Jan. 27, 1959 O. STERNBECK ET AL 2,871,401

METHOD FOR STORING INFORMATION IN AN ELECTRONIC STORAGE TUBE

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Fig. 1

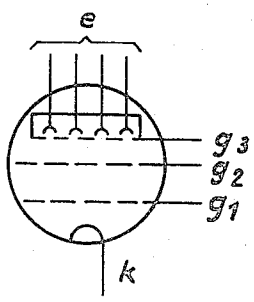
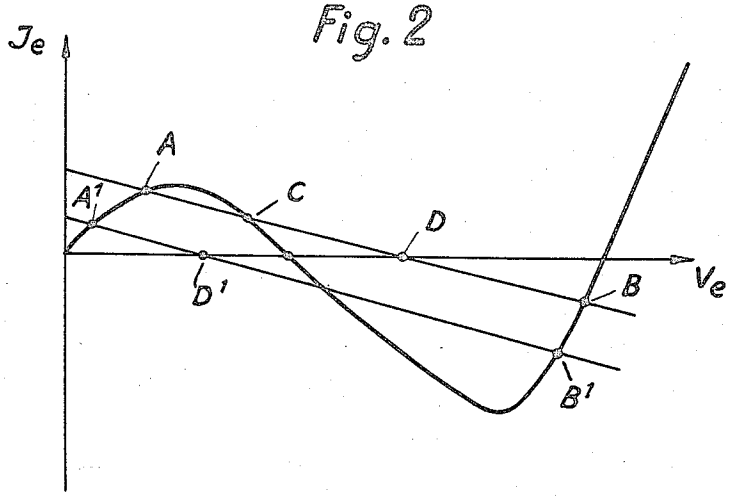


Fig. 2



INVENTORS
OLAF STERNBECK
WOLFRAM ERHARD MAX UHLMANN
BY Rudolf G. Hans
ATTORNEY

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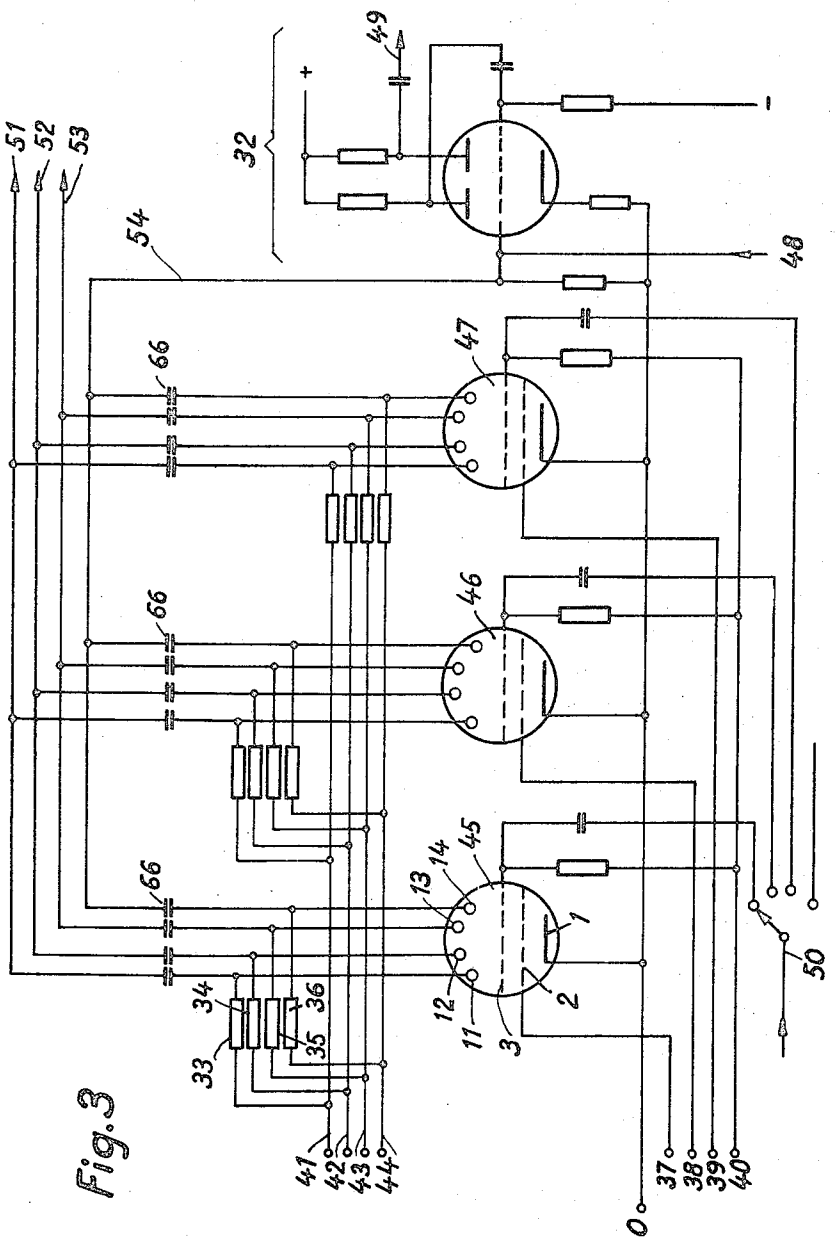

