

Sept. 6, 1949.

A. N. GOLDSMITH
RADIO GUIDING SYSTEM

2,481,410

Filed Dec. 29, 1942

10 Sheets-Sheet 1

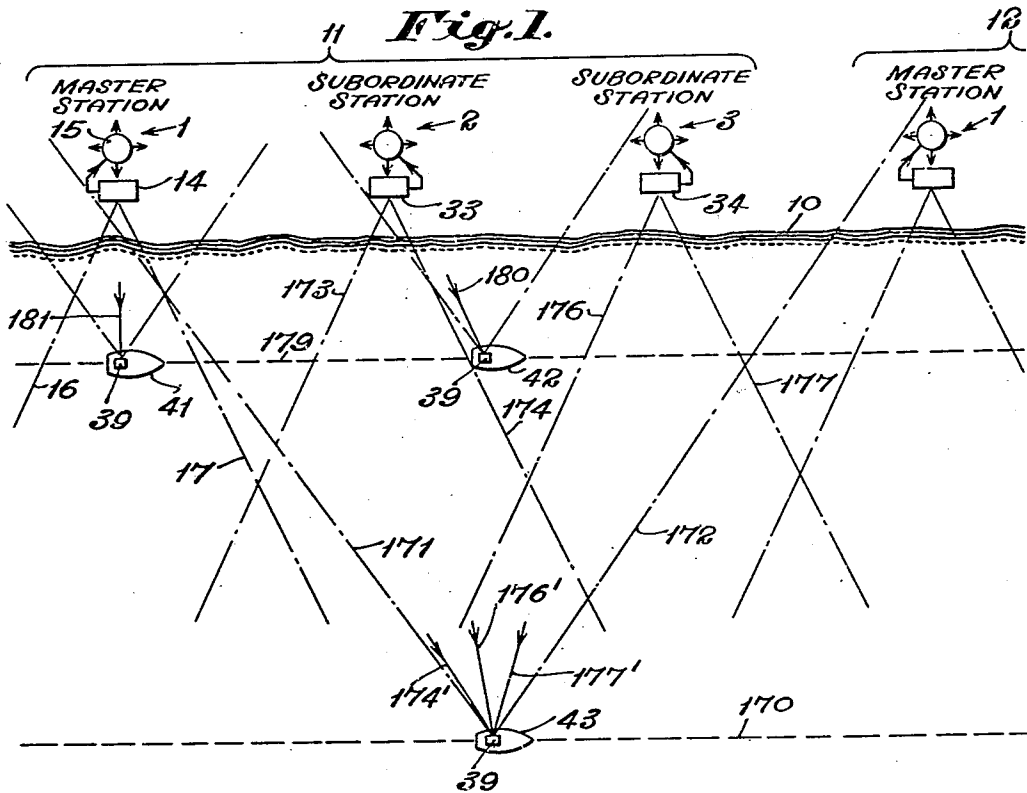


Fig. 5.

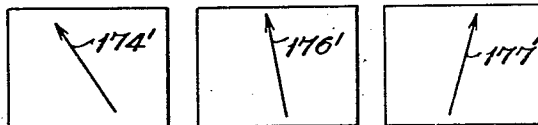


Fig. 6.

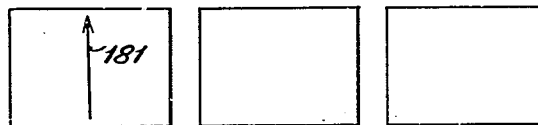
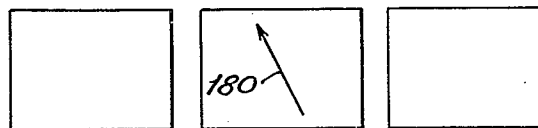


Fig. 7.



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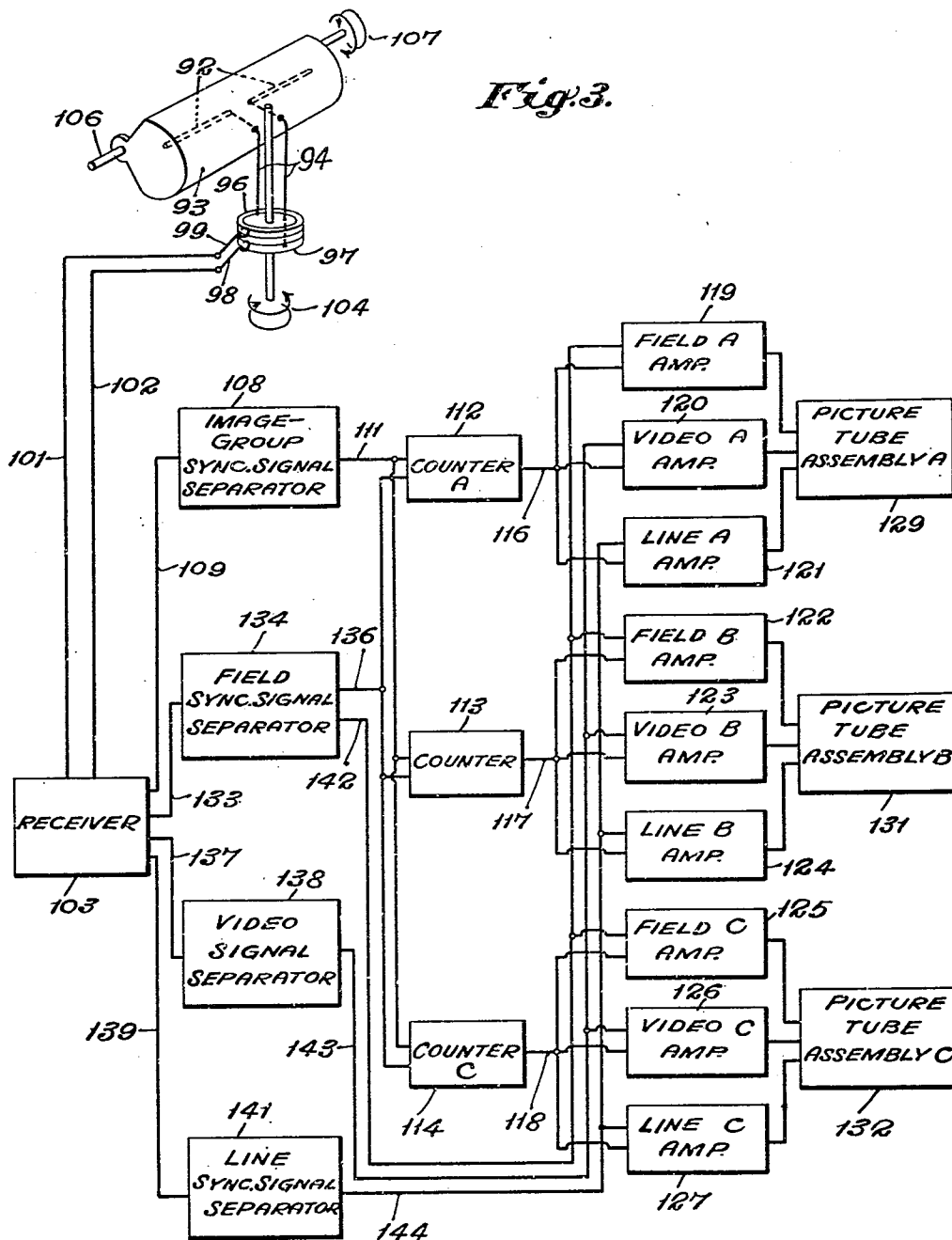
Sept. 6, 1949.

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10 Sheets-Sheet 3



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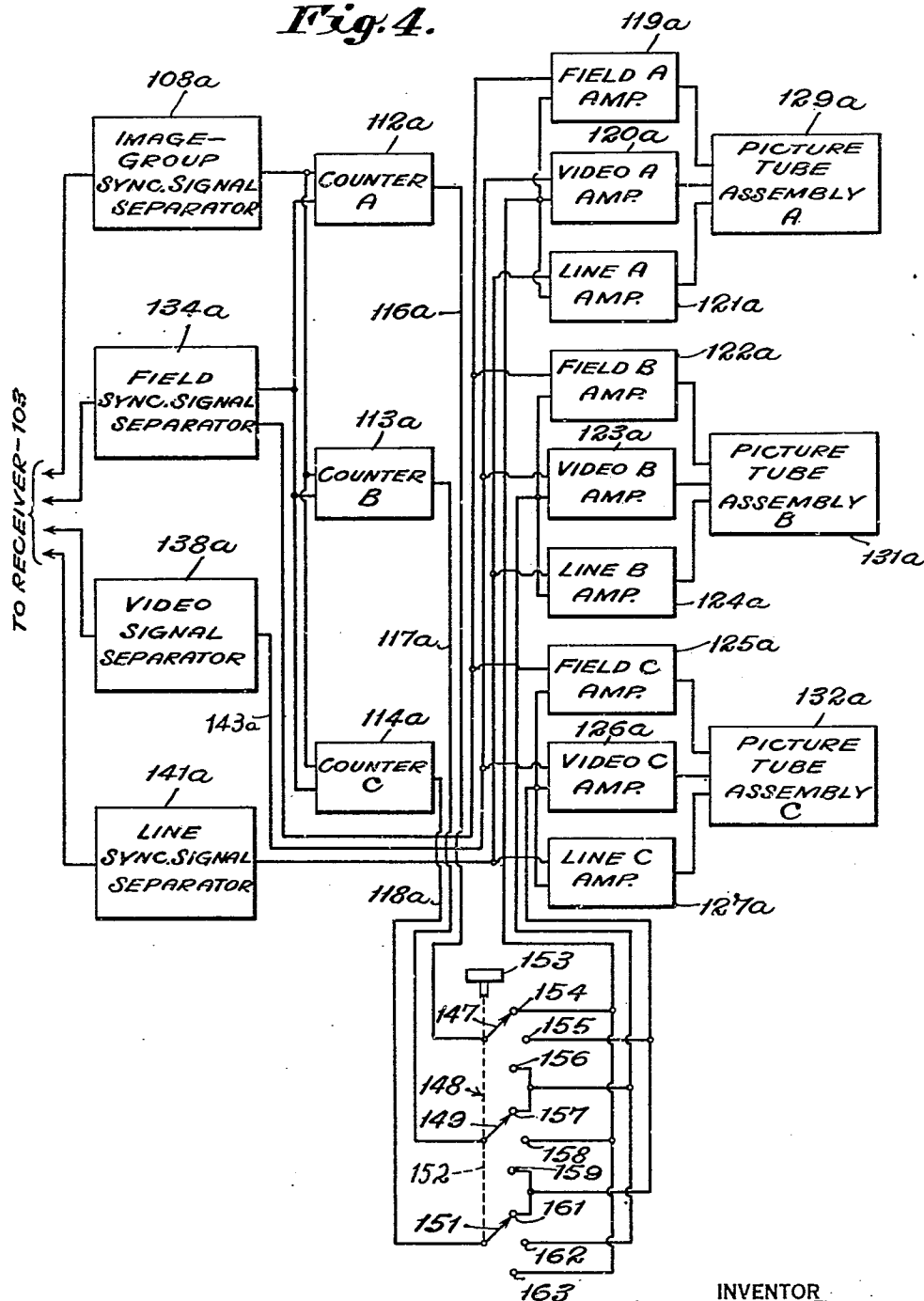
2,481,410

RADIO GUIDING SYSTEM

Filed Dec. 29, 1942

10 Sheets-Sheet 4

Fig. 4.



