

May 26, 1953

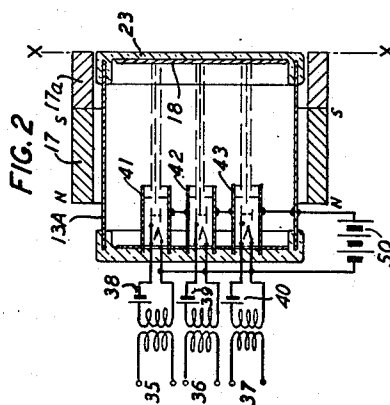
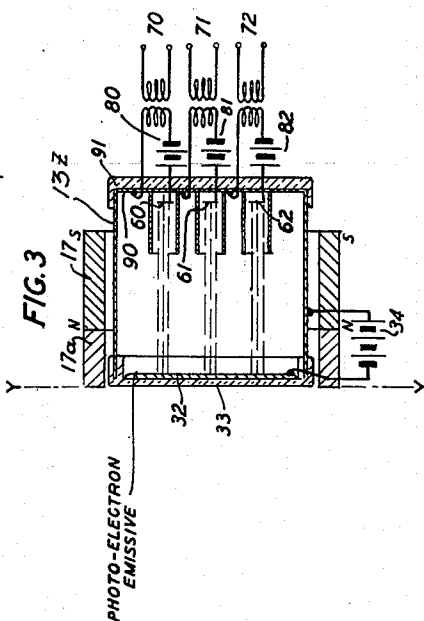
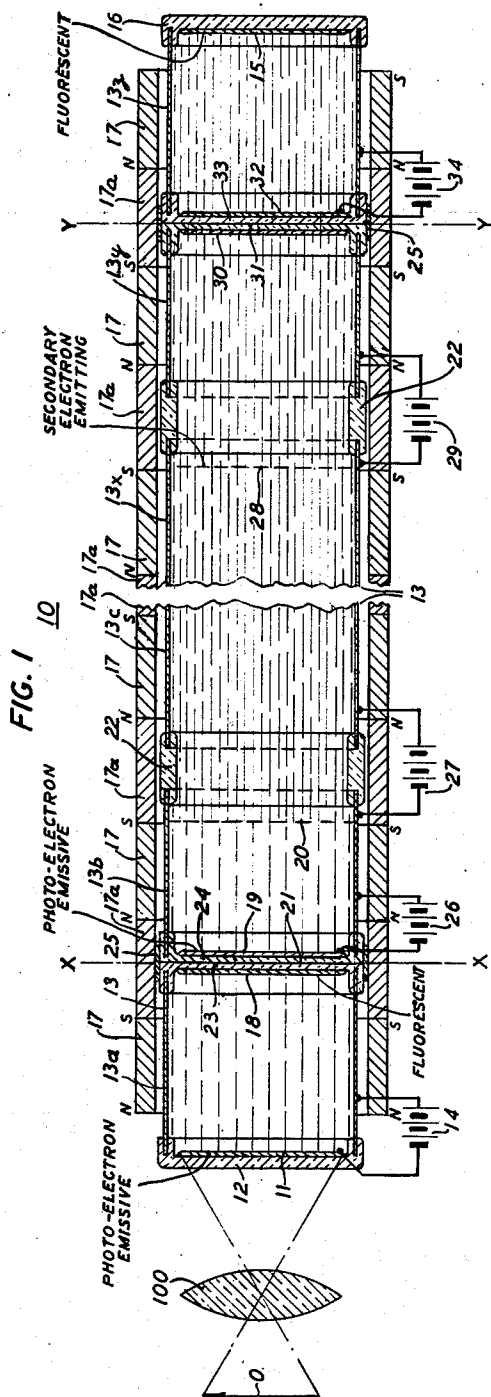
L. ESPENSCHIED ET AL

