Feb. 21, 1956 J. T. McNANEY 2,735,956

CATHODE RAY APPARATUS

Filed July 12, 1952 3 Sheets-Sheet 1

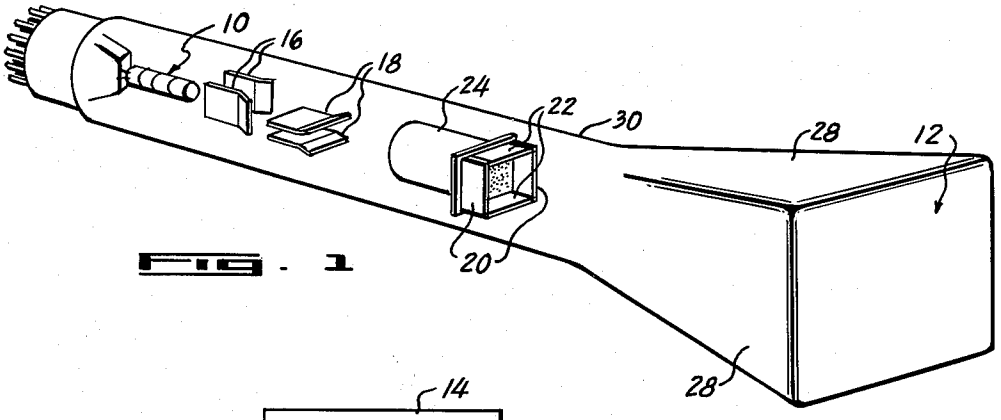

FIG. 1

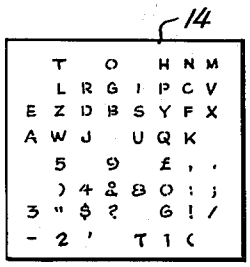

FIG. 2

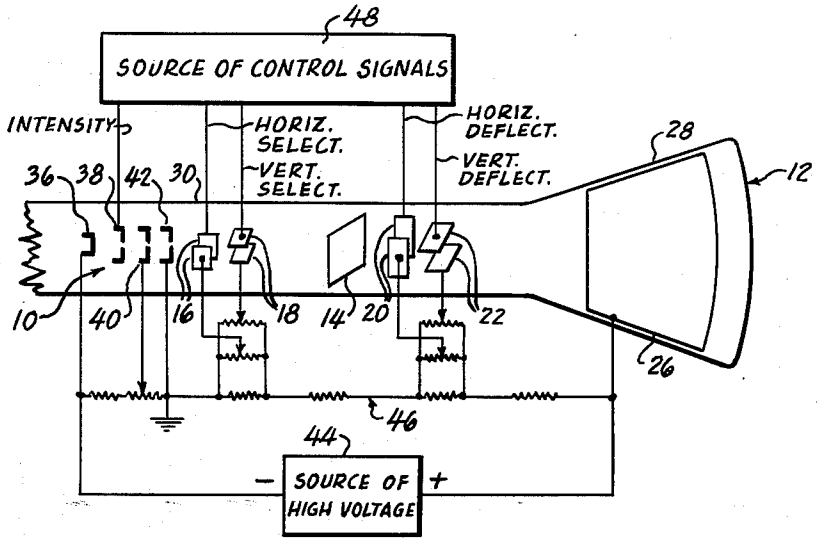

FIG. 3

INVENTOR:
Joseph T. McNaney
BY
Walter J. Jason
ATTORNEY

Feb. 21, 1956 J. T. McNANEY 2,735,956

CATHODE RAY APPARATUS

Filed July 12, 1952 3 Sheets-Sheet 2

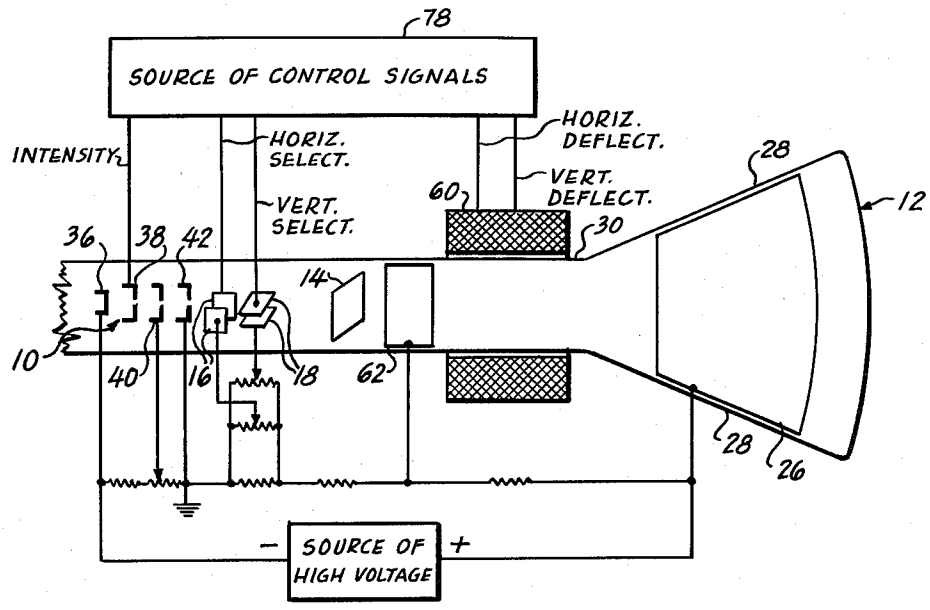

FIG. 4

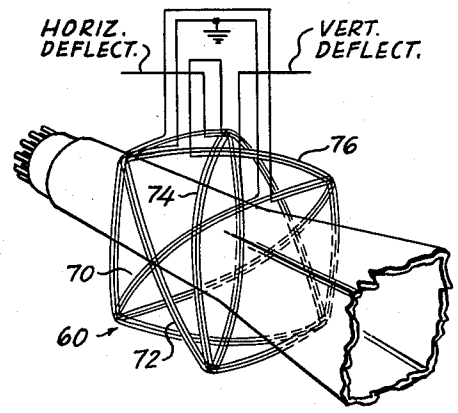

FIG. 5

INVENTOR:
Joseph T. McNaney
BY
Walter J. Jason
ATTORNEY

Feb. 21, 1956 J. T. McNANEY 2,735,956

CATHODE RAY APPARATUS

Filed July 12, 1952 3 Sheets-Sheet 3

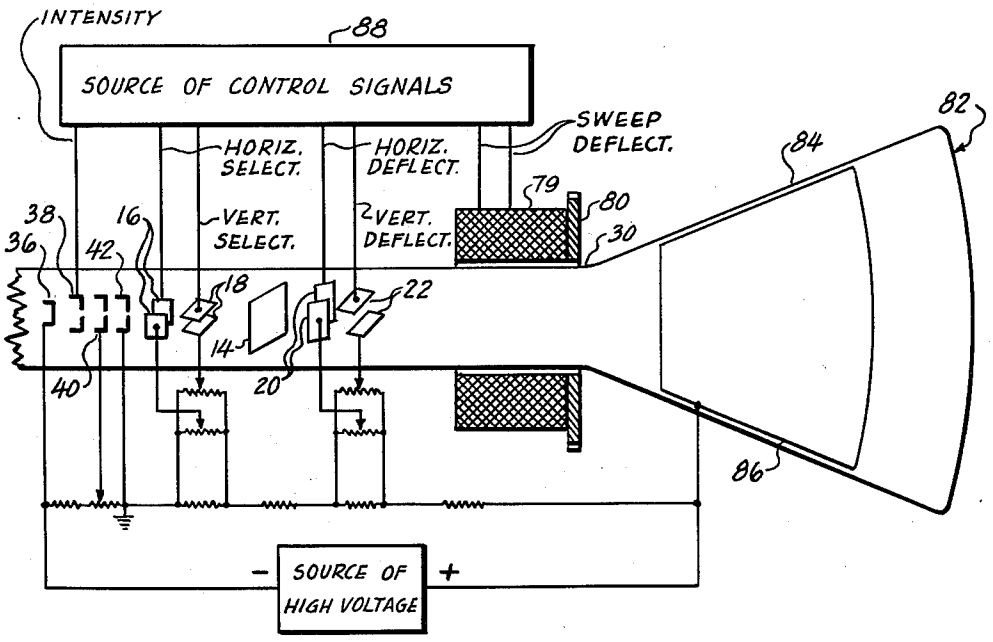

FIG. 6

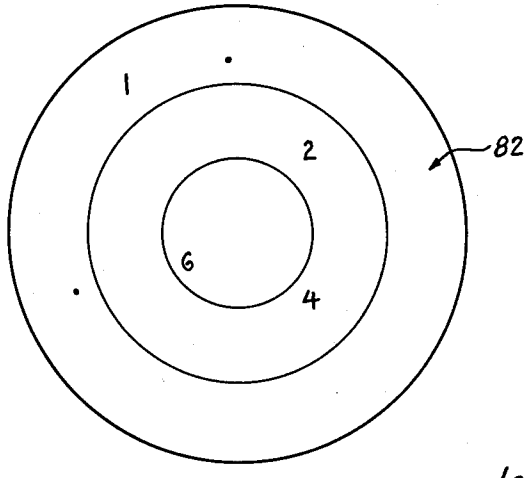

FIG. 7

INVENTOR:
Joseph T. McNaney
BY
Walter J. Jason
ATTORNEY

United States Patent Office 2,735,956 Patented Feb. 21, 1956

2,735,956

CATHODE RAY APPARATUS

Joseph T. McNaney, San Diego, Calif., assignor, by mesne assignments, to General Dynamics Corporation, a corporation of Delaware

Application July 12, 1952, Serial No. 298,603

6 Claims. (Cl. 315—24)

This invention relates to improved cathode-ray apparatus for selectively displaying images having predetermined shapes, such as characters.

The apparatus of my invention is particularly suitable for displaying information at high speeds, and it may be employed with suitable recording apparatus to provide a printed record of the displayed information. One suitable recording arrangement is dsclosed in my co-pending application Serial No. 295,589.

If desired, the apparatus may be arranged to provide a display which is suitable for direct visual observation.