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A. N. GOLDSMITH
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2,481,410

Filed Dec. 29, 1942

10 Sheets-Sheet 5

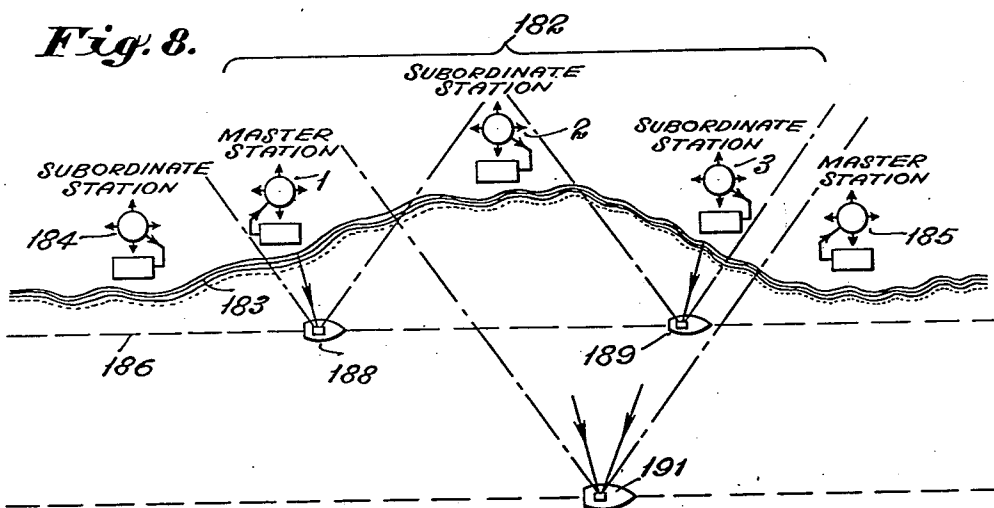


Fig. 9.

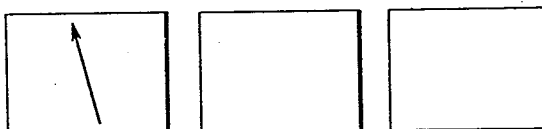
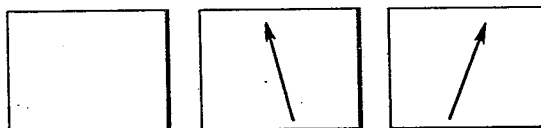


Fig. 10.



Fig. 11.



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A. N. GOLDSMITH
RADIO GUIDING SYSTEM

2,481,410

Filed Dec. 29, 1942

10 Sheets-Sheet 6

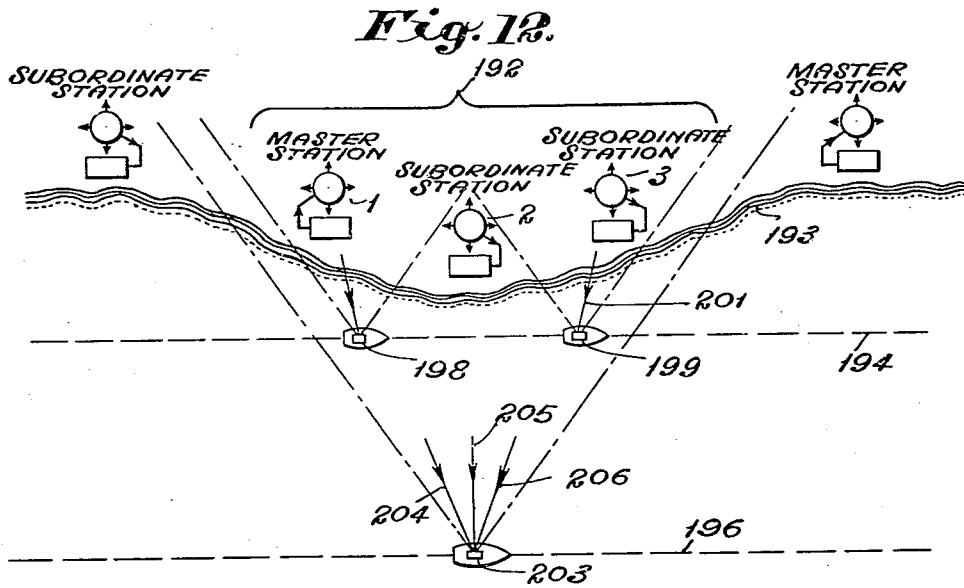


Fig. 13.

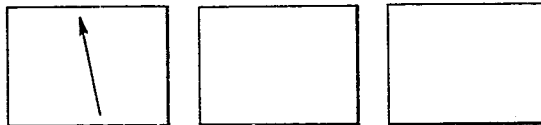


Fig. 14.

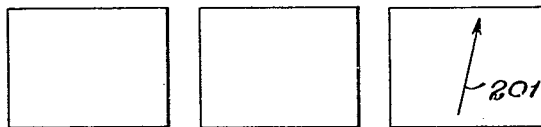
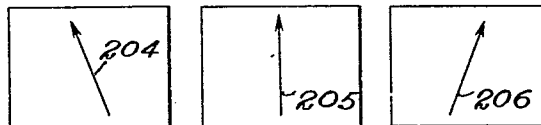


Fig. 15.



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2,481,410

RADIO GUIDING SYSTEM

Filed Dec. 29, 1942

10 Sheets-Sheet 7

Fig. 16.

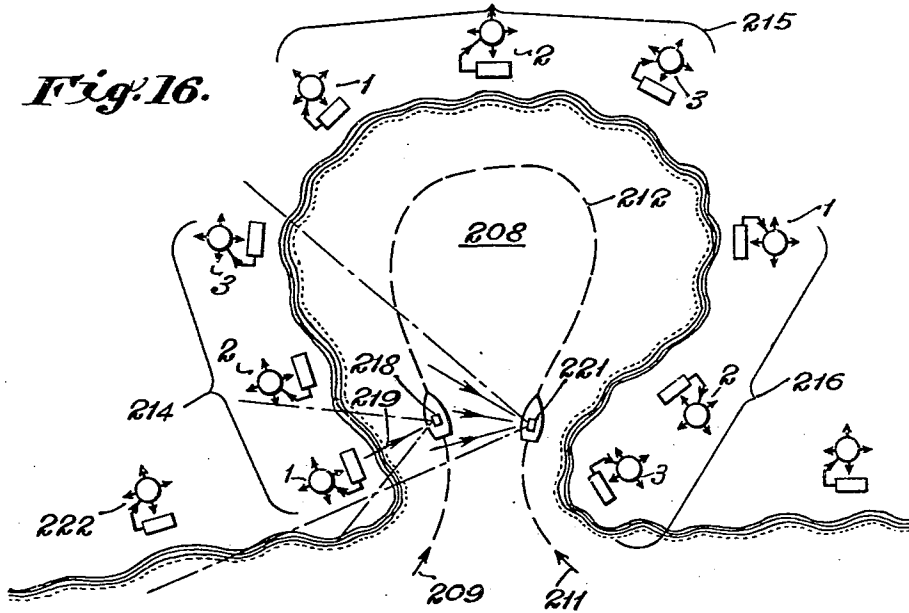
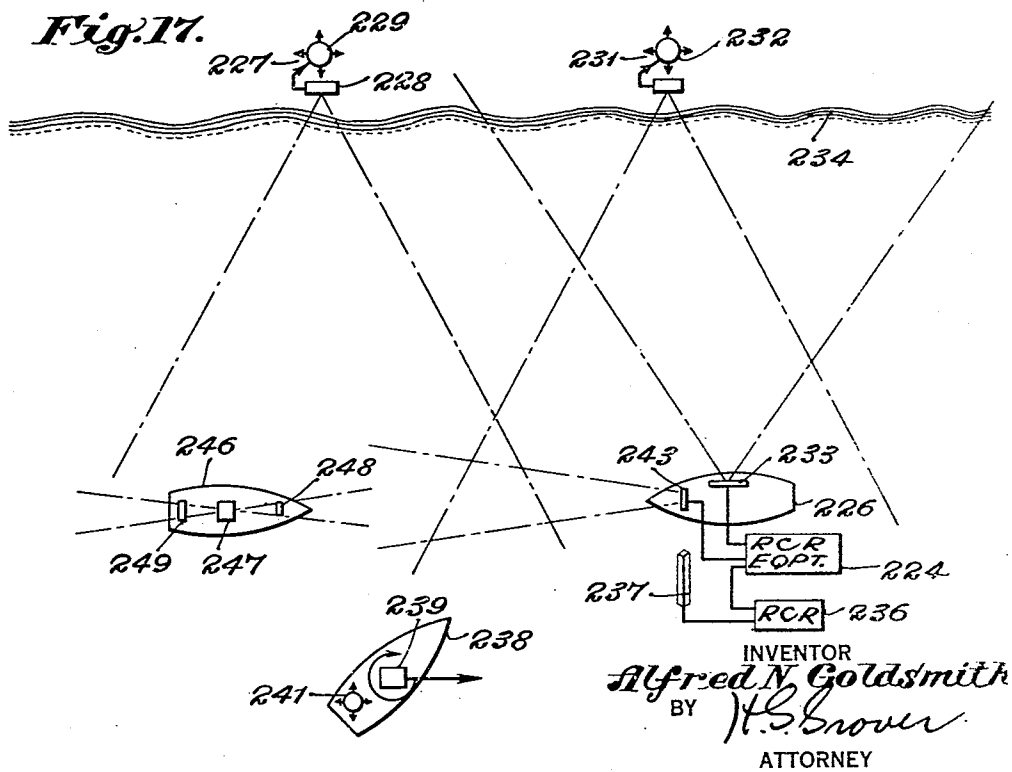


Fig. 17.



Sept. 6, 1949.

A. N. GOLDSMITH
RADIO GUIDING SYSTEM

2,481,410

Filed Dec. 29, 1942

10 Sheets-Sheet 8

Fig. 18.

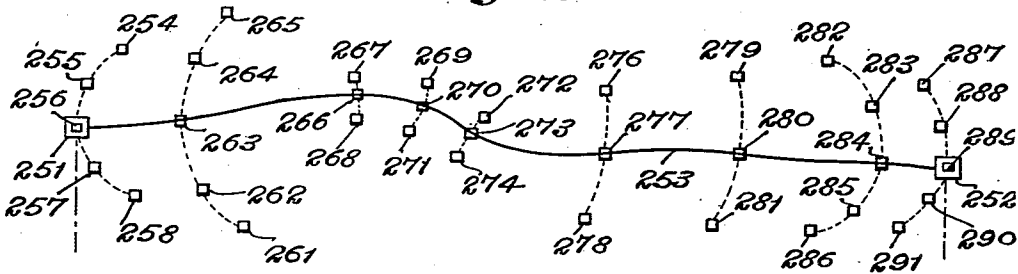


Fig. 19.

