

Oct. 26, 1948.

R. W. SEARS

2,452,157

ELECTRON DISCHARGE APPARATUS

Filed July 10, 1947

2 Sheets-Sheet 1

FIG. 1.

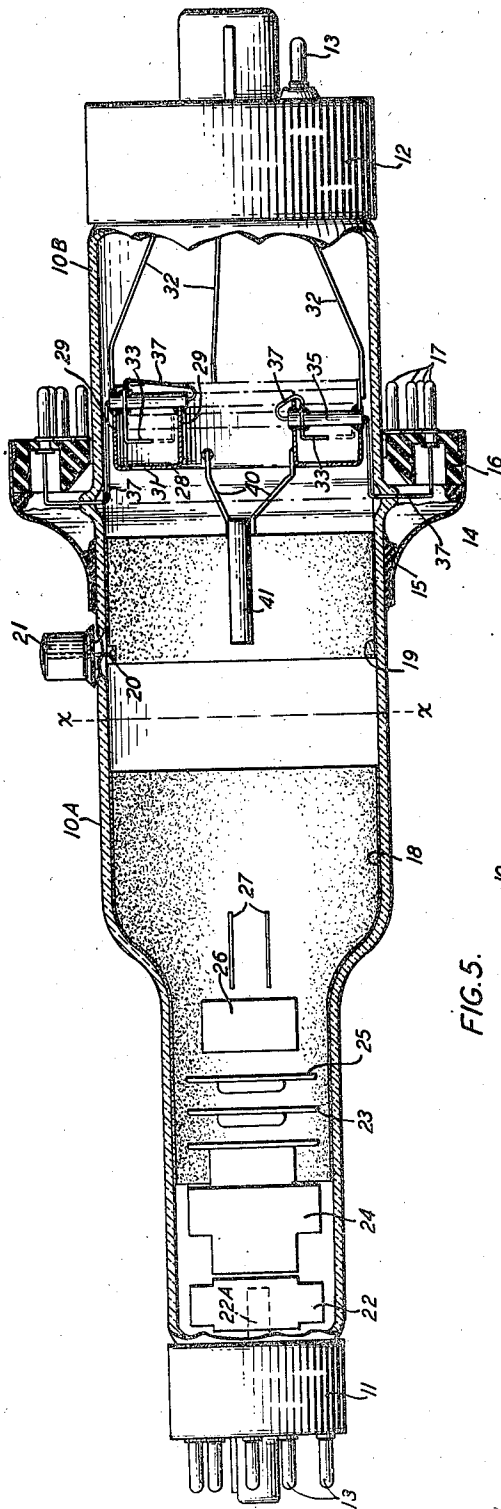
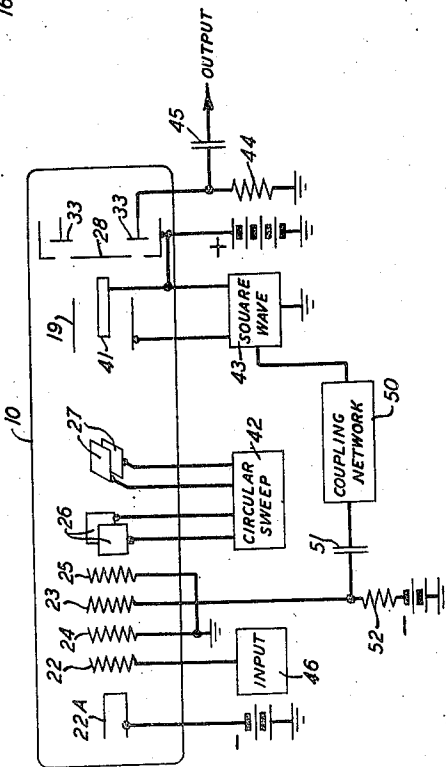


FIG. 5.



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2 Sheets-Sheet 2

FIG.2.