2,640,162

ELECTRONIC TRANSMISSION SYSTEM

Filed May 16, 1947

2 Sheets-Sheet 1



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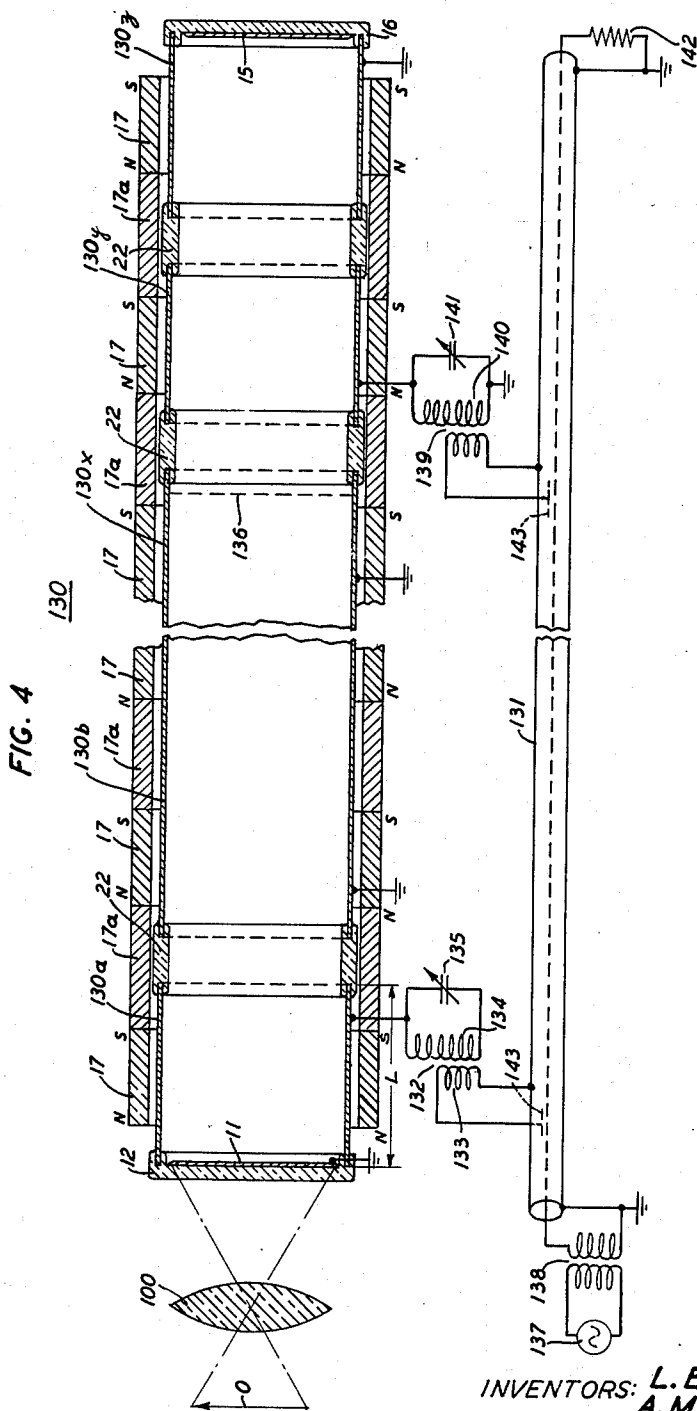
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UNITED STATES PATENT OFFICE

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ELECTRONIC TRANSMISSION SYSTEM

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19 Claims. (Cl. 250—207)

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This invention relates to the transmission of intelligence and more specifically to the utilization of electrons or other corpuscles for this transmission.

Various means for transmitting intelligence electrically are known. Wires, coaxial cables, wave guides and electromagnetic waves are well known to the workers in the electrical communication arts as media for transmitting signals from one place to another. In each of these arrangements, it is a current or voltage wave or a direct current or voltage which is transmitted. In accordance with the present invention, the transmission of intelligence is accomplished by the signal modulation of individual ones of a bundle of electron rays or pencils forming collectively a composite electron beam and by the maintenance of the individual electron rays in the same relative positions in the bundle as they pass through a long, hollow pipe system which may be in a number of sections.

It is an object of this invention to transmit intelligence over long distances by means of the movement of free electrons in hollow tube or pipe systems.