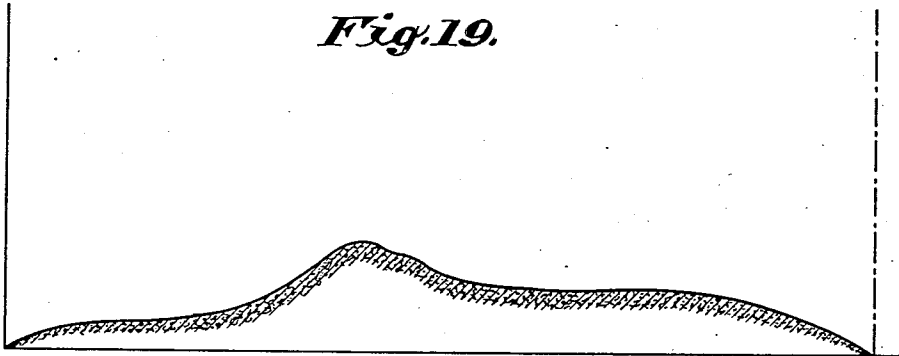
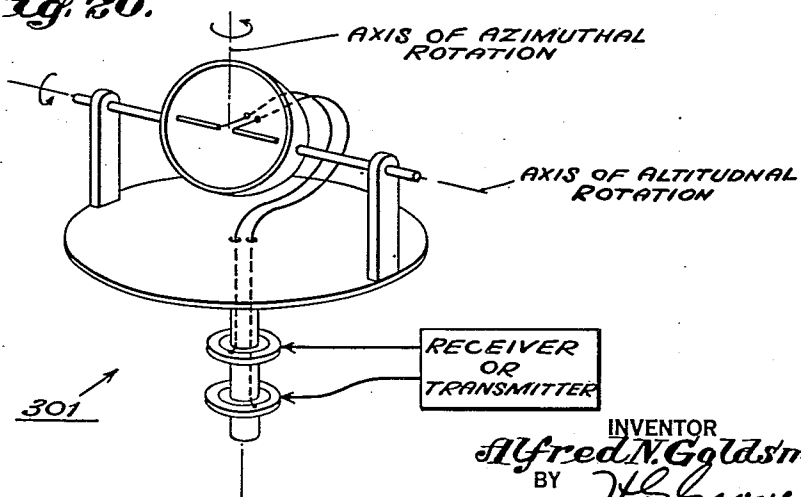


Fig. 20.



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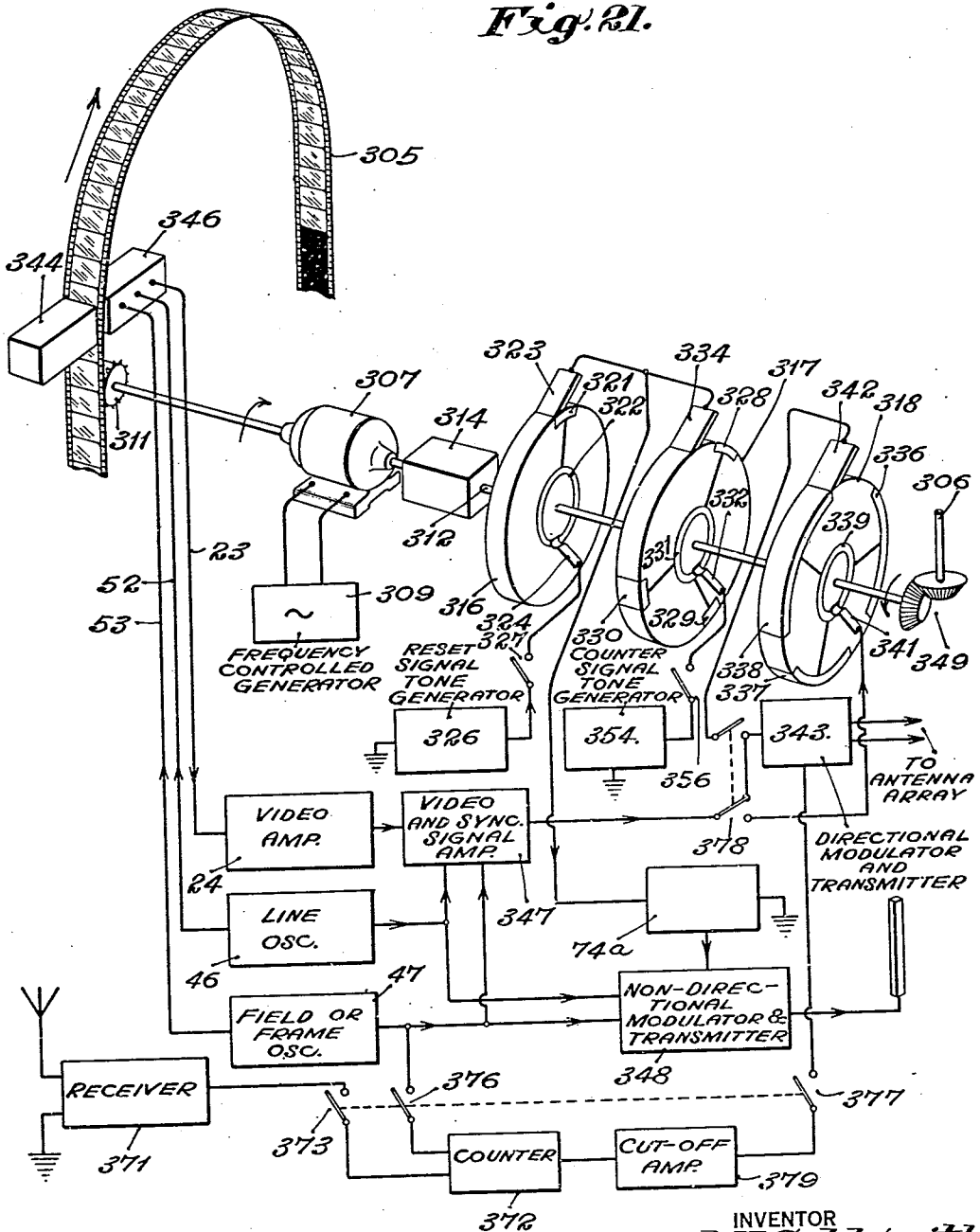
A. N. GOLDSMITH
RADIO GUIDING SYSTEM

2,481,410

Filed Dec. 29, 1942

10 Sheets-Sheet 9

Fig. 21.



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A. N. GOLDSMITH
RADIO GUIDING SYSTEM

2,481,410

Filed Dec. 29, 1942

10 Sheets-Sheet 10

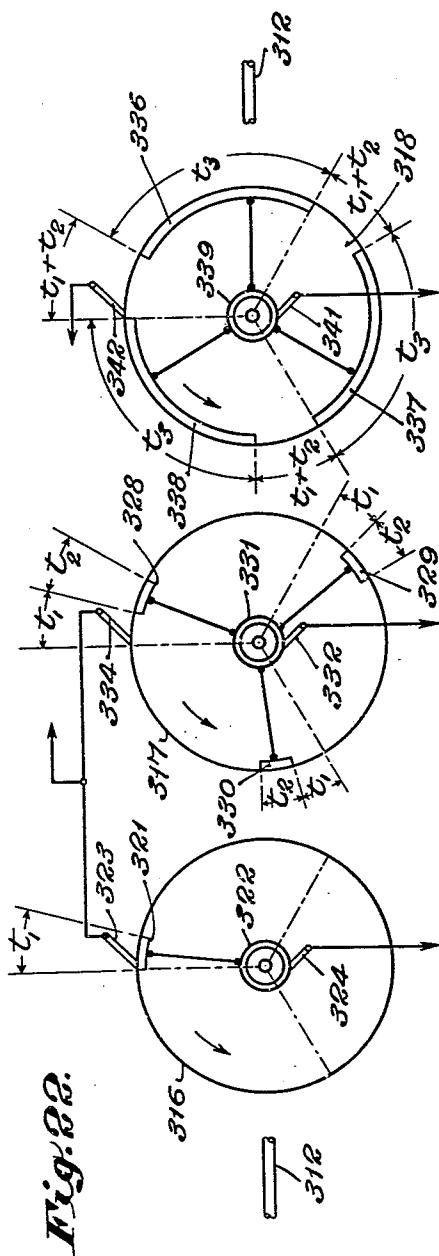
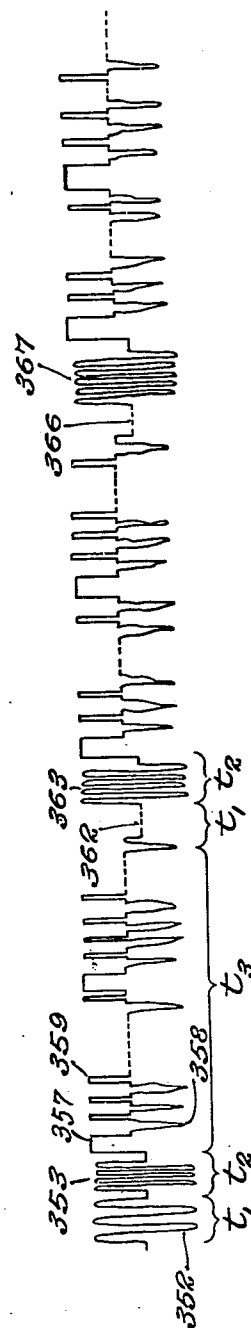


Fig. 22.

Fig. 23.



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UNITED STATES PATENT OFFICE

2,481,410

RADIO GUIDING SYSTEM

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Application December 29, 1942, Serial No. 470,479

30 Claims. (Cl. 178—6)

1

The present invention relates to a system for determining the position or a series of positions of water and air borne craft, or a vehicle or the like with respect to a significant condition, area, location, course or line, or to a series of distributed conditions, areas, locations, courses or lines, and more particularly to television systems for providing a series or group of views correlated in space and time whereby to constitute a changeable panoramic pictorial representation on a ship, aircraft or vehicle of a coast line or other significant line available or established for guiding or to be avoided by the ship or vehicle.

In accordance with the present invention, in one preferred form, a plurality of panoramic television transmitting stations are arranged in a predetermined manner along a significant line, for example, a coast line or an airplane route. These transmitting stations are of the type which radiate directionally, the angle of directivity illustratively changing uniformly. When the significant line is an airplane route, the angle of directivity is generally upward and may pass through the zenith, the arc encompassed being greater or less than 180 degrees. Control of each station is exercised in such fashion that a plurality of groups are formed, a predetermined number of stations forming a group with respect to their transmission periods, the latter being so timed that a non-overlapping series of transmission periods exists within a group. Corresponding stations in the several groups transmit simultaneously and may, because of the directional properties of transmission, transmit at the same frequency. In effect, principles of multiplex transmission and reception are adapted to a new use.

In my Patent No. 2,298,476, dated October 13, 1942, I have disclosed and claimed a guiding system for guiding a freely movable aircraft equipped with a television receiver. The principal object of the present invention is to provide novel means, based on principles set forth in that patent, for guiding air, ground and water borne craft or conveyances along paths related to a significant line.