Fig. 3

INVENTORS
OLAF STERNBECK
WOLFRAM ERHARD MAX UHLMANN
BY Friedrich L. Hamm
ATTORNEY

United States Patent Office

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METHOD FOR STORING INFORMATION IN AN ELECTRONIC STORAGE TUBE

Olaf Sternbeck, Alvsjo, and Wolfram Erhard Max Uhlmann, Hagersten, Sweden, assignors to Telefonaktiebolaget L. M. Ericsson, Stockholm, Sweden, a corporation of Sweden

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Claims priority, application Sweden February 27, 1953

1 Claim. (Cl. 315—12)

The purpose of this invention is to show the procedure for the storage of information in electronic storage tubes. These storage tubes may thereby, with respect to their storage elements, be connected in parallel when, however, it is possible to perform a registering or reading of information in one tube at a time without interaction between the tubes.

The invention is applicable to electronic storage tubes of the type that contains at least one electron emitting cathode, arrangements for controlling the current which is emitted from the cathode, a number of secondary emission electrodes, functioning as storage elements, which electrodes interconnected by means of appurtenant outer impedances can assume two different stable potentials on account of their negative resistance characteristic within a certain voltage range, one or more collector electrodes for gathering of the primary current and the secondary electron currents. All storage elements are thereby electrically accessible directly from the outside of the envelope.

The procedure according to the invention is in principle characterized by the fact that for the registering of information the register elements, which are to be marked by the potential 0, via their outer impedances, are connected to a negative or relatively small positive voltage, near the cathode potential lying direct voltage, and that the registering elements which are to be marked with a positive potential, via their outer impedances, are connected to a higher positive direct voltage, whereby all potentials are to be referred to the cathode potential, and that, during the time when the elements have their respective potentials, the primary electron current is temporarily suppressed.

The invention will hereinafter be described with reference to the attached diagram, where Fig. 1 shows a storage tube, Fig. 2 a voltage-current-characteristic for a storage element, which is an integral part of such a tube, and finally Fig. 3 shows a circuit diagram of an arrangement, which is suitable for the performance of the processes according to the invention and which arrangement contains a number of storage tubes.

In order to make the explanation of the invention easier the principle of operation of such a storage tube, which is used in the circuits in question, will be explained.

A tube of this type contains a hot cathode as an electron emitting source, a control grid which usually operates with a negative potential, an accelerating grid and a collector grid, behind which there are a number of storage elements, in a space, which is surrounded by the collector grid. Fig. 1 shows a schematic view of the tube. An electron beam is generated at the cathode k and controlled by the control grid g_1, the electron beam being accelerated through the accelerating grid g_2, after which the beam impinges partly on the collector grid g_3, and partly diffuses into the space, which is surrounded by the collector and in which space the following happens with relation to the elements therein.