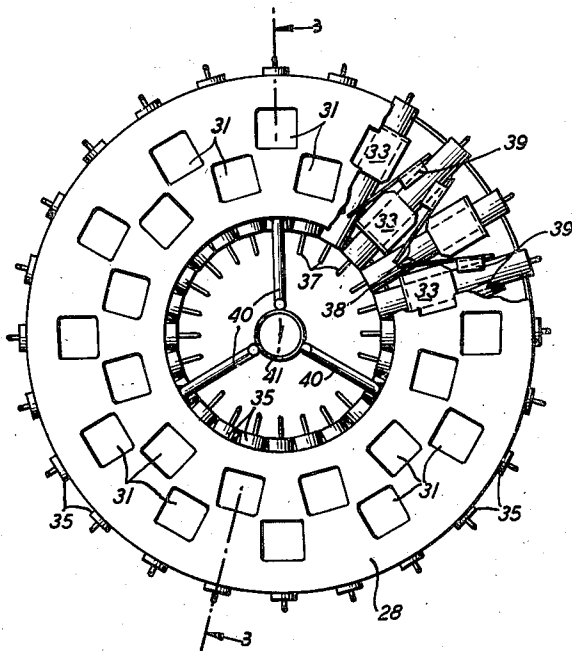


FIG.3

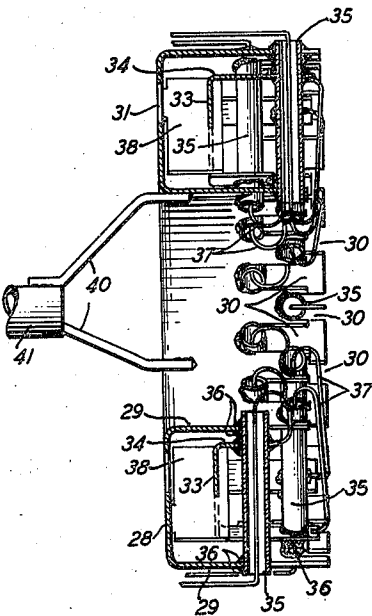
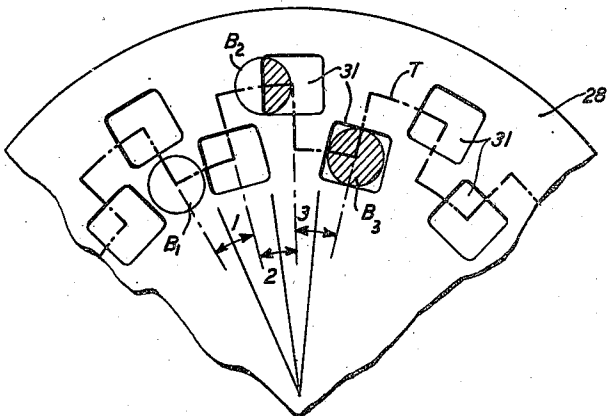


FIG.4.



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UNITED STATES PATENT OFFICE

2,452,157

ELECTRON DISCHARGE APPARATUS

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Application July 10, 1947, Serial No. 760,012

16 Claims. (Cl. 315—21)

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This invention relates to electron discharge apparatus and more particularly to multitarget cathode ray devices especially suitable for use as receivers in multiplex communication systems of the pulse position modulation type, such as disclosed, for example, in the application Serial No. 559,354, filed October 19, 1944, of James O. Edson.

Such systems involve, basically, the conversion, at a transmitter, of a complex input signal into a series of pulses each of which is at a time position in a reference cycle, determined by and representative of the amplitude of a respective sample of the signal. The signals, thus pulse position modulated, from a group or plurality of channels are transmitted in multiplex to a receiver. At the latter, each pulse series is converted or translated into an amplitude modulated signal corresponding to and constituting a reproduction of the respective complex input signal at the transmitter.

One object of this invention is to facilitate the translation or conversion of pulse position modulated signals into amplitude modulated signals.

Another object of this invention is to simplify receiver equipment in pulse position modulation type communication systems.

A further object of this invention is to improve multitarget cathode ray devices, suitable for use in multiplex systems, and, more specifically, to increase the number of targets which can be utilized in any given size device.

Still another object of this invention is to reduce the guard space in cathode ray devices for use in multiplex systems.

In one illustrative embodiment of this invention, a cathode ray device comprises an output assembly including a plurality of target electrodes, an electron gun for projecting a concentrated electron beam toward the output assembly, and a deflection system for sweeping the beam over the target electrodes repeatedly and in succession.