In another broad aspect of the present invention, a plurality of stations having related directions of transmission transmit simultaneously, the transmission from each station representing a panorama of terrain in its vicinity. As a result, a ship, vehicle or other moving conveyance equipped with a directional television receiver may follow a desired path to a given point. Accordingly, another object of the inven-

2

tion is to provide a novel arrangement for guiding a ship, vehicle or other conveyance along a desired or predetermined path or course to an objective such as a dock, hangar or the like.

Still another object of the invention is to provide a novel directional television transmitting station having a timed directional sweep of desired angular extent.

A further and related object is to coordinate the directional sweeps of a plurality of the directional radio transmitting stations so as to obtain successive transmissions, thereby to provide a novel plural transmitter station multiplex system.

A still further object of the invention is to correlate the operation of two or more groups of directional television transmitters.

Still further objects of the invention will become apparent and suggest themselves to those skilled in the art to which the invention is directed upon reading the following specification and claims in connection with the drawings in which:

Fig. 1 represents a significant line or a portion thereof, such as a coast line having a plurality of television transmitters located along it in accordance with the invention;

Fig. 2 is a diagrammatic showing of means for controlling one or more of the transmitters of Fig. 1;

Fig. 3 is a diagrammatic showing of a form of receiving system in accordance with the invention;

Fig. 4 shows a modification of the receiving system of Fig. 3;

Figs. 5, 6 and 7 illustrate the character of the television messages received when employing the receiving system of Fig. 3 in a ship or the like availing itself of the guiding service provided by the transmitter arrangement of Fig. 1;

Fig. 8 is similar to Fig. 1, but represents a curved significant line such as a concave coast line, and may be considered as a continuation of Fig. 1;

Figs. 9, 10 and 11 are similar to Figs. 5, 6 and 7 and correspond to Fig. 8;

Fig. 12 is also similar to Fig. 1, but represents a curved significant line such as a convex coast line, and may also be considered as a continuation of Fig. 1 or of Fig. 8;

Figs. 13, 14 and 15 are similar to Figs. 5, 6 and 7 for the transmitter arrangement of Fig. 12.

Fig. 16 is more nearly like Fig. 8, but represents a curved significant line having more or less closely spaced end portions such as the coast line of a bay.

3

Fig. 17 is a still further modification of the guiding system of Fig. 1;

Fig. 18 shows a significant line such as a route to be followed by aircraft between spaced points over different kinds of terrain;

Fig. 19 indicates by way of example the profile of terrain which may be encountered along an aircraft route, such as that of Fig. 18;

Fig. 20 indicates diagrammatically the airplane equipment contemplated for use in a plane availing itself of the guiding service outlined in Figs. 18 and 19;

Figs. 21 and 22 are diagrammatic showings of a modification, Fig. 21 being similar to Fig. 2, and

Fig. 23 illustrates the signal produced by the embodiment shown in Fig. 21.

Referring to drawings, Figs. 1, 8, 12 and 16 illustrate typical characteristics of portions of a coast line which may be equipped in accordance with the invention to guide watercraft. The term "coast line" will be used hereinafter for the sake of convenience, but it is to be understood that this term is intended to embrace any significant line or boundary provided with an adjacent or related network of panoramic television stations in accordance with the invention. The apparatus and its arrangement for each of these figures of the drawings will be separately discussed, it being understood that the character of a natural coast line may correspond to one or all of the figures of the drawing just named.

Fig. 1 of the drawings, which illustrates a substantially straight section of shore, is to be provided with a linear network of panoramic television stations. In this figure reference character 10 represents a coast line, along which is located a plurality of panoramic television stations located inland any convenient distance from the shore line and preferably close thereto.

In the specific embodiment selected for purposes of illustration three stations constitute a group indicated generally by the reference character 11. In practice any convenient number of stations may make up the group, three being selected merely for the sake of convenience of exposition. The next group, proceeding in a direction from left to right as viewed on the figure, is designated 12 and may be the 12th or any other numbered group in a sequence of groups. Station 1 of group 11 is similar to station 1 of group 12, and may, for example, be of the kind disclosed by Fig. 8 in the drawings of Patent No. 2,298,476 referred to above, but modified to fulfill the purpose of this phase of the invention in the following manner. The station 1, which will be referred to as a master station, radiates not only panoramic picture signals, but also radiates indicial signals. These indicial signals include field and/or frame synchronizing signals, line synchronizing signals, and special signals which will be referred to as image group synchronizing signals. Image group synchronizing signals are special and identifiable signals which mark the initiation of a group of panoramic picture transmissions in succession from stations comprising the group. The manner in which composite panoramic pictures of the line of territory represented by reference character 10 are reproduced will be explained in detail hereinafter.

Station 1 of group 11 comprises a directional transmitter 14 and a non-directional transmitter 15. The direction of transmission of transmitter 14 is continuously variable during its periods of transmission and effective between the line 16 and the line 17. The angle between these lines

4

will be referred to as the transmitter swing angle. The picture signal which is transmitted will represent views at or near sea level of the coast line 10 taken along the successive directions of transmission toward the directional transmitter 14 in a manner fully disclosed in the patent above referred to.

This type of synchronized group transmission may be accomplished by the arrangement diagrammatically illustrated in Fig. 2 of the drawings, which discloses a transmitting station similar in some respects to that shown in Fig. 8 of Patent No. 2,298,476 above referred to. A film 18 is, or may be, prepared by photographing the coast line 10 from a series of points spaced along an arc or a chord of an arc using a portion of line 16 as a radius with station 14 as the approximate center. The film thus prepared may consist of a series of views or a motion picture showing a continuous panorama. The film 18, so prepared, is formed into an endless band and the frames or views on the film are moved into register successively before a suitable light source 21 so that light is projected through the film into a scanning device 22, the output of which is connected by way of a conductor 23 to an amplifier 24. The film, to facilitate synchronizing of its movement with the rotation of a directive radiator or antenna, conventionally shown at 26, may have a series of blackened frames 18a which will run before the scanner during the time in which the transmitter 14 is inactive. It will be understood, of course, that the film may be stopped during the time the transmitter 14 is inactive and if a longer film is desirable for mechanical reasons, the loop of film may contain one or more duplicate series of the views for transmission.

It will be further understood that any of the other methods shown in the above-mentioned patent for the directional television transmission of views with a given sweep angle (e. g., appropriate scanning of a faithful model or replica) may be alternatively used.

The angle between the lines 16 and 17 may be of any desired magnitude but is conveniently and arbitrarily chosen in the illustrative embodiment of Fig. 1 as 60 degrees, and there being three stations in a group, a complete series of transmissions may be obtained from all three stations during rotation of the directional radiator 26 of the station 14 through an angle of 180 degrees, and after this series of transmission has been completed this radiator will be in position to again transmit its series of views. Therefore antenna 26 is shown as a double radiator so that transmission may be resumed from the other side of this antenna at the desired time of initiation of the next series of three transmissions. This arrangement provides for ease of synchronization of the transmitters and correct coordination of their sweep angles. The arrangement of the illustrative example for obtaining this timing and synchronization will more fully appear in the description of the operation of the related groups of transmitters 11 and 12 shown by Fig. 1.

The film may move in the direction shown by the arrow and is advanced by any desired form of film driving arrangement illustrated conventionally as comprising a drive motor 28 which drives a film drive sprocket 29 through a shaft 31. If the supply source 30 for the motor 28 is frequency controlled, the entire system will be maintained in synchronism in a simple manner. Since this drive means for the film may readily serve as well for rotating the two section direc-

5

tional transmitter antenna 26, this antenna may be arranged to be rotated about an axis 32 by way of the drive shaft 33 through suitable gearing 37 and miter gears 36, for example. In this particular and illustrative arrangement, the transmission by radio varies in azimuth, the altitude of transmission being maintained or remaining substantially constant. Thus, if a given frame on the film 18 indicates a view to be projected in the direction of the line 16, then the active side of the directional antenna 26 will also be positioned so that it transmits in this direction to give the proper viewed image at receiving points along this line. The gearing arrangement between the drive for rotating the directional antenna 26 and for advancing the film 18 is such that whenever the double directional transmitting antenna 26 turns through, in this case, a 60 degree angle around its vertical axis, the film will have advanced through one third complete loop so the last frame to be transmitted is in position relative to the transmitter scanning device 22. A double series of blackened frames may be incorporated in the loop to bring the initially transmitted frame into register with the scanning device 22 when the other half of the directional antenna 26 is in position to radiate signals along the line 16.

When signals representative of the portion of the coast line 10 adjacent to the station 14 are developed from the transmitter scanning device 22, these signals appear in the output of the previously mentioned amplifier 24, which is of any conventional form designed to pass a relatively wide band of frequencies without frequency or phase distortion.

In order to synchronize any receiver, for example, radio receivers 39 equipped with a television reproducer or reproducers on vessels at the positions 41, 42 and 43, which may receive signals transmitted from the directional transmitting antennas of stations along the coast line 10 oscillators 46 and 47 are shown as connecting with the transmitters 14 and 15. The transmitter 14 serves to supply energy to the directional transmitting antenna 26 by way of the conductors 48. The transmitter 15 serves to transmit energy by way of the conductor 49 to the non-directional transmitting antenna 51. Conductors 52 and 53 supply controlling pulses in the usual manner to the horizontal and vertical sweep circuits of the picture transmitting tube of any suitable type in the scanner 22.

As stated previously, the directional antenna 26 is preferably a two section type as shown, one section of which comprises a directional doublet 54 with an appropriately mounted reflector means 56 to confine the radiation directionally to pre-selected azimuthal radiation directions. The other section is similar and comprises the doublet 57 and the reflector means 58. It will be understood that the reflectors 56 and 58 may be similar and may be of any suitable type. The conductors 48 carrying the signaling currents may be readily switched from the doublet 54 to the doublet 57 by commutators 61 and 62 on which pairs of brushes 63 and 64 bear respectively. The conductor segments of these commutators will extend for 180 degrees of the circumference, the remainder of the circumference being non-conductive and serving merely as a guide for the brushes.

The output of the amplifier 24 transmits both picture signals and background control signals, which is developed from the scanning tube and other tubes in the scanner 22. The connection of the oscil-

6

lators 46 and 47 into the transmitter, as shown, by the conductors 66 and 67, serves to bias the transmitter 14 to cut-off during at least a portion of the time period when synchronizing signals are to be transmitted in order that picture signals accompanied by background signals only shall be radiated from the directive antenna 26. Where the signals are interrupted in this manner a blanking interval is provided which allows the receiver scanning beam to return to a starting position after scanning each picture line, frame or field. The synchronizing signals may then be transmitted during the interruption period if they are sent separately via transmitter 15 from the non-directional transmitting antenna 51, and a constant background control signal may accompany the transmission of these synchronizing signals where desired. If desired, all signals may be transmitted from the directional antenna 26 without departing from the spirit and scope of the invention.