I have found that the beam of electrons of a cathode-ray tube may be shaped so that its cross-section is in the form of selected characters, and that the beam of electrons can be directed to any part of the viewing screen of the tube after it has been shaped. With such an arrangement, a plurality of characters may be displayed at one time, and the characters may be displayed along lines on the screen of the tube if desired.

In accordance with my invention, I provide a thin solid member located along the path of the beam of electrons in a cathode-ray tube. A plurality of apertures are provided in the solid member for controlling the cross-sectional shape of the electron beam, and the individual apertures are shaped in the form of the configurations to be displayed, say in the form of characters. A first deflection system is located intermediate the electron gun of the tube and the solid member for deflecting the electron beam and causing it to pass through selected individual apertures in the solid member where it is shaped in the form of the selected apertures. A second deflection system is located intermediate the solid member and the screen of the tube for directing the shaped beam toward any part of the screen.

If desired, a further deflection system may be employed to provide a P. P. I. presentation on the screen of the tube.

The cathode-ray tubes and my present invention are of less complex construction than those disclosed in the above patents, and in addition, they may be employed to display images on substantially any part of the screen of the tube.

My co-pending application Serial No. 297,480 discloses cathode-ray tubes which are similar to those of the present invention, but which differ in that a pair of deflection systems are employed intermediate the electron gun and the apertured solid member.

The present invention is explained with reference to the drawings, in which:

Fig. 1 is a perspective view of a preferred embodiment of the invention;

Fig. 2 shows one suitable matrix arrangement for the beam-shaping member of Fig. 1;

Fig. 3 is a diagram showing the tube of Fig. 1 connected to sources of potentials;

Fig. 4 is a diagram showing an alternative embodiment of the invention employing magnetic deflection;

Fig. 5 illustrates a suitable coil for use in the embodiment shown in Fig. 4;

Fig. 6 shows another embodiment of the invention which is suitable for providing P. P. I. presentations on the screen of the tube; and

Fig. 7 shows a typical display which may be produced on the screen of the tube shown in Fig. 6.

The cathode-ray tube shown in Fig. 1 has an electron gun 10 of a conventional type located at one end of an evacuated glass envelope, and a target or screen 12 located at the other end. Various types of screens may be employed, the type of screen being determined by the manner in which the displayed information is used. Ordinarily, a short-persistence type luminescent material is preferable when the displayed information is to be recorded photographically. When the displayed information is to be viewed directly, a medium-persistence luminescent material, such as fluorescent phosphor P–4, is preferable. If the information is to be displayed over long periods of time, dark trace viewing screens may be employed.