As long as these elements are maintained at cathode potential they are unable to receive any electrons, when these electrons return to the collector. As soon as an element receives a positive potential, an electron current appears, which initially will increase with the applied potential and then pass a maximum and then again decrease. At a certain potential where the secondary emission factor of the elements is equal to 1, the current will again decrease to 0, and will become negative at values above this potential. After the function has passed a minimum on having the potential further increased, it will once again pass through the 0 point at a potential which is the same as that of the collector electrode. Fig. 2 shows the characteristic of such an element. If such an element is connected to a suitable potential D via a sufficiently high resistance, so that the resistance line Ra cuts the element characteristics in the three points A, B and C, two stable points of intersection are found, namely A and B. A is then equivalent to the locked or barred condition of the element, at which the element potential is near the cathode potential, and B the locked or barred condition at which the element potential is near the collector potential. Point C is unstable. The two stable points A and B differ fundamentally from each other. In point A the inner resistance of the element in relation to the collector is very high and, consequently, a modulation of the collector potential cannot exert any influence upon the element. In point B, on the other hand, the inner resistance of the element in relation to the collector is very low and the element, therefore, is able to follow the collector modulation and give an initial potential.

A procedure for register information in such storage tubes will be described in the following.

For registering information a direct voltage signal is for example used, which via a resistance is supplied to a certain registering element. The lines A—C—D—B and A′—D′—B′ are resistance lines for the resistances in question at two values of the above mentioned direct voltage. If in the beginning the tube is non-conducting the registering element in question will be at a potential, which is the same as the potential, which is applied externally to the element in question. This potential is assumed to be low and near the cathode potential, for example the potential which is shown in the point D′ in Fig. 2. When, thereafter, the cathode current is caused to flow through the tube and the potential applied externally to the resistance is kept unchanged (point D′) the potential of the element will decrease to point A′, which is the first stable point of the characteristic. If, thereafter, the potential externally applied to the resistance, is increased, for example to the value which corresponds to point D, this will only insignificantly affect the potential of the registering element in question, which only increases to point A of the characteristic. It is evident that the element potential in spite of the fact that a relatively high direct voltage (point D) is applied, will remain at a value near the cathode potential on the assumption made above that the externally applied or registered potential is low at the moment when the cathode current begins to flow.

If, on the other hand, when the tube is non-conducting, the potential externally applied to the resistance of the registering element is high, for example corresponding to point D in Fig. 2, the potential of the element will also be high (point D). When the cathode current is caused to flow again and the potential across the resistance remains unchanged (point D) the potential of the element will increase to point B of the characteristic, which point is the other stable point and is situated near the collector potential. If the potential, externally applied to the resistance, thereby is decreased to, for example, point D′, the potential of the registering element will in this case

decrease only slightly, viz. to point B'. In this case it is also evident that the potential of the element remains at the value, which it originally had, when the tube became conducting.

The potential of the registering element can, therefore, have two values, namely partly a low value (point A—A'), near the cathode potential and partly a high value (B—B'), near the collector potential, independent of the fact how the direct voltage signal externally applied is varied. Which of these two values the potential has, is determined by the value of the above mentioned direct voltage signal at that moment, when the tube current begins to flow, i. e. by the value, which has been registered on the element in question.

Further in order to clarify the registering process in accordance with the principles of the invention a description will be given in the following with reference to Fig. 3 showing a circuit for example with three tubes.

The circuit arrangement shown in Fig. 3 contains three registering tubes 45, 46 and 47. Each of the tubes contains a cathode 1, a control grid 2, a collector grid 3 and four registering elements 11, 12, 13 and 14. The last mentioned elements are via the individual conductors and resistances 33, 34, 35, 36 connected to the input terminals 41, 42, 43 and 44, to which the pulses, which are to be registered in the tubes, are applied. The above mentioned input terminals are common for the registering elements in each of the three tubes 45, 46 and 47. Further, the registering elements are connected to individual, but for the elements in different tubes, common output connections 51, 52, 53 and 54. The grid 2 in each of the tubes is connected to an individual input terminal 37, 38 and 39 and the grids 3 are connected to a common input terminal 40 via a resistance. Further, the collector grids are via condensers connected to individual contact lugs in a distributor 50. Finally, the output connection 54 is shown connected to a multivibrator 32, the output connection of which is designated 49.