As stated previously, station 1 of group 11, which is shown schematically in Fig. 2, preferably serves as a master station, controlling stations 2 and 3 of group 11, and by further extensions stations 1, 2 and 3 of group 12, or other groups if desired. In order to fulfill this control function, Fig. 2 illustrates means by way of example which may be utilized to accomplish this purpose. This means may conveniently be a commutator 68 having a conductive segment 69 occupying a portion, for example, substantially 60 degrees of its circumference and being electrically connected in a suitable manner to the shaft carrying one of the miter gears 36, or to any other metallic portion such as ring 71 upon which a brush 72 may bear. A brush 73 contacts the periphery of the commutator and the segment 69 is oriented angularly with respect to the first frame of the picture series on the film 18 and the directional antenna 26 so that a signal is supplied to an amplifier 74 when the first picture is about to be transmitted. This signal may be derived from any suitable signal source 70 (not shown) and supplied to the amplifier 74 by a transformer or equivalent means 75. The source 70 may be an alternating current generator or an oscillator. This amplifier furnishes a signal to the transmitter 15, which is transmitted along with the other signals impressed on the carrier, which is radiated from the antenna 51. At the end of the picture series the brush 73 leaves the conductor segment 69 giving rise to another signal suitably generated or amplified and passed along by the amplifier 74 to be impressed on the carrier. These signals are utilized at transmitters 2 and 3 of group 11 and all other transmitters of the remaining groups, and, also, receivers which are in a receptive condition and receiving signals from these transmitters in a manner to be explained more in detail hereinafter in connection with the explanation of the system. It will be understood that two commutator segments may be provided, one which contacts the brush 73 at the beginning of the transmission of a series of pictures, the other one coming in contact with brush 73 at the end of the series of pictures. Electronic counting means may be substituted for the commutator 68, if desired.

A switch 76 is provided so that the apparatus shown in Fig. 2 may be used as a subordinate station employed, for example, as station 2 or 3 in group 11, or as any one of the stations in the remaining groups.

The field synchronizing signals pass through

7

conductor 77 into a counter-circuit 78 which may be any of the usual types of counter, for example, the one shown in White Patent No. 2,113,011, granted April 5, 1938, may be used. This counter is set for the sequence number of the corresponding transmitter station at which it is located, for example, at station 2 of any of the transmitter groups it will be set to operate upon reception of the second pulse of each set of image group synchronizing signals transmitted from the antenna 51 of station 1 of group 11. The output of the counter 78 may be a controlling bias which passes along the conductor 79 to control the cut-off amplifier 81. The output of this amplifier 81 appears in conductor 82 as a cut-off bias which is applied to the transmitter 14 to start and stop the carrier wave. Thus, if the counter is actuated by the correct number of field synchronizing signals following a reset signal, the carrier will be turned on for the appropriate period during which directional transmission is to occur and then be turned off by either the next field synchronizing signal, or the next reset signal acting on the counter. It will be understood by those skilled in the art that it will be possible to use a LaCour phonically synchronized mechanical switching means at the transmitters for the same purpose as the electronic means comprising the counter 78, but the electronic means are preferred. Electronic switches per se are well known and accordingly not illustrated in detail. Suitable forms of such devices are shown by Roys et al, Patent No. 2,089,430, granted August 10, 1937, and Shumard Patent No. 2,146,862, granted February 14, 1939.

At station 1 of group 11, considered as a master station, the counter 78 and the amplifier 81 may be and preferably are omitted, since this station originates the reset signals for the remaining transmitters of its group and the transmitters in the other groups by the commutator 68 or equivalent electronic means as pointed out above. In order that the transmitting apparatus shown in Fig. 2 may be used as a subordinate station in other positions in the network, a separate radio receiver 84 of any suitable type for receiving reset signals from a master station, such as station 1 of group 11, is provided. These reset signals are furnished to the counter 78 from the output of the receiver 84. At a master station the commutator 68 or its equivalent may supply reset signals directly to the counter by way of a conductor 86, and if desired a switch 88. The switch 88 may be mechanically or electrically interlocked with a switch 89 in the output of the radio receiver 84 so that when the switch 88 is closed, switch 89 will be open. The switch 89 may operate the heater and power supply circuits of the receiver in the usual manner not shown. It will be understood that when the apparatus of Fig. 2 is used as a master station, switch 88 will be closed and switch 89 will be open. When the apparatus of Fig. 2 is used at a subordinate station for purposes contemplated in this invention, the switch 89 will be closed and the switch 88 will be open. The conductor 86 may be connected directly to the switch 76 where counter 78 is of the type capable of integrating direct current pulses. For other types of counters it will be understood that the amplifier 74, which furnishes a modulating frequency to the transmitter 15, may also furnish undulating or alternating current suitably interrupted to the counter 78.

Fig. 3 of the drawings discloses, by way of ex-

8

ample, a receiver system suitable for use as the receiving equipment designated 39 on Fig. 1 of the drawings. An adjustable directional receiver is preferably provided for the purpose inasmuch as the complexity of the transmitter arrangements along curved coast, harbors and the like make it desirable to enable the receiving station to select, by reason of its angle of directional acceptance, the necessary number of stations in the image group and only these.

Within the acceptance angle of the receiver it is desirable to select each particular transmitting station and to assign signals from this to a corresponding image reproducing device of any desired type. It is possible to accomplish this image distribution by sharply directional reception by way of an antenna having timed rotation, but it is not deemed necessary and hence it is not preferred.

Also it is possible to select each transmitting station by carrier frequency discrimination where each transmitter radiates a carrier frequency different from the others. The position of the transmitting station in a transmitting sequence or group, as described above, in connection with Figs. 1 and 2 of the drawings serves for selection purposes and is the preferred arrangement. Where desired this form of selection can be supplemented by carrier frequency selection which involves having different carrier frequencies for successive image groups of transmitters. That is to say, the three stations of group 11 would operate on one carrier frequency and the stations of group 12 would operate on another carrier frequency, and subsequent and previous groups would operate on still other carrier frequencies.

The apparatus of Fig. 3 is adapted to the reception of three transmitting stations within an image group, all operating on the same carrier frequency as is shown by way of example in Fig. 1 of the drawings. This apparatus to be described is fully electronic in operation, but may be partly electro-mechanical in nature, or it may embody any equivalent arrangement to that shown as will be understood by those skilled in the art.

A directional receiving antenna 92 is provided, which is placed in front of an appropriate reflector or antenna reflector array 93. The flexible leads 94 from the antenna are connected to slip rings 96 and 97 on which rest a pair of brushes 98 and 99 connected to the conductors 101 and 102, which lead to a radio receiver 103 of a suitable type.

The antenna may be manually directed as desired in a horizontal plane by rotation, as indicated by the arrows 104. The antenna may also be directed in a vertical plane by manual adjustment around the axis 106, as indicated by the arrows 107. The arrangement just described is desirable in the case of aviation applications of a modified system of networks, which will be further described below in connection with Figs. 18, 19 and 20 of the drawings.

The output of the receiver 103 in part passes to the image group indicial signal separator or selector 108 by way of a conductor 109. The signal separator 108 is of an electrical type suitable for selecting the reset or image group indicial signal transmitted from the master station of the transmitter group. The discrimination means in the signal separators may be adapted to modulation-frequency selection, amplitude selection, or signal-duration selection, or any combination of these as desired. The resulting indicial or reset

signals pass through a conductor 111 to three counters 112, 113 and 114, thus resetting them simultaneously. These counters may be similar to the counter 78 shown in Fig. 2 of the drawings modified in respect of the integration means so as to produce biasing potentials appearing in their output circuits 116, 117 and 118 respectively upon the application of a suitable number of signals or pulses on the reset circuit conductor 111. The three counters are arranged to respond respectively to the first, second or third field synchronizing pulse which reaches them and to become correspondingly active by producing a bias voltage on activation, which bias voltage is of a polarity and amplitude suited to cause amplifiers labeled 119 to 127 to become active for purposes of amplification. At all other times these amplifiers are biased to cut-off. Amplifiers 119 to 121 are associated with a picture reproducing device of any suitable kind or type such as a "Kinescope" assembly 129 and are respectively the field or vertical sweep amplifier, the picture amplifier and the line sweep amplifier. The "Kinescope" is a well known type of cathode ray receiver or picture tube. Picture tube assemblies 131 and 132 are also each associated with three similar amplifiers designated 122 to 124 and 125 to 127 respectively.

Part of the outputs from the receiver 103 pass through a conductor 133 to a field synchronizing separator 134, which is of the usual type. Part of the output of the field synchronizing separator passes through a conductor 136 to the counters 112 to 114 and serves to operate their counting circuits as previously described. It is to be noted that one frame of the transmissions from station 1 will first be received effectively and with adequate signal amplitude at 39 on ship 41; then one frame from station 2; and then one frame from station 3. Thus the corresponding and associated frame or field synchronizing signals, received at separated and related intervals, will appropriately actuate sequentially the counters 112-114.

In place of using the field synchronizing signal to actuate the counters, a special station-indicial signal can be sent from each station of a group prior to each group transmission, and from a non-directional antenna. This signal can be derived from the output of receiver 103 by a station-transmission indicial or identifying signal separator (not shown), the output of which will be conductor 136 (which, in that case, is not connected to field-synchronizing signal separator 134).

Other portions of the output of the receiver 103 pass through a conductor 137 to the picture signal separator 138 of conventional type and through a conductor 139 to a line synchronizing signal separator or selector 141, also of the conventional type. The output of the signal separator 134 passes by way of a conductor 142 to amplifiers 119, 122 and 125. The output from the signal separator 138 goes by way of a conductor 143 to the amplifiers 120, 123 and 126. The output of the signal separator 141 goes by way of a conductor 144 to the amplifiers 121, 124 and 127.

It will be noted that the counter 112 controls or activates the group of amplifiers associated with the picture tube assembly 129, which assembly comprises the picture tube, including its grid control means and also its field and line deflection means. Thus, whenever the counter 112 is activated or tripped, and only for that period,

the group of amplifiers associated with the picture tube assembly is active and a picture is reproduced on the picture tube of the picture tube assembly 129. The same description holds for the amplifiers and picture tube assembly associated with the counters 113 and 114.

Fig. 4 of the drawings shows schematically an arrangement which may be employed with the apparatus arrangement of Fig. 3 to insure the desired sequence or arrangement in desired adjacent positions of views on the picture tubes of the picture tube assemblies 129 to 132 to simulate a continuous panorama of the coast line. Apparatus and circuit elements shown in Fig. 3, which also appear in Fig. 4, are given the same numerical reference characters with the suffix "a" added to facilitate description of this modification and to show the circuits which are modified. The counters and their input circuits remain the same as shown in Fig. 3 of the drawings, and also the connections from the elements 134a, 138a and 141a to the amplifiers 119a to 127a are unchanged. The amplifiers 119a, 120a and 121a remain connected to the picture tube assembly 129a and likewise the amplifiers 122a to 127a remain connected to their respective picture tube groups 131a and 132a respectively. The output circuit of the counter 112a is connected by way of a conductor 116a to rotary brush or wiper arm 147 of a rotary switch indicated in its entirety by reference character 148. This switch may be of any desired triple pole, triple throw type which may be cyclically operated and for purposes of convenient operation I have chosen a three bank switch of the type generally employed for range selection switching purposes in radio receivers to illustrate this portion of the system embodying my invention. The counter 113a is connected by a conductor 117a to another brush or wiper arm 149 of the switch 148. The counter 114a is connected by conductor 118a to the third brush or wiper arm 151 of the switch 148.

