and forming thereon an invisible line, drawing, or picture,—according to the character of motion and intensity of the rays,—consisting of negative charges imparted to the spots of the screen hit by the pencil of rays. This invisible "electrical picture" can easily be made visible in a manner similar to that used in producing the known

"Lichtenberg-figures", i. e. by spraying the screen with a fine electrically charged powder. To this purpose, I preferably use a mixture of fine, powdered sulphur and minium. When this mixture is sprayed on the screen by a current of air produced for instance with a rubber-ball sprayer, the sulphur acquires a negative, the minium a positive charge, as is well known, and therefore the minium particles adhere to the negatively-laden spots of the screen, thereby making the "electrical drawing" visible in red lines.

By means of this new process, all the known feats of the known Braun-tube can be accomplished, that is, the shape of curves of alternating currents, electrical oscillations, etc. can be recorded permanently electrically on the screen, and made visible by spraying it with sulphur-minium powder, this picture also being fixable in the known manner used for instance for fixing Lichtenberg figures. By means of the new process, electrically transmitted pictures can also be recorded. The new process may be used in the most suitable, and simple manner if instead of a separate screen disposed inside the tube, which must be, in most cases, taken out for "developing" the electrical picture, the wall of the cathode ray tube itself is used as picture-recording screen. As the wall of the tube is made of highly insulating material for instance of glass, silica or the like, it presents no obstacle to the electric lines of force, and therefore nothing prevents the further use of the "electric picture" transmitted to its outer surface. For instance it may be rendered visible by dusting over the outer surface in the same way as described above. The picture obtained in this manner is slightly less sharply defined, owing to the divergence of force lines, than the picture which can be developed on the inner surface of the wall of the tube, or on a separate screen of highly insulating material disposed inside the tube, but as weighed against the simplicity of the process, this circumstance represents no serious drawback.

For obtaining better visibility of the picture, it is advisable to make the part of the wall of the tube used as screen of opaque ma-

terial, for instance black glass, or to provide it on its outside with a thin layer of black, highly insulating, varnish.

The sensitivity of this process of recording or of developing is extremely high. I have found that a line "written by means of electricity" containing 1 unit of electro-static charge, i. e. a charge of 1/3000 micro-coulomb per centimetre may still be rendered quite visible by means of the dusting over process. If therefore the current intensity of the bundle of rays is 1 milliampere, i. e. if it carries a charge of 1000 microcoulombs per second, it may be used for writing on a highly insulating screen at a speed of 1000:

$$1/3000 = 3000000 \text{ cm./sec.} = 30 \text{ km./sec.}$$

and there will still be obtained a curve capable of being well developed besides, the carrying out of this process according to what has been said above is very simple. In order to make the tube suitable for taking the picture of a new curve, the dust which has adhered to the vessel is wiped off and the vessel deprived, by means of a Bunsen lamp, of any charges it may have possessed.

A copy may, of course, be drawn or a photograph made, of the picture, previous to its being wiped off, or it may be fixed on the tube wall itself, for instance by spraying a liquid which forms a transparent film over it. The following process has been found suitable for making the pictures permanent: A very thin membrane of insulating material, as paper, collodium, rubber and the like, stretched over a frame, is laid on the outside of the tube or valve wall which serves as a screen on which the picture is obtained. The picture is developed, for instance by means of dusting over, fixed, and the framed film removed from the wall of the vessel.

It is of course necessary to remove the charges of the screen before using the tube again. If the wall of the vessel is of glass, it is possible to impart to it the amount of conductivity required for removing the wall charges by heating it slightly.

The process according to the invention may also be used for reproducing pictures transmitted by means of electricity. The reproduced picture appears on the tube wall used as a screen. Many methods are known for transforming pictures into corresponding electric impulses. It is also well known that the ordinary Braun tube provided with a fluorescent screen may be employed as a receiving device for the purposes of electric transmission of pictures.