In accordance with one feature of the invention, the target electrodes are mounted in two concentric inner and outer circles with the electrodes in one circle in alternate relation with those of the other, and the deflection system is constructed to rotate the beam about an axis concentric with the circles and to step the beam from each target electrode to the next adjacent one, that is, from a target electrode on the inner circle to the next adjacent one on the outer circle, then to the next one on the inner circle, and so on.

In accordance with another feature of this in-

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vention, a screen or mask is provided between the electron gun and the output assembly, the screen or mask having therein a plurality of apertures, one for each target electrode and in alignment therewith. The target electrodes advantageously are constructed to have a secondary electron emission coefficient greater than unity and the screen or mask is utilized as a collector for secondary electrons emanating from the target electrodes.

In accordance with a further feature of this invention, the target electrodes and screen or mask, together with additional elements such as, for example, shields and a part of the deflection system, are fabricated as a unitary assembly which is readily mountable in coaxial relation with the electron gun and other elements of the device.

The invention and the above-noted and other features of the invention will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is an elevational view, mainly in section, of a multitarget cathode ray device illustrative of one embodiment of this invention;

Fig. 2 is a face view of the unitary output assembly included in the device illustrated in Fig. 1, a portion of the shield or mask being broken away to show details of construction;

Fig. 3 is a sectional view taken along line 3—3 of Fig. 2;

Fig. 4 is a diagram showing the relation of the apertures in the shield or mask and the beam trace thereat; and

Fig. 5 is a circuit schematic illustrating one manner of operation of the device shown in Fig. 1.

Referring now to the drawing, the cathode ray device illustrated in Fig. 1 comprises an evacuated vitreous enclosing vessel having two coaxial portions 10A and 10B hermetically joined in endwise relation as indicated at X, the portions having bases 11 and 12 carrying terminal prongs 13 at the outer ends thereof. A dish sheet 14 is affixed to the vessel portion 10B, as by cement indicated at 15, and supports an insulating disc 16 carrying a plurality of terminal prongs 17. The inner wall of the vessel portion 10A has thereon an electrically conductive coating 18, for example, of colloidal graphite known commercially as "Aquadag"; the inner wall of the vessel portion 10B has thereon a similar cylindrical coating 19 to which electrical connection may be established by way of a conductor 20 extending from a cap terminal 21 sealed to the vessel portion 10B.

Mounted coaxially within the vessel portion 10A is an electron gun which comprises a cathode 22A, a beam-modulating or control electrode 22, and focussing and accelerating anodes 23, 24 and 25, connected electrically to respective terminals 13 on the base 11. The gun may be of conventional construction and, in order to simplify the drawing, the electrodes thereof are shown in outline form in Fig. 1 and the supports and leading-in conductors therefor have been omitted. Also mounted within the vessel portion 10A and connected to respective terminals 13 on the base 11 by leading-in conductors, not shown in Fig. 1, are two pairs of deflector plates 26 and 27 arranged in space quadrature. The electron gun, when energized, projects a concentrated electron beam axially of the vessel 10 and centrally between each of the pairs of deflector plates 26 and 27.

A unitary assembly, shown in detail in Figs. 2 and 3, is supported within the vessel portion 10B and comprises a metallic mask or shield having a base 28 and coaxial cylindrical portion 29 provided with a plurality of pairs of radially aligned slots 30. Advantageously, the shield is treated, in ways known in the art, to minimize secondary electron emission therefrom. As shown most clearly in Fig. 2, the base 28 of the shield is provided with a plurality, for example twenty-four, of identical rectangular or square apertures 31, arranged in two concentric circles coaxial with the electron gun, the apertures in each circle being equally spaced and the apertures in the two circles being in staggered relation. The shield is supported by rigid metallic wires 32 which are connected together electrically and to the terminal prong 13 on the base 12 and serve as leading-in conductors for the shield 28, 29.