The brush arms of the switch are carried on a rotatable shaft 152, which may be rotated by a conveniently located knob 153. Three contact studs 154 to 156 cooperate with the switch arm 147 and are connected to the amplifier groups for the picture tube assemblies 129a to 132a in the order named. These amplifier groups are composed of the amplifiers 119a to 127a. The second group of three contact studs 157, 158, and 159 is connected to the amplifier groups for the picture tube assemblies 131a, 129a and 132a in the order named. The third group of three contact studs 161, 162 and 163 is connected to the amplifier groups for the picture tube assemblies 132a, 131a and 129a in the order named.

The operation of the modification shown by Fig. 4 of the drawings and just described will be reviewed in connection with the operation of the complete system shown by Figs. 1, 2 and 3 of the drawings with reference also to Figs. 5, 6 and 7. Briefly, with the switch arms in the position shown, with counter 112a tripped to render the amplifiers 119a, 120a and 121a active, picture signals will be applied by way of conductors 143a to the picture tube in the picture tube assembly 129a. These picture signals may be applied to any of the other picture tube assemblies by rendering either group of the two remaining groups of amplifiers active. The same is true of the other counters so that the received views may be oriented in space with the actual appearance of the significant line or boundary as indicated

by the juxtaposition of suitably related views thereof.

As regards means for the exclusion of incidentally picked-up weaker signals which fall, so to speak, within the same time as stronger and desired signals, it is possible that in complicated televisibility systems or under "freak" propagation conditions, such an effect may occur. It is then desirable to shut out the weaker of the signals and to receive, and show on a picture tube, only the stronger of the two "interfering" signals. This can be accomplished by such means as using frequency-modulation transmission. Or it can be accomplished by means of threshold circuits which permit the passage therethrough only of signals exceeding a certain amplitude.

Referring to Figs. 1, 2, 3, 5, 6 and 7, a general description of the operation of the system as employed for giving guiding information to a ship or other water borne craft will be briefly given, although the function of each piece of apparatus comprising the system has been pointed out somewhat in detail in the foregoing.

The vessel 43, for example, proceeding on a course 170 generally parallel to the shore line 10 is shown as being in a position by reason of the directional acceptance angle of its receiver to receive transmissions from all of the stations in group 11 of the continuous network of coastal stations. The lines 171 and 172 on Fig. 1 indicate generally the receiver acceptance angle of the receiver 39 on the ship 43. The acceptance angle of the ship receiver is taken at the convenient though purely illustrative value of 80 degrees. The three stations in group 11 are transmitting successively and separately, that is, station 1 projects a series of views in succession between the lines 16 and 17, following which station 2 projects a series of views between the lines 173 and 174, and next the station 3 projects a series of views between the lines 176 and 177, this operation being cyclically repeated. The transmission times of each of the stations in the illustrative embodiment are equal, and the number of views transmitted from each station is optimum for the character of the coast line adjacent to the stations. For example, where the coast line is regular and the adjacent territory is flat, little would be accomplished by sending a detailed panoramic showing since distinctive land marks would be lacking. The views sent are preferably identified by distinctive marks showing, for example, the assigned number of the sending station, the name of the area and the compass direction toward which the view was taken. When the directive antenna or antenna array of a group transmitting station, such as the doublet antenna 57 of station 1 is in a position to direct signals along the line 16, the transmitter 15 projects an image group indicial signal from the antenna 51, which is received by the stations 2 and 3 of group 11 and the stations in group 12 and other groups under control of this master station. The image group synchronizing signal is also received by the receiver 39 on the ship 43 and other receivers in the vicinity.

Where the system embodying this invention is such that any or all indicial signals are sent out by a fixed master station, and that a number of fixed subordinate stations are also in operation, compensation for the approximate differences in transmission paths to the receiving stations from the master station and subordinate stations, and the consequent slightly different times of indicial signal arrival may be embodied in the form of ad-

justable phase delay means in the receiving circuits for the indicial signals as applied to each of the corresponding subordinate station picture signals. The phase correction means employed must be substantially free from frequency or phase distortion effects on the indicial signals in question. They can function only on an average basis for mobile receiving stations, described above, but they enable compensation of such phase-delays for each position of the receiving station by manual adjustment. Instead of phase delay systems, the requisite picture shift can be more simply introduced into the receiving system at the final picture reproducing point by means of alterations in the horizontal or line deflection biasing means. In view of the distinctly finite length of the systems that may be established along an extended coast line, it is obvious that delay-correction means must be suitably embodied between or in the successive relay stations for neutralizing such delays, the maximum delay being introduced at the initiating stations, successively lesser delays at the successive relay stations, and the minimum or zero delay at the last station utilizing the reset signals.

The first image to be received from station 1 of group 11 will represent with sufficient clearness for the purpose a picture of a portion of the coast line 10 in the vicinity of the intersection of the line 17. The line 17 it will be understood, is the approximate center of the beam or elongated coverage area which is reached by the radiation field of station 1 at the limit of its swing angle. The direction of reception is indicated in the same manner by a line 174'. The next image to be received in the pre-arranged sequence will be from station 2 along the direction 176', followed by reception of an image from station 3 along the direction 177'. Assuming panoramic transmissions in each case, the combined views will closely correspond to those which would be seen optically by looking from the ship along the directions 174', 176' and 177'. Since these images will be suitably formed on adjacent picture tubes, they will give an acceptably correct panoramic view of the section of the coast line adjacent to the stations in group 11 as viewed from the ship 43. Even if the transmitters of group 11 were to send out only a single television picture corresponding to the orthogonal view of the coast in that vicinity, a good impression of the corresponding view of the coast line from the location at 43 would be obtained at the ship receiving station. Projecting television pictures corresponding to the orthogonal view is a feasible operating simplification. However, in a preferred system embodying the invention a panoramic view will be transmitted in the manner disclosed above, particularly for irregular and dangerous coast lines.

The ship 43 on the course 170 is assumed to be at approximately the outer limit of the reliable operating range of stations in group 11. Inasmuch as the transmitters of these stations will be operated with carrier waves of extremely high frequency in the preferred television embodiment, the operating range of the stations will be of the order of the optical or quasi-optical range. The position 43, therefore, is the estimated furthest recession of a ship receiving station from the shore, and at this position the space intervals between the stations of group 11 and other station groups comprised in a linear network will provide a number of views simultaneously corresponding to the number of transmitter stations

desired to form a group of adjacent images at the receiver.

As the ship 43 proceeds along the course 170, it will be seen that with the receiver acceptance angle shown, stations 2 and 3 of group 11, and station 1 of group 12 will be received. The mode of reception of these signals will be the same as when all of the stations of group 11 were received, except that, as pointed out above, the picture from station 1 of group 12 will be received on the picture tube assembly 129 since the amplifiers associated with this picture tube assembly are rendered operative by operation of the counter 112. The modified receiving system shown by Fig. 4 of the drawings permits reproduction of this image by the picture tube of assembly 132 and reproduction of the images from stations 2 and 3 of group 11 on picture tube of assemblies 129 and 131 respectively. Arrangement of a composite picture of the shore line 10 may be, or preferably is, facilitated, as pointed out above, by providing an angular sectorial series of views with identifying indicia.

Figs. 5 to 7 show the effect obtained by the results of the transmissions and receptions indicated diagrammatically of Fig. 1 of the drawings. Each rectangle represents a picture viewing surface as the observer faces the picture tubes. The line of rectangles in Fig. 5 shows what will result at the ship position 43. The arrows in the rectangles represent reproduced pictures and illustrate purely conventionally and generally the directions along which the picture transmissions are being received; and it will be understood from the foregoing description that reproduced pictures will appear as though the observer were viewing the coast line optically from a position such that he could see along the lines 174', 176' and 177'.

The vessel 41 proceeds along the course 179 parallel to the shore and at a distance which is the nearest safe or desirable approach of the vessel to the shore. This distance will, of course, be different for each section of the shore line and the network of guiding stations will be arranged to indicate this to a ship availing itself of the guiding service. The point of intersection of the center lines of the directional transmission beams from adjacent stations is such that a vessel approaching the shore line 10 with its receiver acceptance angle aimed at the shore will generally receive useful signal energy from only one station at a time.

At the position 41 only station 1 of the group 11 will be received in the assumed example if the center of the receiver acceptance angle is aimed perpendicularly to the coast. At a position 42, after the ship has advanced along its course, only station 2 of the group 11 will be effectively received under the same conditions. In fact, it will be found that, when employing apparatus arranged in accordance with principles disclosed above, for each position of the ship along the course 179 only one shore line station will be received at a time for the depicted conditions. If the stations 1 to 3 of group 11 send their pictures or angular-sectorial transmissions in sequence, preceded by the appropriate image group synchronizing indicial signal before each such sequence, and if the receiver is arranged so that the first effectively received transmission of each such image group goes, for example, to a left-hand picture tube as viewed by the observer, the second transmission goes to a central or middle picture tube, and the third and last transmis-

sion of each such group goes to a righthand picture tube, the image received at ship position 41 will appear at a left-hand picture tube and that at 42 on the central picture tube.

Fig. 6 shows the resulting view on the picture tube array at the position 41 in Fig. 1. The coast line will be apparently viewed along the direction 181 (transferred to a horizontal plane). At the position 42 the view will be as shown in Fig. 7, line 180, representing the direction of view. It will be noted that the image will appear on the second picture tube of the picture tube array, thereby indicating that the received station is the middle station of a series of time grouped stations.

In general when a picture is received clearly on only one of the picture tubes, it is an indication that the vessel is approaching closely or even too closely to the shore line and should change course until at least two stations are received clearly, and in some instances preferably until the images transmitted from all of the stations of the group are received on all of their respective picture tubes.

Fig. 8 of the drawings discloses the method of laying out a system of stations 182 for a concave coast line 183. The coast line 183 may be a continuation of the coast line 10, and in that instance the station group 182 will be synchronized by or along with the station group 11 and 12 or other groups and the transmission times of the stations 1, 2 and 3 composing the group 182 may be controlled from station 1 of group 11. Reference characters 184 and 185 indicate transmitting stations of adjacent groups, or if the depression or bight in the coast line occurs near the beginning or end of a group of stations 184 and 185 may occupy any position within two adjacent groups of stations. The course of nearest approach is indicated by the line 186, and this course is as far from the adjacent straight portions of the coast as the nearest course 179 in Fig. 1 is from its corresponding straight coast line. The swing angles of the transmitters and the acceptance angles of the receiver are taken as identical as those shown in Fig. 1 of the drawings. When the shortest or straight line course 186 is assumed as the course of nearest approach to the curved coast line the transmitters 1, 2 and 3, which are indicated as composing a group 182 are usually placed so as to be more widely separated than the transmitters of Fig. 1. At a position 188 only the station 1 of the group 182 will be received and its corresponding stretch of coast line will be imaged on a picture tube of a picture tube array of a vessel at this position. At a position 189 only station 3 of the group 181 will be received. At a position 191 stations 2 and 3 of the group 181 will be received.