It is evident that the cathode ray tube according to the invention may in the same manner be used for the purpose referred to, with the essential difference, however, that whilst the picture appearing on the fluorescent screen is immediately visible it likewise disappears immediately. The picture "drawn"

upon the screen by means of charges of varying strength imprinted on its various places by the process according to the invention is not yet visible after the transference has been effected, but is already fixed in the form of electric charges. If the screen is dusted over with a fine powder possessing an electrical charge, the picture becomes visible and at the same time remains permanently fixed. In this case it will be preferable to influence the bundle of cathode rays not only as regards its direction but also as regards its strength, which may be done with the aid of the governing electrode in a manner per se known.

In what follows, I shall describe and illustrate by means of the drawings annexed a few embodiments, shown by way of example, of the discharge vessel employed for carrying out the process according to the invention, describing also the corresponding methods for operating these discharge vessels. In the drawings, Fig. 1 illustrates an oscillograph tube of the incandescent cathode type, fitted with cathode ray deflecting magnetic coils, a governing electrode, and its connections. Fig. 2 shows the arrangement and wiring of the deflecting coils as seen as the cross-section of the tube, approximately along line E—F of Fig. 1. Whereas Fig. 3 illustrates a similar tube or valve, fitted with deflecting condensers built into it, the arrangement of those latter, along lines III—III and IV—IV, being visible in cross-section in Figs. 4 and 5. Fig. 6 shows in section G—H of Figs. 1 and 3 the end wall 6 of the tube consisting of insulating material and functioning as recording surface with the illustrative pattern of a rotary magnetic field, in the shape of an ellipse, recorded on it by the process according to the invention.

The oscillograph tube shown on Fig. 1 possesses the well known form of tubes of similar purpose; it is made of glass, silica or the like, and is fitted with three or four electrodes, notably the incandescent cathode 1, the cap 2 used for concentrating the cathode rays, the governing electrode 3 at the centre of which a round hole 3' is provided, and the anode 4. The latter is made in the shape of a thin metallic layer, metal mirror, which covers the whole inner surface of the tube with the exception of the front wall 6 used as a screen and the part of the valve on the neck side 7, and is fitted with a lead-out electrode 5.

This metallic mirror may for instance be produced by evaporating magnesium in the tube in a known manner, and using heat from outside for making the magnesium mirror disappear from the places it is intended to leave bare. This way of making the tube ensures many advantages from the point of view of manufacture and correct function-

ing of the tube. It was found, that the highest vacuum obtainable is necessary for the correct functioning of the tube, because if the tube contains any small quantity of residue gas molecules, these are ionized by the cathode rays and the positive ions produced thereby have a neutralizing effect on the negative charges set up on the screen or the wall of the tube by the cathode rays and it is impossible to obtain lasting permanent electrical pictures.

It is well known to experts, that the more metal parts a discharge tube contains, the more difficulties there are to be faced when it is to be evacuated completely. If the anode of the tube consists of a metal layer on the inner wall of the tube—as stated above—the advantage obtained thereby not only consists in avoiding the metal parts difficult to free from residue gases, but it is at the same time possible to utilize the known vacuum-improving qualities of the magnesium evaporated in the tube. The electrical connection of the tube is made up in such fashion, that the incandescent filament 1 is heated by battery 8, the regulation of heating being effected by means of resistance 9, whereas the voltage of a few kilovolts employed for accelerating the cathode rays is connected to points 10 and 11, of which the latter is preferably provided with an earthing device 18.

Care must also be taken to insure that the cathode rays reach the screen 6 only during the time when the phenomenon to be registered is taking place. According to the invention this operation is carried out by making use of the governing electrode 3. According to the diagram of connections shown on Fig. 1 governing electrode 3 is connected, in normal condition of the tube, with the negative pole of battery 13 through contact 15 of key 14. This negative tension prevents the emission of electrons by the incandescent filament 1 and thus prevents the production of cathode rays. If, however, the key 14 is pressed down simultaneously with the starting of the phenomenon to be registered, positive tension derived from battery 12 is set up on grid 3 through contact 16 and the emission of electrons by the incandescent filament and the production of cathode rays take place.

It is possible to produce, notably by making use of electron valves, methods of connection, known per se, effects which make the voltage variations of the governing electrode correspond automatically to the phenomenon which it is intended to register. By which means it becomes possible to register, in an automatic manner, phenomena happening casually, for instance excess voltages set up on transmission lines and so forth. The correct operation of the tube shown on Fig. 1 also comprises the

known employment of the magnet-coil 17 supplied with direct current, of experimentally determined practically constant intensity, from any suitable source, connected with the coil at the points 37 and 38. By the magnetic field of this coil the divergent bundle of cathode rays issuing forth from opening 3', is concentrated or focussed on the screen 6.