A matrix 14 is located along and disposed at right angles with respect to the path of the electron beam of the tube. The matrix is provided with apertures shaped in the form of the images to be displayed on the screen of the tube, say in the form of characters as shown in Fig. 2. The characters are ordinarily the letters of the alphabet, the numbers 1 to 9, and any desired punctuation marks and symbols.

The matrix 14 serves to shape the electron beam by interrupting the electrons which approach or strike the solid portions of the matrix and by permitting the other electrons of the beam to pass through the selected apertures. The matrix may be composed of substantially any solid material, and it may be either conductive or non-conductive. A matrix composed of copper is particularly suitable because of the ease with which the character-shaped apertures may be formed by etching or engraving. The material should be thin so that it will not cause undesirable distortion of the electron stream as it passes through the selected apertures. Material having a thickness of .002 inch is suitable for a matrix of the type shown in Fig. 2 in which the portion of the matrix within which the apertures are located measures .625 inch by .625 inch.

The particular order in which the characters are laid out in the matrix depends primarily on the application of the tube and the type of control signals to be used. The layout shown in Fig. 2 is suitable for tubes which are employed to display information which is represented by five- or six-digit binary code signals.

A set 16 of horizontal selection plates and a set 18 of vertical selection plates are provided for controlling the horizontal and vertical deflection of the electron beam. These plates are employed to direct the electron beam through selected individual apertures in the matrix.

A pair of horizontal deflection plates 20 and a pair of vertical deflection plates 22 are provided for deflecting the electron beam after it traverses the matrix, so that the electron beam may be directed to any part of the screen of the tube. The spacing between the deflection plates 20, 22 is larger than the spacing between the selection plates 16, 18 in order to accommodate the beam of electrons at any of its possible locations after it traverses the matrix.

Each pair of the deflection plates 20, 22 is arranged to provide an electric field across an area which is somewhat larger than the area in which the apertures are located in the matrix 14, and each pair of the deflection plates 20, 22 is positioned to provide a field having substantially uniform density along planes disposed perpendicularly with respect to the longitudinal axis of the

tube in order to provide uniform deflection of the beam of electrons at all of the various locations through which the beam may be projected.

In the embodiment of the invention shown in Fig. 1, a hollow metallic member 24 of cylindrical shape is employed to support the matrix assembly. This cylindrical member serves to provide a rigid support for the matrix; however, it is not essential and any desired arrangement may be employed to support the matrix.

Preferably, the tube shown in Fig. 1 is also provided with an intensified anode 26 (see Fig. 3) of a conventional type located adjacent the screen 12. By way of example, the intensified anode may be an aquadag coating around the interior of the glass envelope of the tube.

The preferred embodiment of my invention employs a square screen 12, and the side walls 28 which extend between the screen and the cylindrical body portion 30 of the cathode-ray tube are substantially flat. In such an arrangement the four surfaces of the intensifier anode are substantially flat, and the electric field produced by the intensifier anode does not have an adverse effect upon the linearity of information displayed on the screen of the tube.

A circular screen may be employed if desired. However, the conventional type intensifier anode employed in such tubes is of conical shape, and such anodes cause a slight amount of curvature in the display of information on the screen of the tube. Such curvature is undesirable when the tube is employed to display information which is intended to be aligned on the viewing screen, say along a straight line.

Fig. 3 is a diagram showing the tube of Fig. 1 connected to sources of potentials for operating the tube.

The electron gun 10 is a conventional type having a cathode 36, a control electrode 38, a focusing electrode 40, and an accelerating electrode 42.

A source 44 of high voltage is connected between the cathode 36 and the intensifier anode 26. A voltage divider 46 is connected across the source 44 of high voltage to provide suitable operating potentials for the focusing and accelerating electrodes and the selection and deflection plates. The focusing and accelerating electrodes and the selection and deflection plates are maintained at potentials corresponding to their relative positions with respect to the cathode and the intensifier anode, in accordance with conventional cathode-ray tube design practice. However, the potentional applied to the focusing electrode 40 is adjusted so that the cross-section of the electron beam is larger than the highly-focused beam which is employed in ordinary cathode-ray tubes. The focusing voltage is adjusted to provide an electron beam having a diameter which is just large enough to cover the individual apertures in the matrix.

As shown in Fig. 3, the matrix 14 is floating. If a conductive matrix is employed, it may be connected to a suitable point along the voltage divider; however, I have found that the potential at which the matrix is maintained has little effect upon the operation of the tube.