It is another object of this invention to maintain the individual rays in a large bundle of rays making up a composite electron beam in the same relative positions in the bundle while the electrons in the beam are being transmitted through a long tube or pipe system.

It is still another object of this invention to form, at relay stations in a long tube or pipe transmission system, from a composite electron beam comprising a plurality of electron rays, relay composite electron beams in which each individual ray therein has a position similar to the position of the corresponding ray in the beam producing the relay beam.

It is a further object of this invention to transmit intelligence over long distances by the movement of free electrons in a long tube or pipe system without building up a large direct accelerating voltage.

It is another object of this invention to transmit images from one end of a long transmission path to the other without scanning.

In accordance with a specific illustrative embodiment of the present invention, there is provided a long, evacuated, hollow, metallic pipe system utilized as a transmission line, the transmission being effected by means of electrons which traverse this pipe system and are continuously maintained in the same position in the beam cross-section. A semitransparent

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photosensitive surface at one end of the pipe transmission system, which is preferably in a plurality of sections, converts an optical image into an electronic one. These electrons, or others produced under the control thereof at spaced relay stations, are held in the desired paths throughout their travel down the pipe system by means of a substantially uniform longitudinal magnetic field parallel to the axis of the pipe. This field is provided by a succession of permanent magnetic rings or cylinders which envelop the pipe sections and are magnetized parallel to the axis of the rings and the pipe system. At the far end of the system there is positioned a fluorescent screen on which impinging electrons reproduce the original optical image. Individual points of the optical image can be used as terminals of individual transmission lines so that it is possible to send multiplex telephone or telegraph signals down the pipe systems.

Because of the fact that there is attenuation in such a transmission system over long distances due to a loss of electrons in the streams caused by their striking gas molecules in the pipe sections, repeater or relay devices are provided. These repeating devices, which can be placed at or near junctions in the system, can be either of an electro-optical or of an electron multiplying type. The electro-optical repeating device, for example, comprises a fluorescent screen for producing a light image and a photoelectric surface for producing an electronic image of this light image. The electron multiplying repeater, for example, comprises a thin metal foil member or a close-meshed grid, either of which can be coated or otherwise covered with secondary emitting material. The direct potentials of the secondary emitting members progressively increase with the length of the transmission line or system. An electro-optical junction in the pipe system can include a lens to transpose the image on the fluorescent screen terminating one section into one on the photoelectric surface beginning another section, or these two surfaces can be placed in contact with each other.

In a modification, a corpuscular transmission line with repeaters that operates on the principle of a potential energy multiplier, such as that shown in a Patent 2,407,296 issued to A. M. Skellett on September 10, 1946, is provided. In this modification, the transmission line is similar to that described above, but alongside it there is a coaxial or other type of transmission line that carries the energy in high frequency form for the terminal equipment and for the repeaters.

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The potential gradient at the surface of the photoelectric screen is an alternating one so that the electrons are started off down the tube only at the maxima of positive halves of the cycle of oscillation of the first section of pipe to which is applied the high frequency energy. The length of this section is adjusted so that these electrons reach the end of the section when the potential of the section is zero, or one quarter cycle later. The length L of the section is therefore determined by the frequency of oscillation. This relation can be expressed by the following equation:

$$L = \frac{1.48 \times 10^7 \sqrt{V_m}}{f} \text{ cm.} \quad (1)$$

where f is the frequency of oscillation and V_m is the maximum potential in volts applied to the section. The electrons which start near the peak of the cycle travel down the tube with the velocity v and it is these electrons for which the rest of the system is designed. Electrons which leave at other times in the half cycle are either lost because they arrive at the first repeater when it is inoperative or are effective if their velocity is a submultiple of the velocity given by the equation:

$$v = 5.93 \times 10^7 \sqrt{V_m} \text{ cm./sec.} \quad (2)$$

This repeater and the others which follow it are energized cyclically at the proper times to accommodate these electron groups. Each repeating section of the transmission line terminates in a grid or foil member preferably coated with secondary emissive material such as in one form of the direct current repeaters. The potential of the section is phased so that the potential difference between the grid or foil and the section is V_m when the group of electrons strike the grid or foil. The secondary electrons are thus accelerated to the velocity defined by Equation 2. A repeating section like that described above has a length such that the electrons with this velocity traverse it in a quarter cycle and thus cross the gap between adjacent sections when the potential difference across it is zero. The potential energy is changed from V_m electron volts to zero while the electrons traverse a repeating section. No direct voltages are required at the repeater station and all the energy is sent down the coaxial line at one frequency. After traversing the length of the transmission line, the electron rays strike a fluorescent screen as in the first embodiment.

Instead of a transmitting end section which is provided with a photoelectric surface to which is applied a light image (the term "light" is intended to be broad enough to cover ultraviolet and infra-red radiations as well as those in the visible spectrum), thermionic means such as, for example, a plurality of electron guns can be used. Similarly, instead of a fluorescent screen at the receiving end, a plurality of targets for receiving the electron streams can be provided. The various kinds of terminal equipment can be made interchangeable.

The invention will be more readily understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof in which:

Fig. 1 is a schematic diagram of a long tube or pipe transmission system in accordance with the invention;

Figs. 2 and 3 show, respectively, modified transmitting and receiving end equipments for

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a transmission system of the type shown in Fig. 1; and

Fig. 4 shows a modified transmission system.

Referring more specifically to the drawings, Fig. 1 shows, by way of example for illustrative purposes, a transmission system employing a corpuscular transmission path 10. By way of example, it has been shown as a system equipped to transmit an image from one end of the transmission path to the other without the scanning that is employed in the usual television system. An optical image of an object O is focussed by any suitable lens system represented schematically by the single lens 100 upon a fluorescent screen 11 mounted on the inside of a glass wall 12 which is fastened to a long evacuated metal pipe system 13 which can be, for example, many miles long and have many sections 13a, 13b, 13c . . . 13x, 13y, 13z, etc., placed at progressively larger positive potentials. The photoelectric surface 11 is semitransparent and is connected to the metal pipe section 13a through a source of direct voltage 14. The photoelectric surface 11 converts the optical image into an electronic one and, if the pipe is continuous and has no barriers therein, the electron rays produced by the surface 11 are accelerated toward the fluorescent screen 15 mounted on a glass or other suitable transparent terminal member 16 at the far end of the pipe 13. The electrons are held in desired equally parallel paths throughout their travel down the pipe system 13 by means of a substantially uniform longitudinal magnetic field parallel to the axis. This field is provided by permanent magnetic rings 17 which envelop the pipe system 13 and are magnetized parallel to the axis of the rings and pipes as shown in the drawing. To approximate a uniform field down the pipe, the spaces between these rings may be filled in with soft iron sections of pipe 17a or the magnets themselves may take the form of a succession of long magnetic cylinders enveloping the evacuated pipe, or the longitudinal magnetic field may be established by means of a winding wrapped around the pipe and extending along its length such as is shown in Fig. 7 of B. M. Oliver Patent 2,278,478, issued January 10, 1941. The original optical image is reproduced on the screen 15 at the far end of the tube. The pipe system need not be straight throughout its entire length but may have bends therein. In such a case the magnetic lines will follow the bends and thus permit the rays to preserve the desired positions in the bundle. The electron beam lines have been shown schematically by dashed lines in Fig. 1. It is obvious that each electron beam emanating from an elemental area of the photoelectric surface 11 can be used as an individual transmission line so that it is possible to send a multiplicity of telephone and telegraph transmissions through the pipe 13 at the same time. For television, of course, a succession of time-spaced pictures can be propagated, say 30 to 60 per second.