A plurality of target electrodes, equal in number to the apertures 31, are mounted within the shield, each of these electrodes having a base 33 and a flange 34, the base being aligned centrally with a respective aperture 31. Advantageously, the target electrodes are constructed to have a secondary electron emission coefficient greater than unity. For example, they may be of an alloy of substantially 99 per cent silver and 1 per cent magnesium, or the faces of the bases 33 toward the apertures 31 may be coated with a material having a high secondary electron emission coefficient. Each of the target electrodes is supported by an insulating, e. g. ceramic, tube 35 which is fitted in an aperture in the electrode flange 34, seated in a respective pair of the radially aligned slots 30 in the shield portions 29, and affixed to the flange 34 and portions 29 as by insulating cement indicated at 36 in Fig. 3.

Individual electrical connection to the target electrodes may be established through leading-in conductors 37, which extend through the tubes 35, are sealed to the vessel portion 10B and are connected to respective ones of the terminals 17.

The segregation of the several target electrodes from one another is enhanced by a plurality of metallic shields or barriers 38 which have tabs or flanges 39 affixed to the shield 28 and which extend between adjacent target electrodes.

Supported from the shield 28, 29 by a plurality, for example three, of rigid metallic wires 40 is a cylindrical electrode 41, coaxial with the conductive coating 19 and constituting a radial deflection system therewith.

One manner of operation of the device shown in Fig. 1 and described hereinabove is illustrated in Fig. 5. The electrodes of the electron gun, only the cathode and control electrode of which

are shown in Fig. 5, are operated at appropriate potentials to produce a highly concentrated electron beam which is projected toward the target electrodes, between the deflector plates 26 and 27. These plates are energized from a source 42 to produce a deflecting field for rotating the beam about the axis of the device. The coaxial deflecting electrodes 19 and 41 are energized from a source 43 to superimpose a square wave deflecting force upon the circular deflecting force due to the plates 26 and 27. The two sources 42 and 43 are correlated so that at the base 28 of the shield the beam trace is of the form illustrated in Fig. 4. Specifically, the beam, designated as B and which is of a diameter substantially equal to the width of the apertures 31, follows a circular and repeatedly stepped trace T so that it passes into one of the apertures 31 in the inner circular row, moves radially outwardly, then circularly into the next adjacent aperture in the outer circular row, then radially inwardly between adjacent apertures in the inner row, into the next aperture in the inner circular row, and so on.

When the beam passes through any aperture, it impinges upon the target electrode therebehind and secondary electrons are emitted from the target electrode and are collected by the shield 28, 29, which, as shown in Fig. 4, is maintained at a positive potential relative to both the target electrodes and the cathode. Each target electrode has connected thereto a respective output channel including, for example, an output resistor 44 and series condenser 45, only one output channel being shown in Fig. 4. Alternatively, a transformer type output coupling may be used. The current in each output channel in response to impingement of the beam upon the associated target electrode will be, of course, the difference between the secondary electron current from the target electrode to the shield 28, 29 and the primary or beam current to this target electrode. Also, it will be noted that the output current can be determined or controlled by the portion of the beam current which impinges upon any target electrode.

As has been pointed out heretofore, in a pulse position modulated type of system, at the transmitter the output is composed of pulses each of a position relative to a reference cycle determined by the signal sample corresponding thereto. Each of these pulses, as received at the receiver, is utilized to control the beam current to a respective target electrode in such manner that each pulse is translated into an output signal of amplitude determined by the pulse position and proportional to the original signal sample represented by that pulse. Specifically, in one case, the control electrode 22 may be biased from the input circuit 46 so that normally, i. e. in the absence of a signal pulse applied to the control electrode by way of the input circuit, the beam is extinguished. The pulses are so applied that they overcome the bias and in effect turn the beam on. The point in the sweep cycle, which is synchronized with the sampling and transmitting cycles at the transmitter, is determined by the time position of the pulse. Thus, each pulse determines the amount of beam current which passes through an aperture 31 when the beam is turned on thereby.