Figs. 9 to 11 of the drawings show the effect obtained by the results of transmissions and receptions considered by way of example in connection with Fig. 8 of the drawings. Fig. 9 shows the reception at point 188. Fig. 10 shows the reception at point 189, and Fig. 11 shows the reception at point 191.

Fig. 12 shows the manner of laying out an image group of stations 192 along a convex or quasi-peninsular portion 193 of an otherwise straight coastline. The course of nearest approach to the coastline 193 for navigational safety will be the line 194, which is at the same distance from the protruding portion 193 of the coastline as the course 179 in Fig. 1 is from the straight coastline 10. The farthest course from

15

the coast along a coastal course is indicated by the reference character 196. At a point 198 station 1 of the group 192 will be shown on the left-hand picture tube of the group of three picture tubes assumed to be located on a vessel at the position 198. At the position 199 the image radiated from station 3 of the group 192 along the direction 201 or as closely approximate thereto as the panoramic system permits will be seen on the righthand picture tube of the group at the receiver. At a position 203 there will be received three images from stations 1, 2 and 3 of the group 192 corresponding to the images of the coast line in the viewing directions 204 to 206, or as close thereto as the panoramic direction transmissions permit. It will be seen also that the stations in group 192 may be more closely located than in the cases of Figs. 1 and 8.

Figs. 13 to 15 of the drawings show diagrammatically the images received in picture tubes of a ship receiver at the positions 198, 199 and 203 respectively. Fig. 13 shows reception of station 1 of the group 192 at the position 198. Fig. 14 shows reception of station 3 from the point 199 along the line 201. Fig. 15 shows reception of the three stations of the group 192 at the point 203 along the lines of reception 204 to 206. The directions of viewing are conventionally indicated by arrows referred to a horizontal plane.

Fig. 16 of the drawings shows schematically the general arrangement of a series or network of transmitting stations along a portion of coastline which is sharply indented, such as occurs at a bay used as a natural harbor or a sheltered harbor made by erecting breakwater structures or other artificial means.

Networks of this type will in general be designed in accordance with the invention by observing the principles disclosed in the following description. The transmitting stations are located most closely to each other when they are on opposite sides of a narrow channel, or on sharp convex bends in the shore line. The stations are most widely spaced when they are on the sides of a wide channel or strait, on concave bends of the short line and in the special case where they are located on a shore line which recedes sharply from a navigable course.

The following description of an embodiment of this aspect of the invention illustrates the application of the foregoing general rules in a specific manner to a bay having the illustrated irregularity of coastline. Vessels approaching the harbor 208 in the directions indicated by the arrows 209 or 211 will be assumed not to come closer to the shore in their course (until going to their pier or dock) than the dashed line indicated by reference character 212. The transmitter swing angles and the acceptance angles of the receiver are assumed to be the same for this figure as for Figs. 1, 8, and 12.

Three image groups of stations 214, 215 and 216, each comprising three stations numbered 1 to 3, surround the harbor 208 in the illustrative example shown. It will be understood that the number of station groups will vary in accordance with the length of the shore line surrounding the harbor, and as pointed out above each image group may comprise any desired number of stations, three stations per group being selected merely for purposes of illustration. The station groups surrounding the harbor 208 may all operate on the same carrier frequency, or they may be on different frequencies selectable on the ship receiving stations. It is irrelevant to the

16

purpose of this invention which of these last mentioned expedients is adopted in practice. It will be assumed that in each image group of stations, the same sequence of operations as previously described will be adopted. At a point 218 only station 1 of the group 214 will be received and with an image in or close to the viewing distance from 218 along line 219. Similarly, at a point 221 stations 1, 2 and 3 of the group 214 will be received. A station 222 along an adjacent portion of the coastline is assumed to be too far away to be effectively received at the position 221.

At the location of a pier or dock it will be understood that the panoramic television transmission from a station at or adjacent to the dock will show this landing place, and, therefore, a vessel may head to the dock in safety, guided by its viewing equipment.

Fig. 17 discloses the use of mobile subordinate stations of this invention for indicating the present direction of travel (and, if desired, the actual appearance) of a conveyance and its approximate distance from a receiving station such as a receiver 224 on a vessel 226. The mobile transmitter station may also be arranged so that an indication of the direction in which it lies with respect to the receiver 224 may be obtained. Fig. 17 also indicates, by way of example, a mobile transmitter station which projects panoramic television views of the object, vehicle or vessel upon which it is located; and the direction of reception from this mobile station will, therefore, give a clear and unmistakable representation of the side from which it is viewed, and if it is moving, its direction of movement may be ascertained. 227 is a master station similar to station 15 of Fig. 1 and comprises a directional transmitter 228 and a non-directional transmitter 229. The station 227 may be any one of an image group of stations, including one or more subordinate stations, such as the station 231 the latter including, if desired, a non-directional transmitter 232. The supplementary signals of station 227 or station 231 or other stations in the vicinity of the ship 226 are received on the ship receiver 224. If the directional antenna 233 is to be used for the primary purpose of receiving guiding signals from the series of stations along the shore 234, then the antenna 233 may be relied upon to pick up the synchronizing signals from transmitter 229 or 232. If, as usually will be the case, the receiver 224 on the ship 226 is to be employed generally for the purpose now to be described without reference to direction or distance from the shore 234, an additional non-directional receiver 236, fed from a non-directional antenna 237, may be used for receiving the synchronizing signals. A ship 238, equipped in accordance with this aspect of the invention, carries a directional transmitter 239 which sends out a picture of the ship 238 itself. It will be understood that ship 226 is or may be provided with a transmitter 239. Then timing of the directional sweep from the transmitter 239 is, or it may be, controlled from a supplementary non-directional receiver 241, which also picks up the supplementary signals from the transmitter 229 or 232. The picture receiver 224 picks up the picture signals from the picture transmitter 239 on the ship 238. Thus, persons on the ship 226 can "see" televisibly the approaching ship 238 in correct relationship through picking up the picture signals transmitted from the panoramic directional transmitter 239 and the sup-

plementary signals from the transmitter 229 or 232. As a simplified alternative procedure, the individual subordinate station 239 may send out a single fixed picture of the conveyance upon which it is located. This fixed picture may, for example, be a head-on view of the ship itself, and in that case it will be projected forwardly.

A suggested mode of operation of the radio guiding equipment on the ship 226 for searching for the presence of ships, such as the ship 238, in its vicinity is to direct the directional antenna 233, which may correspond in all respects to the directional antenna associated with the receiver 39 on the ships 41, 42 and 43 of Fig. 1, around the horizon or straight ahead from time to time. To provide continuous protection an additional directive antenna 243 having a narrower acceptance angle than the acceptance angle of the antenna 233 is aimed so that it will receive signals projected from a point ahead of the ship. This additional antenna functions continuously as a collision monitor antenna, and will instantly detect a ship approaching a colliding position.

As shown by way of example in Fig. 17, a ship 245 is provided with a radio transmitter 247 feeding radio signals to sending antennas 248 and 249. These antennas are arranged to give a bi-directional characteristic as shown transmitting signals fore and aft with a narrow projection angle in each direction. The transmitter 247 may transmit an audio tone, which will modify the raster of the picture or pictures being exhibited by the picture tubes on a ship lying in the path of the ship 245. In the example shown the tone signal from the transmitter 247 will be received by the directional antenna 243 on the ship 226.

When this effect of raster or picture modification is noted, and it will be apparent as soon as danger of collision exists, the operator of the radio equipment on the ship 226 may swing the directional antenna 233 until the maximum noise interference with the received picture is obtained, thereby giving an understandable indication of the direction from which the tone transmitting equipped vessel is approaching. The tone type of transmitter will, because of its simplicity and cheapness, be adaptable for use on smaller craft such as tug boats, barges and the like; while the panoramic television transmitter equipment, as on 238, may be used on larger vessels. Its signals will be similarly detected as an interfering and overlaid-picture signal in 224 by means of monitoring antenna 243.

A ship equipped with the bow and stern directional antenna arrangement 248 and 249 may alternatively be equipped with an audio tone transmitter 247 or with a television transmitter similar to that disclosed in the patent referred to above and described in connection with the foregoing description of the equipment on the ship 238, except that the transmission time will be divided so that the bow-on and stern-on pictures are transmitted in their respective directions alternately. This arrangement may in turn be modified by employing two separate transmitters sending continually, or a single transmitter with means to switch it alternately from one film scanner to another.

Figs. 18 to 20 illustrate the application of tele-
visible guiding principles to the guiding of an aircraft along a pre-determined route between two terminal points. Fig. 18 shows the location of an airplane route between two terminal points 251

and 252, and Fig. 19 shows the profile of the selected route.

Moreover, the distance of the furthest course will be a much larger multiple of the distance of the nearest course in aviation to the station network than is the case for most marine or land applications. Indeed, these ratios may be hundreds to one instead of small integers. In view of this fact, as well as the desirability of minimizing the weight of equipment to be carried on airplanes, the embodiment of the invention here described for avigational purposes is one wherein only one station is received at the airplane at a time, and a picture tube array is not used. Inasmuch as the directional selectivity of the airplane receiving station, while made as high as feasible, may be insufficient to select only one transmitting station among the stations on the network, it is preferred that in addition to directional selectivity one or more of the following arrangements be used at the receiving station. Sequence selection may be employed in addition to directional selectivity wherein the time of transmission of a given station within the image group or network sequence determines its reception. This arrangement has already been described in detail in connection with Fig. 2 of the drawings. Carrier frequency selection may be employed in addition to directional selectivity wherein the carrier frequency of the station wholly or in part determines its reception. This involves radio frequency selective means of the usual type at the receiver. Sequence selection and carrier frequency selection may be used in combination or in addition to directional selectivity.