The nature of the attenuation in the transmission pipe system 13 when it extends over long distances is such that there is a loss of electrons in the beams due to their striking gas molecules in the pipe. Therefore the arrangement of Fig. 1 makes use of repeating sections to increase the number of electrons in the stream. Successive ones of the sections 13a, 13b, 13c . . . 13x, 13y and 13z are joined by non-conducting rings 22 or by other suitable means. Two types of repeater sections are shown in Fig. 1 each of which

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produces a new group or bundle of electron rays in response to the bundle of electron rays in the section immediately preceding the repeater section. One type of repeater is represented by the fluorescent screen 18 and the electron emissive screen 19 closely adjacent thereto. In Fig. 1, the members 13 and 19 are shown on opposite sides of a glass or transparent plastic barrier 21 between sections 13a and 13b but it is obvious that sections 13a and 13b may have individual terminal members and be separated from one another by a greater distance than that indicated in the drawing, the image on the fluorescent screen 18 in that case being focussed on the member 19 by a suitable lens device (not shown). Preferably, the barrier 21 comprises two parts or terminal members 23 and 24 held together by the ring 25 so that the section 13a can be removed and another type of terminal apparatus, such as the arrangement shown in Fig. 2 (which will be described below), substituted without disturbing the evacuated condition of either section 13a or 13b. The bundle of electron rays or beams in section 13a produces an image on the screen 18 which produces a second group or bundle of electron rays by causing photoelectric emission from the photoelectron emissive screen 19. The electron rays of the second group are held in the desired paths by the magnets 17 until they reach the next repeater. By way of example, this is one of the second type of repeater sections shown in Fig. 1. This second type of repeater section comprises a mesh grid or metal foil member 20, covered or coated with or embodying secondary electron emitting material, mounted at the far end of the section 13b of the pipe system 13. The screen 19 is connected to the section 13b through a source of direct potential 26 so poled that the section 13b is at a positive potential with respect to the screen 19, and the section 13b is connected to the section 13c through the source 27 poled so that the latter section is at a positive potential with respect to the former section. The amplification is by secondary electron multiplication and a gain of 12 decibels per section can be readily realized. One or more of these repeater sections can be included throughout the length of the pipe system 13. For example, the grid member 28 in section 13x is similar to the grid member 20 in section 13b. The section 13x is connected to the section 13y through the source 29 poled in the same direction as the sources 26 and 27. Between the sections 13y and 13z is a repeater like that comprising the screens 18 and 19. This repeater comprises the fluorescent screen 30 on the glass or plastic wall 31 and the photo-electron emitting screen 32 on the glass or plastic wall 33. A ring 25 keeps the members 31 and 33 in contact with one another. The source 34 is used to place the section 13z at a positive potential with respect to the screen 32.

Fig. 2 shows a transmitting terminal arrangement 13A which can be substituted for section 13a and Fig. 3 shows a receiving terminal arrangement 13Z which can replace section 13z. Signals are applied by means of individual circuits 35, 36, 37, etc. to modulate respectively beams formed in the individual electron guns 41, 42, 43, etc. by applying signals between the respective cathodes and control elements of these electron guns. All of the gun anodes are placed at a positive potential with respect to their corresponding cathodes by means of the source 50. Individual biasing batteries 38, 39, 40 are con-

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netted respectively between the cathodes and control elements of the guns. The section 13A is evacuated and provided with a fluorescent screen 18 on a transparent wall 23 which can be placed adjacent wall 24 in the arrangement of Fig. 1.

The section 13Z is evacuated and provided with a photo-electron emitting screen 32 on a wall 33 as in the section 13z and utilizes a source 34 and a magnet 17 as before, but differs from section 13z in that it is provided with a plurality of isolated electron targets 60, 61, 62, etc., placed so that the repeated or relayed versions of the beams originating in the guns 41, 42, 43, etc., strike them. Each target is connected to a separate output circuit 70, 71, 72, etc. If desired, each target 60, 61, 62, etc. can be positively biased such as, for example, by connecting a respective source 80, 81, 82, etc. between the target and a metal layer or coating 90 on the end wall 91 of the section 13Z. It will be observed that by using the arrangements of Figs. 2 and 3 with the middle sections of the arrangement of Fig. 1, both the input and the output are electrical signals rather than optical images as in the complete arrangement shown in Fig. 1.