By suitably choosing the position and current intensity of the concentrating coil it is possible to insure that the cathode rays unite into a sharply defined point of small size on the screen 6, the size of which point equals that of the opening 3' and makes the "picture" a very sharply defined one.

In the tube shown on Fig. 1, the direction of the cathode rays is influenced, in a manner well known by itself, by the deflecting coil 29, 30 and 33, 34, the arrangement of which is best shown on Fig. 2. As seen on this figure, the opposite coils are connected in series, and the rays can be deflected by them in a manner known by itself. Under the influence of their magnetic fields, generated by the electrical currents influenced by the phenomena to be recorded, these currents being supplied by any suitable source and connected to the two pairs of deflecting coils at the points 31, 32 and 35, 36.

If, for instance, two different phases of a three-phase current are connected to the two pairs of deflecting-coils, the rays will record on the wall 6 an ellipse-like figure as shown on Fig. 6, which can be made visible by sprinkling it with a mixture of finely powdered minium and sulphur in the manner mentioned above; the clearness of the figures can be increased, if the wall 6 consists of black glass, or has a thin layer of highly insulating black varnish on its outer side.

Whilst in the tube according to Figure 1 the direction of the cathode rays can only be influenced by means of a magnetic field, the tube shown in Fig. 3 is also suitable for electric deflection. For this purpose, deflecting condensers built into the tube are employed. The outward shape of the tube as well as the arrangement of incandescent filament 1, cap 2 and the governing electrode 3, which latter is provided with opening 3' is similar to that of the tube or valve shown on Fig. 1. In the present case, however, it is preferable to divide the discharge tube, in the usual way, into two parts by means of the metallic diaphragm 19.

The voltage accelerating the electrons is connected between the governing electrode 3 and diaphragm 19, the latter therefore assumes the role of anode, and the cathode rays passing through its opening pursue their way in a space practically free from lines of force. It has been found practical, in this case also, to coat the inner wall of the tube with a me-

tallic layer, which consists in the embodiment shown by way of example on the drawings, of parts 4 and 4' and is in conductive connection with, or may be connected to the diaphragm 19 through the lead-out electrodes 5 and 5'.

The tube shown on Fig. 3 differs from similar devices known up to now, also as regards the arrangement of the deflecting condensers built into it. The plates of the deflecting condensers are composed of the semi-cylindrically-shaped parts, insulated from each other, and provided with leading out electrodes, of the metallic layer covering the inner wall of the tube. One of the condensers is formed by the semicylinders 21 and 22 fitted with leading out electrodes 23 and 24, whilst the other condenser is formed by the pair of semicylinders 25 and 26 fitted with leading out electrodes 27 and 28, as shown in Figs. 4 and 5, the cross-sections of the tube along lines III—III and IV—IV.

The metallic layers 4 and 4', and the metallic layers 21, 22, 25 and 26, constituting the deflecting condensers, may be formed on the inner wall of the tube in the above-mentioned manner, that is, by evaporating magnesium inside the tube, whereby a metallic layer is formed on the entire inner surface of the tube. By heating the outside walls of the tube with a Bunsen-flame, the layer is made to disappear from those parts of the wall, where it is not wanted, as for instance, the part 6 used as screen. In the same manner, by heating with a sharply pointed flame, the metallic layer is subdivided to form the separate layers 21, 22, 25 and 26 constituting the deflecting condensers, whose leading out electrodes 23, 24, 27 and 28 have been molten into the tube in a previous stage of its manufacture, in a manner to insure good electrical contact with the metallic layers made afterwards in the above-mentioned manner.

The advantage of this arrangement—besides its simplicity of manufacture—consists in the fact that the cathode rays filling the whole cross-section of the tube also pass through the condensers. The drawings also show the diaphragm 20, which is employed for keeping back the secondary rays reflected from the tube wall i. e. from the metallic layer 4 or originating there.