The control signals which are applied to the tube are determined by the displays to be presented. The source 48 of control signals may be manually operated, or it may operate automatically in response to code signals. One suitable source of control signals is disclosed in my co-pending application Serial No. 331,806.

The source 48 of control signals serves to provide potentials to the selection plates 16, 18 for deflecting the electron beam so that it passes through selected individual apertures in the matrix 14. The source 48 also provides potentials to the deflection plates 20, 22 for deflecting the shaped electron beam to predetermined locations on the screen of the tube. Preferably, the control electrode 38 is biased to cut-off, and the source 48 provides a signal coincident with the selection and deflection signals which raises the voltage of the electrode 38 and permits the electron gun to produce a beam of electrons only during the periods when the respective images are to be displayed.

For example, if a message is to be displayed on the screen of the cathode-ray tube, coincident signals are applied by the source 48 to the tube elements 38, 16, 18, 20 and 22 for each character to be displayed. The potentials applied to the selection plates 16, 18 cause the electron beam to be deflected so that it passes through the character-shaped apertures in the required sequence, and the potentials applied to the deflection plates 20, 22 cause the shaped electron beam to be deflected so that the successive characters are displayed on the screen in the desired positions, say along one or more lines.

Fig. 4 illustrates a modification of the cathode-ray tube in which an electromagnetic deflection arrangement is employed to control the position of the images displayed on the screen of the tube, instead of the electrostatic arrangement shown in Fig. 3.

The tube shown in Fig 4 is the same as that shown in Fig. 3 except that a coil assembly 60 is substituted for the deflection plates 20, 22, and an auxiliary anode 62 is provided intermediate the matrix 14 and the coil assembly 60.

The auxiliary anode 62 may be an aquadag coating around the interior of the cylindrical body portion of the glass envelope, for example, and it serves to maintain the required speed and focus of the electrons of the beam to provide clearly defined images on the screen of the tube. The potential at which the auxiliary anode 62 is maintained is determined by the position of the anode with respect to the electron gun and the intensifier anode 26 in accordance with conventional cathode-ray tube design techniques.

Since the electron beam of the tube is projected through a large number of positions in order to select the various characters to be displayed, the magnetic fields produced by the coil assembly 60 must be arranged to act upon the beam in any of the various locations through which the beam may be projected. In order to provide uniform deflections of the beam, each of the magnetic fields should be of substantially uniform density along planes disposed perpendicularly with respect to the longitudinal axis of the tube.

The coil assembly shown in Fig. 5 illustrates a suitable coil arrangement for providing the required magnetic fields. A pair of horizontal deflection coils 70, 72 are disposed at right angles with respect to one another. A pair of vertical deflection coils 74, 76 are also disposed at right angles to one another, and the coils of the respective pairs are radially displaced 90° with respect to one another around the tube.

The individual pairs of coils are connected in series, and when energized, provide magnetic fields disposed at right angles to the longitudinal axies of the tube and also at right angles with respect to one another. Since the coils of each pair are disposed at right angles to one another, their fields combine to form magnetic fields having substantially uniform density along planes disposed perpendicularly with respect to the longitudinal axis of the tube.

The power requirements for the deflection coils of Fig. 5 are several times greater than the power requirements for standard television deflection coils because the coils of Fig. 5 are located farther from the electron gun and because they must be energized to produce magnetic fields of substantially uniform density throughout the cross-section of the tube.

The source 78 of control signals for the arrangement shown in Fig. 4 may be the same as that of Fig. 3 except that the horizontal and vertical deflection signals are currents which are suitable for energizing the deflection coil assembly 60.

Fig. 6 shows an embodiment of the invention which is primarily suitable for providing P. P. I. presentations in a radar receiver.

The horizontal and vertical selection arrangement and the horizontal and vertical deflection arrangement of this embodiment of the invention are the same as those shown in Fig. 3. In addition, a rotatable coil assembly **79** is provided for causing the electron beam to sweep radially across the screen of the tube, as is required in conventional P. P. I. presentations.

The coil assembly **79** for this embodiment of the invention is arranged to provide a substantially uniform magnetic field across the section of the tube through which the electron beam is projected so as to provide uniform radial deflections of the electron beam without distorting the cross-sectional shape of the beam. This coil assembly may be similar to that shown in Fig. 5, and it is affixed to a gear **80** which may be coupled to suitable mechanisms (not shown) for rotating the assembly in synchronism with the antenna of the radar set.