The arrangement shown in Fig. 1 utilizing a number of repeater stations has a disadvantage for long lines in that the direct voltages produced by the sources 26, 27, 29 and others like them add up along the transmission path and it is thus necessary to maintain a considerable potential difference between the input and output ends of the line or path. A way to avoid this voltage pile-up is shown in the arrangement 130 of Fig. 4, comprising sections 130a, 130b . . . 130x, 130y and 130z. The sections of the transmission line are coupled by glass or other suitable rings 22 as in Fig. 1, and permanent magnetic rings or cylinders 17 and soft iron members 17a are utilized as in the arrangement of Fig. 1; and these magnetic cylinders may extend the length of the sections themselves or may form one continuous magnetic sheath the length of the line. Each section of the transmission line is evacuated throughout its length for the electronic or other corpuscular transmission. Alongside it, there is a coaxial or other type of transmission line 131 which carries energy in high frequency form for the terminal equipment and for the repeaters. In the arrangement of Fig. 4, the input and the output ends of the tube (comprising the members 11, 12, 15 and 16) are similar to those shown in Fig. 1 but the joints between sections 130a and 130b and between sections 130y and 130z are not provided with repeaters as in the case of the corresponding sections in Fig. 1. The potential gradient at the surface of the photoelectric layer 11 is an alternating one instead of a direct one as in the arrangement of Fig. 1 because an alternating wave is applied to the section 130a by means of the transformer 132 having its primary winding 133 coupled to the coaxial cable 131 and its secondary winding 134 (shunted by a condenser 135) connected to the section 130a. The oscillations are generated by oscillator 137 and applied to the cable 131 by means of transformer 138. The electrons emitted by the surface 11 are started off down the tube 130 only during the positive halves of each cycle of oscillations of the potential wave applied to the cylinder 130a. Consider the electrons that start out during the time when the potential on the cylinder 130a is a maximum, V_m . The velocity of these electrons will be equal to the value given in Equa-

tion 2 above. The length L of the cylinder 130a is adjusted so that these electrons reach the end thereof when the potential of the cylinder is zero, or one quarter cycle later. The length L of the cylinder 130a is given by Equation 1 above. Another arrangement employing a theory of operation similar to that described above is disclosed in the above-identified Skellett patent and reference is made to this patent for a more complete description of this theory.

The sections following 130a in Fig. 4 are designed for the electrons which start out near the peak of the cycle and which travel down the tube with a velocity v . Electrons which leave at other times in the half cycle are either (1) lost because they arrive at the first repeater section when it is inoperative or (2) effective if their velocity is a submultiple of the velocity given by Equation 2.

Each repeater is energized cyclically at the proper times to accommodate these electron groups. A typical repeater (not necessarily the first one) is shown as the section 130y following a secondary emitting grid or thin metal foil member 136 mounted in section 130x. Oscillations from the oscillator 137 are taken from the cable 131 at this repeater station by means of the transformer 139 the secondary winding 140 of which is shunted by a condenser 141. The potential wave of the cylinder 130y is phased by the tuned circuit comprising members 140 and 141 so that the potential difference between the grid 136 in the cylinder 130x and the cylinder 130y is V_m when the group of electrons strike the grid 136. The secondary electrons are thus accelerated to the velocity defined in Equation 2 above. The section 130y has a length such that the electrons with this velocity traverse it in a quarter cycle and thus again cross the gap at the end thereof when the potential difference across it is zero. The potential energy of these electrons is changed from V_m electron volts to zero while they traverse section 130y. It should be noted that there are no direct voltages required at this repeater station as all the energy is sent down the coaxial line 131 at the one frequency. The coaxial line is terminated in its characteristic impedance by the resistance 142.

After traversing the length of the line the electron rays or beams strike the fluorescent screen 15 to reproduce the image as in the arrangement of Fig. 1.

By way of example, consider V_m is one thousand volts and the length L of a section is 27 centimeters or about 8 inches and also that the main transmission line is, for example, $1\frac{1}{2}$ inches in diameter. The frequency as calculated from the above formulae is 23.4 megacycles. This frequency can readily be transmitted along a coaxial cable with little attenuation.