For example, if the pulse occurs very early in the time segment of the channel corresponding to the period represented by the arrowed line 1 in Fig. 4, the beam will impinge upon the base 28 of the shield as indicated at B; and no current change will be produced in the respective output

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channel. If, however, the pulse is applied at the time corresponding to beam position B₂, approximately one-half the beam current will flow to the target associated with the channel corresponding to the time segment indicated by the arrowed line 2, and a corresponding current will be produced in this channel. If the beam is turned on by a pulse at a time corresponding to beam position B₃, the maximum beam current reaches the target associated with the channel corresponding to the time segment represented by the arrowed line 3 in Fig. 4 and the maximum change in current for this channel occurs. For other pulse positions, the output current change in any channel will be of amplitude between the minimum, such as at B₁, and the maximum, such as at B₃. For any pulse position, the output current change in the respective channel will be determined by the beam position and proportional in amplitude to the original signal sample corresponding to the pulse. The current supplied to each channel is appropriately passed to a low-pass filter, not shown, having a cut-off frequency of half the sampling frequency. Thus, the pulse position modulated signals are translated into amplitude modulated signals which are reproductions of the original complex signals.

In the mode of operation described above, the signal pulses are utilized to turn the beam on. They may be utilized also to extinguish the beam which is normally on. The difference between the two cases, it will be apparent, resides in the sense of the change in the output currents.

It will be appreciated that in devices constructed in accordance with this invention, a large number of target electrodes may be utilized in any given space because of the in and out stepping of the beam. Furthermore, separation or segregation of the channels obtains inasmuch as the beam cannot overlap two apertures. Hence, cross-talk between channels is minimized and faithful translation results. Additionally, it will be noted that by virtue of the arrangement of the apertures 31 and the character of the deflecting fields, substantial guard space is provided between successive apertures so that effective segregation or separation of adjacent channels can be obtained without the use of long guard times. Because of the arrangement of the apertures, it will be appreciated that but a small guard space is necessary to assure segregation of the channels and thus prevent cross talk. When the apertures on the two circles are of the same size and of coordinate dimensions substantially equal to the beam diameter, adequate guard space, which need be only double the pulse width, is provided inherently by virtue of the fact that the outer row of apertures is on a larger circle than the inner row. The guard space is much less than half a channel width as would be necessary in a construction involving a single row of apertures or targets. Thus, this invention enables a great increase in the useful area at the output assembly.

If desired, additional reduction in the guard space may be effected by making the outer apertures larger than the inner ones, and by controlling the beam diameter, as by controlling the potentials of the focussing electrode 23 in the electron gun from the source 43, such that the diameter of the beam is increased when it is on the outer arcuate parts of the trace T. For example, as shown in Fig. 5, the focussing electrode 23 may be connected to the source 43 over a coupling network 50 and condenser 51 and resistor 52.

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Furthermore, the targets and shield constitute a unitary assembly wherein the several elements are readily mounted in prescribed relation and which can be mounted expeditiously in coaxial relation with the electron gun and the deflection electrodes 26, 27, and 19.

Although specific embodiments of the invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. Electron discharge apparatus comprising a plurality of targets arranged in two adjacent rows, the targets in the two rows being in staggered relation, means for projecting an electron beam toward said targets, and means for deflecting said beam to sweep it successively over adjacent targets in said two rows.
2. Electron discharge apparatus comprising a plurality of targets mounted in inner and outer rows, the targets in the two rows being in staggered relation, means for projecting an electron beam toward said targets, and means for deflecting said beam to produce a trace passing through all of said targets, said trace passing from each target in one row to the next adjacent target in the other row.
3. Electron discharge apparatus comprising a plurality of targets mounted in inner and outer circular rows, the targets in the two rows being in staggered relation, means for projecting an electron beam toward said targets, and means for rotating said beam and deflecting it at an angle to the axis of rotation to direct the beam against said targets in succession and from each target in one row to the next succeeding target in the other row.
4. Electron discharge apparatus comprising a plurality of targets arranged in two concentric, inner and outer circular rows, the targets in the two rows being in staggered relation, means for projecting an electron beam toward said targets, and means for rotating said beam about an axis passing through the center of said rows and for periodically deflecting it radially relative to said rows such that the beam passes from each target in one row to the next succeeding target in the other row.
5. Electron discharge apparatus comprising a plurality of targets arranged in two concentric, inner and outer circular rows, the targets in the two rows being in staggered relation, means for projecting an electron beam toward said targets, a first deflection means for rotating said beam to produce a circular sweep thereof at said targets, and a second deflection means for superimposing a square wave deflecting force upon the beam rotating force, said first and second deflection means being correlated so that said beam passes from each target in one row to the next succeeding target in the other row.
6. Electron discharge apparatus comprising a member having a plurality of apertures therein arranged in inner and outer rows, with the apertures in the two rows in staggered relation, means for projecting an electron beam toward one face of said member, target electrode means opposite the other face of said member, and means for deflecting said beam to produce at said one face an undulating trace such that said beam passes from each aperture in one row to the next succeeding aperture in the other row.
7. Electron discharge apparatus comprising a