Preferably, a circular screen **82** is employed in the tube shown in Fig. 6 so that conventional P. P. I.-type displays may be presented on the screen. The portion **84** of the envelope which is located between the screen and the cylindrical body portion **30** of the tube is of conical shape, and hence the intensifier anode **86** is also of conical shape.

The cathode-ray tube of Fig. 6 is primarily suitable for use in radar systems which provide means for identifying friendly vessels or objects. For example, friendly vessels may be provided with transponders which transmit identifying code signals in response to the radar signals.

The source **88** of control signals may be the receiver of the radar system provided with suitable output circuits for producing control signals for the cathode-ray tube. When an identifying signal is received from a vessel, the source **88** provides selection signals which cause the beam of the cathode-ray tube to pass through the aperture in the matrix **14** corresponding to the identifying number or letter for the vessel. The source **88** also provides deflection signals which cause the identifying number or letter to be displayed at the location on the screen which represents the location of the vessel. When the radar system encounters a vessel which does not produce an identifying signal, the source **88** provides selection signals which cause the beam of the cathode-ray tube to pass through a circular aperture in the matrix **14**, and the source **88** also provides deflection signals which cause the resulting spot to be displayed at the location on the screen which represents the location of the vessel.

Fig. 7 illustrates a typical P. P. I. presentation which may be produced on the screen of the tube shown in Fig. 6.

It will be apparent that the intensifier anodes **26** and **86** shown in Figs. 3, 4 and 6 are not essential; however, it is preferable to provide such anodes because they increase the intensity and clarity of the displayed images. Also, it will be apparent that a conventional magnetic deflection system may be employed instead of the horizontal and vertical selection plates **16**, **18** shown in the various embodiments of the invention.

I claim:

1. Cathode ray tube display means for visually presenting characters in response to a predetermined set of binary code signals, said display means including beam generating means, selection means for deflecting the beam along two directions in response to one of said set of code signals, a unitary thin beam-shaping member positioned to intercept said beam and presenting character-shaped apertures substantially non-serially aligned in conformance with the set of code signals, said apertures being arranged in a system of Cartesian coordinates, the coordinate arrangement being adapted to convert the code signals into intelligible characters, positioning means for deflecting the character-shaped beam to any predetermined position upon a target, said member being disposed along the path of the beam intermediate the selection means and the positioning means.

2. Cathode ray tube display means as set forth in claim 1 wherein the positioning means includes a pair of electron deflecting fields disposed substantially perpendicularly with respect to one another and with respect to the longitudinal axis of the tube, each field having substantially uniform density along planes disposed perpendicularly with respect to the longitudinal axis of the tube.

3. Cathode ray tube display means as set forth in claim 1 wherein the positioning means includes a pair of electron deflecting fields comprising a coil assembly located outside the tube and having four coils, two of the coils being disposed perpendicularly with respect to one another to provide a magnetic field along one direction and the other two coils being disposed perpendicularly with respect to one another to provide a magnetic field along a direction disposed at right angles with respect to the other magnetic field.

4. Cathode ray tube display means as set forth in claim 1 wherein the positioning means includes two electron-deflecting fields disposed substantially perpendicularly with respect to each other and the longitudinal axis of the tube and a third deflection means located intermediate the positioning means and the target for deflecting the shaped beam radially with respect to the center of the target.

5. Cathode ray tube display means as set forth in claim 1 wherein the positioning means includes two electron-deflecting fields disposed substantially perpendicularly with respect to each other, and a third deflection means located intermediate the positioning means and the target for providing an electron deflecting field which is disposed perpendicularly and rotatable with respect to the longitudinal axis of the tube.

6. Cathode ray tube display means as set forth in claim 1 wherein the selection means deflects the beam along two directions congruent with the system of Cartesian coordinates.

References Cited in the file of this patent

UNITED STATES PATENTS

2,137,888	Fuller	Nov. 22, 1938
2,267,827	Hubbard	Dec. 30, 1941
2,275,017	McNaney	Mar. 3, 1942
2,283,383	McNaney	May 19, 1942
2,379,880	Burgess	July 10, 1945
2,571,723	Jonker et al.	Oct. 16, 1951