Having now particularly described and ascertained the nature of my invention and the manner in which it is to be performed, I declare that what I claim is:—

1. A process for registering and permanently recording phenomena transformed into varying electrical forces, by means of cathode rays produced in a cathode ray tube, comprising producing, intensifying and focussing said cathode rays in a vacuum, intercepting said cathode rays by an electrical insulating medium, changing the form and intensity of the cathode rays corresponding

to said electrical forces and retaining on said medium the charges imparted to it by said differentiated cathode rays by means of charged particles distributed on said insulating medium.

2. A process for registering and permanently recording phenomena transformed into varying electrical forces by means of cathode rays produced in a cathode ray tube, comprising producing, intensifying and focussing said cathode rays in a vacuum on the wall of said tube, electrically influencing the cathode rays corresponding to said electrical forces and distributing charged particles on said wall of the tube.

3. An apparatus for registering and permanently recording phenomena transformed into varying electrical forces by means of cathode rays, comprising a cathode ray vacuum tube having an insulating end wall intercepting the cathode rays, electrical means to differentiate in form and intensity the cathode rays corresponding to said electrical forces and charged particles distributed over said insulating end wall for recording the differentiated cathode rays corresponding to said phenomena.

4. An apparatus for registering and permanently recording phenomena transformed into varying electrical forces by means of cathode rays, comprising a cathode ray vacuum tube having an opaque insulating end wall intercepting the cathode rays, electrical means to differentiate in form and intensity the cathode rays corresponding to said electrical forces and charged particles distributed over said insulating end wall for recording the differentiated cathode rays corresponding to said phenomena.

5. An apparatus for registering and permanently recording phenomena transformed into varying electrical forces by means of cathode rays, comprising a vacuum cathode ray tube having an insulating end wall intercepting the cathode rays, an incandescent cathode in the neck of said tube, an anode on the side walls of said tube, a diaphragm between said cathode and anode, electrical means to differentiate in form and intensity the cathode rays corresponding to said electrical forces and charged particles distributed over said insulating end wall for recording the differentiated cathode rays corresponding to said phenomena.

6. An apparatus for registering and permanently recording phenomena transformed into varying electrical forces by means of cathode rays, comprising a vacuum cathode ray tube having an insulating end wall, an incandescent cathode in the neck of said tube opposite said end wall, a diaphragm provided with a hole adjacent said cathode, a thin metallic layer on the side walls of said tube divided so as to form two cylindrical anodes, two condensers having semi-circular

plates and being in quadrature and charged corresponding to said phenomena, electrical means to differentiate in form and intensity the cathode rays corresponding to said electrical forces and charged particles distributed over said insulating end wall for recording the differentiated cathode rays corresponding to said phenomena.

7. In an apparatus according to claim 6, in combination, a governing electrode adjacent said cathode and means normally impressing a negative voltage on said governing electrode and impressing a positive voltage thereon during the occurrence of said phenomena.

8. In an apparatus according to claim 6, in combination, a governing electrode adjacent said cathode and electrical means mechanically operated normally impressing a negative voltage on said governing electrode and impressing a positive voltage thereon during the occurrence of said phenomena.

9. In an apparatus according to claim 6, in combination, a governing electrode adjacent said cathode, electrical means normally impressing a negative voltage on said governing electrode and impressing a positive voltage thereon during the occurrence of said phenomena, and means simultaneously effecting occurrence of said phenomena and impression of said positive voltage on said governing electrode.

10. An apparatus for registering and permanently recording phenomena transformed into varying electrical forces by means of cathode rays, comprising a vacuum cathode ray tube having an insulating end wall, an incandescent cathode in the neck of said tube opposite said end wall, an anode on the side walls of said tube, a diaphragm between said cathode and anode, means electrically differentiating the cathode rays corresponding to said phenomena and positively charged particles exteriorly placed on said end wall for recording the thus differentiated cathode rays corresponding to said phenomena.

In witness whereof, I have hereunto signed my name.

PAUL SELÉNYI.

CERTIFICATE OF CORRECTION.

Patent No. 1,818,760.

Granted August 11, 1931, to

PAUL SELENYI.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 19, after "tube" insert a comma and phrase , in manner known by itself hits a screen of highly insulating material disposed in the tube; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of December, A. D. 1931.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.