member having therein a plurality of apertures arranged in two concentric, inner and outer circular rows with the apertures in the two rows in staggered relation; means for projecting an electron beam toward one face of said member, target electrode means opposite the other face of said member, and means for deflecting said beam to produce at said one face an undulating circular trace such that the beam passes from each aperture in one row to the next succeeding aperture in the other row.

8. Electron discharge apparatus in accordance with claim 7 wherein said beam deflecting means comprises a first means for producing a circular beam sweep and a second means for superimposing a repeating substantially square wave component upon said circular sweep.

9. Electron discharge apparatus comprising an electrode member having a portion provided with a plurality of apertures arranged in inner and outer circular rows, the apertures in the two rows being in staggered relation, means for projecting an electron beam toward one face of said portion, a plurality of secondary electron emissive target electrodes opposite the other face of said portion, each of said target electrodes being in alignment with a respective one of said apertures, and means for deflecting said beam to produce an undulating trace thereof at said one face such that said beam passes from each aperture in one row to the next succeeding aperture in the other row.

10. Electron discharge apparatus in accordance with claim 9 wherein said deflecting means comprises a first means for producing a circular beam sweep and a second means for superimposing a repeating substantially square wave component upon said circular sweep.

11. Electron discharge apparatus in accordance with claim 10 comprising means for varying the cross sectional area of said beam in accordance with said square wave component.

12. Electron discharge apparatus comprising a shield member having a base portion and spaced cylindrical portions extending from one face of said base portion, said base portion having therein a plurality of apertures arranged in inner and outer circular rows with the apertures in the two rows in staggered relation, a plurality of target electrodes mounted between said cylindrical por-

tions, each target electrode being opposite a respective one of said apertures, means for projecting an electron beam toward the other face of said base portion, and means for deflecting said stream to pass through said apertures.

13. Electron discharge apparatus in accordance with claim 12 wherein said cylindrical portions have aligned slots, the apparatus comprising also a plurality of support members, one for each target electrode, mounted in said slots, each target electrode being mounted by a respective support member.

14. Electron discharge apparatus in accordance with claim 13 comprising a plurality of shields each extending between two adjacent target electrodes and supported from said shield member.

15. In a multitarget cathode ray device, a target structure comprising a shield member having an annular base portion and laterally spaced cylindrical portions extending from said base portion, said cylindrical portions having radially aligned slots therein and said base portion having therein a plurality of apertures arranged in a circular row, a plurality of target electrodes between said cylindrical portions and each in juxtaposition to a respective one of said apertures, and a plurality of insulating supports seated in said slots, each target electrode being supported by a respective one of said supports.

16. Electron discharge apparatus comprising a member having a plurality of apertures therein arranged in two concentric, inner and outer circular rows with the apertures in the two rows in staggered relation, electrode means opposite one face of said member, means for projecting an electron beam toward the other face of said member, and means for rotating said beam to produce at said other face an undulating trace including arcuate sections concentric with said rows and each extending from substantially midway between two respective adjacent apertures in one row into one of the two apertures and including also sections extending radially with respect to said rows and connecting successive arcuate sections.

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No references cited.

Disclaimer

2,452,157.—*Raymond W. Sears*, West Orange, N. J. ELECTRON DISCHARGE APPARATUS. Patent dated Oct. 26, 1948. Disclaimer filed Aug. 30, 1950, by the assignee, *Bell Telephone Laboratories, Incorporated*.

Hereby enters this disclaimer to claims 1 and 2 of said patent.

[*Official Gazette October 3, 1950*]