The registering of information is, in the circuit diagram shown in Fig. 3, carried out as follows. The potential is at the commencement of the registering process about zero on the input terminals 41—44 and the grids 2 in the tubes 45—47 have a positive bias via the terminals 37—38, for example +10 volts. Current will thereby flow through all the tubes 45—47 and all the registering elements of these tubes have the potential zero. The elements are in other words locked at this potential. The desired registering potential is then applied as a direct voltage signal to the terminals 41—44. The tubes are meant to receive the registrations of the binary system and the terminals 41—44 shall, therefore, have one of two different potential values. It is assumed in this case that these different values are a positive potential, for example 100 volts, and the cathode potential, i. e. 0 volt. Further, it is assumed that the desired registering voltage 100 volts is applied to the terminals 41 to 44, while the terminals 42 and 43 receive the potential 0 volt. By applying the above mentioned potentials to these terminals nothing happens in the tubes, because they are conductive at this moment. Further, it is assumed that it is wished to register the information applied to the terminals 41 to 44, viz. +, 0, 0, + in the first tube 45. For this purpose the cathode potential (0 volt) is applied to the grid for a moment, whereby, the current in tube 45 will be supressed. The electrodes 11 to 14 of this tube will thereby get the potentials, which are applied to the corresponding terminals 41 to 44, so that in the case in question the electrodes 11 and 14 will get a high positive potential and the electrodes 12 and 13 receive the potential 0. A positive potential (+10 volts) is then again applied to the grid 2, so that current again will flow in this tube. The different electrodes will thereby mainly keep the potentials which they have got on account of the registering potential of the terminals 41—44 so that the potential of the electrodes 11 and 14 will be high and the potential of the electrodes 12 and 13 low. The potential of the secondary emitting electrodes will thus be found to coincide with point B in Fig. 2 in case of the two first mentioned elements while for the two last mentioned their potentials will correspond to point A in the same figure. The above mentioned electrodes will in other words be locked either in the upper or lower potentials, respectively, in compliance with the potentials applied to the registering terminals. The electrodes 11 to 14 maintain in the future the potentials +, 0, 0, +, as long as the grid 2 is positive (10 volts), whereby the information in question or the digit combination is registered in these elements in the tube 45. As soon as the positive control potential (10 volts) again has been applied to the grid 2 the registering potentials of the input terminals 41 to 44 may again be removed. These terminals are then accessible for a new registering process in either of the two tubes 46 and 47, without the information registered in the tube 45 being obliterated or distorted. Thus, the information +, 0, 0, 0 in the tube 46 and the information 0, +++ in the tube 47 may be registered.

The time necessary for registering information will in the arrangement shown in Fig. 3 be determined by the values of the resistances 33—36 and the condensers 66.

The above arrangement is only an embodiment of the invention suitable for a certain purpose and a number of modifications of the invention may be performed by those skilled in the art.

We claim:

A control system for storing an information in electronic storage tubes, which contain at least one electron emitting cathode, means for control of the current emitted from the cathode, a number of secondary emission electrodes functioning as storage elements, which electrodes interconnected with their appurtenant outer impedances may obtain two different, stable potentials on account of their negative current potential characteristic within a certain area, means for applying one of two potentials to each storage element through the above mentioned impedances, the lower of said potentials being in the vicinity of zero potential, at least one collector electrode for collection of the primary current and the secondary electron currents and in which tubes all storage elements separately are from outside directly, electrically accessible, the said system comprising circuit means connecting, for registering binary information, the registering elements to be marked at one potential, via their outer impedances, to said lower potential in the vicinity of the cathode potential, circuit means connecting the registering elements, which are to be marked with a positive potential, via their outer impedances to a higher positive direct potential, whereby all potentials are referred to the cathode potential, and circuit means for temporarily suppressing the primary electron current while the said elements have their respective potentials.

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