The transformers 132 and 139 are very easily coupled to the coaxial line cable 131 by means of small elements 143 capacitatively coupled to the inner conductor as shown. This prevents setting up a bad standing wave condition. The voltage taken from the coaxial line cable 131 is stepped up to V_m by the tuned circuits 134, 135 and 140, 141.

Various other changes can be made in the embodiments described above without departing from the spirit or letter of the invention, the scope of which is indicated by the appended claims. In the claims, the term "group of modulated beams" refers to a single large beam made up of a number of individually or group modu-

lated smaller beams as well as to a number of beams with finite spacings therebetween. Moreover, in the case where the system comprises one or more repeating stations, the term "beam" includes both the original beam and the repeated beam.

What is claimed is:

1. In a system for the communication of intelligence, an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, successive means located in said pipe between said first and said second point adapted to receive a group of electron beams traveling in the direction of said second point and in response to said received group of beams to produce a subsequent group of beams traveling towards said second point, means for maintaining all of said beams in courses generally parallel to the axis of the pipe during the passage of electrons therein down said pipe, and means at said second point for utilizing beams arriving at that point through said pipe.

2. In a system for the communication of intelligence, an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, photoelectric means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, a plurality of electron multiplier means successively spaced along said pipe to periodically replenish the electron beams traveling toward said second point, a plurality of direct-voltage accelerating means producing sufficient electric field strength after said electron multipliers for maintaining a certain average velocity of the electron beams along their paths, permanent magnet means surrounding said pipe substantially throughout its length forming a longitudinal magnetic field coaxially aligned with the pipe axis for maintaining all of said beams in courses generally parallel to the axis of the pipe during the passage of electrons therein down said pipe, and photoelectric means at said second point forming a fluorescent image from beams arriving at that point through said pipe.

3. In a system for the communication of intelligence, an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, said means including a plurality of electron guns, successive means located in said pipe between said first and said second point adapted to receive a group of electron beams traveling in the direction of said second point and in response to said received group of beams to pro-

duce a subsequent group of beams traveling towards said second point, means for maintaining all of said beams in courses generally parallel to the axis of the pipe during the passage of electrons therein down said pipe, and means at said second point for utilizing beams arriving at that point through said pipe.

4. In a system for the communication of intelligence, an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, said means including a plurality of electron guns, successive means located in said pipe between said first and said second point adapted to receive a group of electron beams traveling in the direction of said second point and in response to said received group of beams to produce a subsequent group of beams traveling towards said second point, said successive means comprising a fluorescent screen upon which said received group of electron beams impinges and a photoelectron emissive target upon which radiations from said fluorescent screen are caused to impinge, means for maintaining all of said beams in courses generally parallel to the axis of the pipe during the passage of electrons therein down said pipe, and means at said second point for utilizing beams arriving at that point through said pipe.

5. In a system for the communication of intelligence, an evacuated hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, said means including a plurality of electron guns, successive means located in said pipe between said first and said second point adapted to receive a group of electron beams traveling in the direction of said second point and in response to said received group of beams to produce a subsequent group of beams traveling towards said second point, said successive means comprising a fluorescent screen upon which said received group of electron beams impinges and a photoelectron emissive target upon which radiations from said fluorescent screen are caused to impinge, said fluorescent screen and said electron emissive screen being closely adjacent one another, means for maintaining all of said beams in courses generally parallel to the axis of the pipe during the passage of electrons therein down said pipe, and means at said second point for utilizing beams arriving at that point through said pipe.

6. The combination of elements as in claim 1 in which said evacuated hollow pipe comprises a number of sections having conducting side-walls separated by non-conducting members, and means for applying a progressively larger positive direct potential to said sections in the direction of electron flow.

7. The combination of elements as in claim 1

in which said evacuated hollow pipe has at least one barrier therein at which electrons in one group of beams are halted and are utilized to produce another group of beams.

8. The combination of elements as in claim 1 in which said successive means for producing in response to a group of electron beams a subsequent group of electron beams traveling in the direction of the second point comprises a secondary emitting grid or foil member placed across the path of the electron beams.

9. In a system for the communication of intelligence, an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, successive means located in said pipe between said first and said second point adapted to receive a group of electron beams traveling in the direction of said second point and in response to said received group of beams to produce a subsequent group of beams traveling towards said second point, means for maintaining all of said beams in courses generally parallel to the axis of the pipe during the passage of electrons therein down said pipe, and a fluorescent screen at said second point on which electron beams arriving at that point through said pipe impinge.

10. In a system for the communication of intelligence, an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, successive means located in said pipe between said first and said second point adapted to receive a group of electron beams traveling in the direction of said second point and in response to said received group of beams to produce a subsequent group of beams traveling towards said second point, means for maintaining all of said beams in courses generally parallel to the axis of the pipe during the passage of electrons therein down said pipe, and a plurality of electron targets at said second point, one for each of the electron beams arriving at that point through said pipe.

11. The combination of elements as in claim 1 in which said means for maintaining the beams in courses parallel to the axis of the pipe comprises a plurality of permanent magnets each surrounding the pipe system and being polarized so that the north pole faces the first point and the south pole faces the remote second point.

12. The combination of elements as in claim 1 in which said evacuated hollow pipe comprises a plurality of cylindrical sections in tandem and in further combination with means for applying a high frequency alternating wave to certain ones of said cylindrical sections, the phase of the wave, the frequency thereof and the length of the section being so chosen that the electrons reach the beginning of each of said certain sections when the potential of the wave is a maxi-

imum in the positive direction and the end of said section when the wave is zero.

13. The combination of elements as in claim 1 in which said evacuated hollow pipe comprises a plurality of cylindrical sections in tandem, and in further combination with means for applying a high frequency alternating wave to certain ones of said cylindrical sections, the phase of the wave, the frequency thereof and the length of the section being so chosen that the electrons reach the beginning of each of said certain sections when the potential of the wave is a maximum in the positive direction and the end of said section when the wave is zero, and means for placing all sections except said certain ones at zero potential.

14. In a system for the communication of intelligence, an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at said first point for forming and launching within said pipe a group of modulated electron beams moving in parallel courses in the direction of said second point, repeater means in said hollow pipe for producing electron beams modulated in a manner corresponding to that of said group of modulated beams, and means for obtaining indications at said second point, and in response to said last mentioned electron beams, representative of the modulations of said group of modulated electron beams.

15. Means for electronically transmitting intelligence to a distance comprising an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at the first point sending end of said pipe for releasing electrons therein in accordance with the intelligence to be transmitted, means disposed along said pipe providing magnetic fields for guiding and propelling the electrons therein, and means at the receiving end second point for absorbing the electrons and converting their energy into signals capable of being discerned.

16. Means for electronically transmitting intelligence to a distance comprising an evacuated,

hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at the first point sending end for releasing a group of electron streams therein varying in accordance with the illumination of the various elemental areas of an object or field of view, means for retaining the streams in their respective places cross-sectionwise as the streams traverse said pipe, and means for receiving the streams on a target or screen at said second point.

17. Means for electronically transmitting intelligence to a distance comprising an evacuated, hollow pipe in the form of a long transmission line sectionalized by a plurality of gas-tight windows such that successive sections of pipe are joined together without loss of vacuum into a composite integral continuous line extending from a first point to a remotely located second point, means at the first point sending end for releasing a plurality of space-separated streams of electrons varying in accordance with the intelligence it is desired to transmit, means for retaining the streams in their respective places cross-sectionwise as the streams traverse said pipe, and means for individually receiving the streams at the receiving end second point of the pipe.

18. The combination of elements as in claim 1 in which said hollow pipe has a length of the order of miles.

19. The combination of elements as in claim 1 in which said pipe has a length at least a thousand times greater than the maximum transverse dimension of the tube.

LLOYD ESPENSCHIED,
ALBERT M. SKELLETT.

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