Referring to Fig. 18 for a detailed description of typical placement of the ground televisibility stations along a given flight course, the location and spacing of the stations is preferably based on their relation to a pre-determined or assumed flight path, the height of the assumed flight path when receiving such stations, and the separation of a transmitting station in question from an airport or other region of considerable air traffic congestion. In Fig. 18 the course indicated by the line 253 is shown in horizontal projection between the airports 251 and 252. A group comprising stations 254 to 258 is located in the manner shown so that the station 256 is at the airport 251. The next group of stations along the course comprises the stations 261 to 265. These stations are illustratively further apart and lie along an arc of greater radius than the stations of groups 254 to 258. It will be noted by reference to Fig. 19 that the terrain is relatively level at this location. Toward the center of the course nearly half way between the airports there is assumed to be an elevated valley which curves somewhat downwardly between high mountain ranges. Here the stations are lesser in number per group, are grouped fairly close together and lie on lines not far from perpendicular to the course. Thus a station 266 may be in the center of a valley over which the course leads, whereas the side stations 267 and 268 lie on or near mountain peaks on each side of the valley. The course is clearly indicated to the airplane observer, and the chief obstacles near the course, mountains in the assumed case, are clearly depicted in the panoramic or orthogonal view transmissions from stations 267 and 268. Similar comments apply to the other image groups of stations 269 to 271 and 272 to 274 respectively. Past this section of the flight path the stations are further apart and appear in groups of three since the aviator may somewhat

depart horizontally from the exact course without danger, the underlying terrain being assumed to be a plain. The stations in this region are represented by the reference characters 276 to 281. A typical airport-approach group of stations, arranged preferably along arcs of decreasing radii of curvature and spaced more closely together as the airport is approached, are located in the neighborhood of the airport 252. These groups comprise stations 282 to 286 and stations 287 to 291, the latter of which contains the central airport station 289. The stations near an airport are preferably placed in relation to their utilization by airplanes approaching the airport. The stations along the route 253 may be arranged to project views taken from the successive points shown in Figs. 1 and 2, Fig. 3 or Fig. 4 of Patent 2,298,476 above referred to, and these stations will be of the types fully disclosed in the said patent. For example, the stations in the group comprising stations 254 to 258, are preferably arranged to transmit in succession, and the stations comprising the remaining groups transmit in succession in each group. The transmission from the stations will preferably include identifying indicia of the type described above so that the operator of a plane may select the prescribed course passing over the center stations of each group. Time division of the transmitting time among the stations in a group may be allotted in any suitable manner. For example, station groups containing five stations may divide the transmitting time for a series of transmissions equally among the five stations and the timing means, which may be similar for example to the counter 78 of Fig. 2, may be arranged so that for the groups having three stations, the outside stations of the group together transmit for $\frac{2}{3}$ of the transmitting time as these stations depict objects which are to be avoided, whereas the central station 267 indicates the safe route to be followed.

Fig. 20 of the drawings illustrates by way of example a receiver 301 suitable for use in an airplane operating in regions provided with transmitting equipment disclosed and claimed in the above noted patent and/or operating over terrain equipped as shown in Figs. 18 and 19 accompanying this disclosure and described above. The receiver 301 is similar to the receiver fully disclosed in the Goldsmith Patent No. 2,298,476 above referred to and shown by Fig. 19 of the patent drawings. The other receivers disclosed in the said patent may be employed depending upon conditions of service.

Another transmitter system embodying this invention is shown by way of example in Figs. 21 and 22 of the drawings and is a modification of the arrangement shown in Fig. 2. The transmitter selected for purposes of illustration is a panoramic transmitter having provisions for originating special signals such as the indicial signals referred to above. The arrangement shown has provisions for producing and radiating reset signals and counter signals in addition to intelligence signals indicating or representing a significant condition or conditions. In the preferred embodiment, these intelligence signals are panoramic picture signals and may be derived by scanning a film, a replica or may be obtained from a recording of a scanning code recorded when the original or replica is first scanned or when a film depicting the original or replica is first scanned. The scanning code may be recorded on a magnetic wire, as a "sound on film" type of record, or as a laterally or vertically cut record in a

plastic tablet. This scanning code record may include the synchronizing pulses and the indicial signals, or either.

In Fig. 21 the drive arrangement for the film 305 and the rotary driver and/or support 306 for the antenna array is similar to that already described in detail in connection with Fig. 2 of the drawings. A drive motor 307 is of the speed controlled or synchronous type, and its speed is controlled or driving power is supplied to it from a frequency controlling source 309. This source may, if desired, be tied in with a local power supply or some other stabilizing means related to other elements in the station network or to receivers in a well known manner. The motor 307 imparts driving power to a film sprocket 311 and also drives a shaft 312 through suitable gear means 314 similar to the gear driving means 37 of Fig. 2. The shaft 312 provides a common drive means for three commutators 316, 317 and 318.

The commutator 316 is provided with a segment 321, which is electrically connected to a continuous conducting portion or slip ring 322. A brush 323 bears on the periphery of the commutator, and a brush 324 makes continuous sliding contact with the slip ring 322. A signal generator, indicated conventionally at 326, is shown as being connected to furnish signalling energy to the brush 324 by way of a switch 327.

The commutator 317 is provided with three conducting segments 328 to 330 which are electrically connected to a slip ring 331 contacted by a brush 332. A brush 334 bears on the periphery of the commutator 317.

The commutator 318 is provided with three segments 336 to 338, which are electrically connected to a slip ring 339 contacted by a brush 341. A brush 342 engages the periphery of the commutator 318.

The angular relationships existing between the commutators and their respective segments for the embodiment shown in Fig. 21 is illustrated more in detail in Fig. 22 of the drawings, and Fig. 23 shows the wave form of the modulating signal furnished to the directional modulator and transmitter 343. The means for scanning the film shown conventionally at 344 and 346 is or may be the same as that shown in Fig. 2 of the drawings and the picture signal amplifiers, scanning wave generators and synchronizing pulse generators are of any type known in the art and may be as shown in Figs. 2 and 21. A picture and synchronizing signal amplifier 347 is shown as combining the intelligence signals, in this instance the picture signals, with the synchronizing pulses. A non-directional modulator and transmitter 348 provides a separate radio transmission channel for the synchronizing pulses and the special signals provided by the commutators 316 and 317.

In operation of the arrangement shown in Fig. 21, the shaft 312 and the rotary support 306 for the antenna array are rotated at the same speed by reason of the miter gear connection 349. It will be understood that the number of commutator segments may be multiplied if desired by changing the gear ratio 349 and that the several brushes may be rotated over stationary commutator distributor segments in accordance with well known telegraph practice.

The indicial and picture signals shown illustratively in Fig. 23 are to be interpreted in a manner similar to that explained in the Goldsmith Patent No. 2,298,476 above referred to in

connection with Fig. 21 of that patent. Referring now to Fig. 23, the length of the time axis represents the complete transmission time for three stations of a series, for example, stations 1, 2 and 3 of group II of Fig. 1. The entire time of transmission of the stations of a group is represented by one revolution of the shaft 312. The reset signals 352 from the generator 326 are sent for a time t_1 indicated on Fig. 23 and also by the angle t_1 subtended by the commutator segment 324. The first counter actuating signal 353 is sent for a time t_2 , which is the angle subtended by each of the commutator segments 328 to 330. The source of these counter signals is indicated at 354 and is connected to the brush 332 by way of a switch 356. The first counter actuating signal of time t_2 is produced by contact of the commutator segment 328 with the brush 334. Station 1 of the group then sends twelve individual pictures panoramically. These picture transmissions are indicated by field or frame signals 357, of which there are twelve in the illustrative example, followed by picture signals 358 and horizontal synchronizing pulses 359. Equalizing pulses may be added in well known manner if desirable or necessary. The picture signals are each sent in a direction of 60 degrees divided by 12; or 5 degrees apart illustratively for time corresponding to twelve fields or total time indicated as t_3 . It will be understood that the transmission of twelve individual pictures is selected by way of example, and that this number may be varied as pointed out above.

Following a transmission of station 1 of group II outlined above, a blank space 362 of time t_1 occurs, which is indicated on Fig. 23 of the drawings, just ahead of the commutator segment 329.

The second counter actuating signal 363 is sent for time t_2 from the commutator segment 329. Station 2 of group II sends twelve individual pictures in a manner similar to that described above for the transmission from station 1. This transmission occupies time t_3 represented by the commutator segment 337. It will be understood also that the number of pictures may vary in the manner pointed out above in connection with the description of the transmission from station 1 but the number of pictures per transmission from all stations within a group is preferably the same.

Following this transmission from station 2 of the group, a blank space 366 of time t_1 occurs, which is followed by the third counter actuating signals 367 sent for a time t_2 from the commutator segment 330. Station 3 of the group sends twelve individual pictures similarly to the transmission from stations 1 and 2 described above for a time t_3 .

The sequence just described for the group is then cyclically repeated.

By way of example, the reset signal generator 326 may supply a 450 cycle tone for 0.05 second corresponding to the time t_1 . The counter signal generator 354 may supply a 930 cycle tone for 0.05 second representing the time t_2 . Time t_3 may be occupied by a video transmission for 12 times $1/60$ of a second, or 0.2 second. It will be noted that the 450 cycle and the 930 cycle frequencies have been chosen not to be an integral multiple of the field frequency usually of 60 cycles, or of frame frequency, so that the tone transmission energies fall in relatively unoccupied gaps in the television- or video-transmission energy spectra. If desired, these tone frequencies can then be comparatively harmlessly blocked by ab-

sorption filters in the receiver video-demodulation circuits.

Fig. 21, like Fig. 2, shows a receiver 371 connected to a counter 372 through a switch 373 so that the equipment of Fig. 21 may be operated as a subordinate station when the switch 373 is closed together with switches 376 and 377. A double pole single throw switch shown at 378 is arranged so that the commutator 318 may be cut out and the directional modulator and transmitter 343 will then transmit under control of the counter 373 and its associated cut-off amplifier 379. The switches 327 and 356 may be open at this time in which case the equipment of Fig. 21 will operate as a station sending original picture signals and synchronizing signals. The distributor equipment at receivers receiving the signals will rely on reset and counter signals received from a master station.

The commutator segments 336 to 338 are shown as being on the commutator 318, in which case the blank or blackened portions of the film 305 will occur in the sequence described in connection with Fig. 2 so that the picture transmission will not occur except at the appropriate time for the station with respect to its position in a group. For example, at the first station of the group, transmission will occur while the commutator segment 336 is under the brush 342, and at the second station in the group, transmission will occur while the commutator segment 337 is under the brush 342, and so on for all of the stations in the series.

As an alternative arrangement, which it is not thought necessary to illustrate since it may be and is now described in connection with Fig. 21 of the drawings, the commutator 318 at the first station of the group may have only the segment 336, while the second station of the group may have only the commutator segment 337 on its commutator 318 and so on for all of the stations in the group.

Where the arrangement shown in Fig. 21 is employed having a film 305 with a blank or blackened space or spaces, subordinate stations may be equipped as shown in Fig. 21 with the receiver 371 and the illustrated switching system, so that transmission time is controlled from the master station through the agency of the counter 372 since the master station will operate with the switches 327, 356 and 378 closed, and the switches 373, 376 and 377 open. At a station such as that shown on Fig. 21 operating as a subordinate station, the switches will be in the reversed position and the picture transmissions will occur under control of the counter 372 at the proper time.

Where the blank or blackened spaces in the film are omitted and the commutator 318 carries all of the commutator segments, the antenna array will radiate indicial and picture signals in three separate directions successively and cyclically which may be useful at a significant point or area or at special points on a significant line.

Having now described the invention, what is claimed and desired to secure by Letters Patent is the following:

1. The method of furnishing information for the purpose of guiding a freely movable television station with respect to a predetermined significant line comprising the steps of projecting an apparently spacially-continuous image of territory constituting said line by transmitting directed television signals from a plurality of spaced points contiguous to said line, each directed television signal representing an image of a portion

of said territory as viewed toward the point from which it is transmitted, and receiving said signals at said freely movable television station in a manner to reproduce a portion of said apparently spatially-continuous transmitted image and to indicate the direction from which said image is received.

2. The method of furnishing information for the purpose of guiding a freely movable radio receiving station with respect to a predetermined significant line, comprising the steps of projecting pictorial information concerning the characteristics of territory constituting said line, said information being projected by transmitting a series of image intelligence signals in timed systematic relationship from a plurality of spaced points contiguous to said line, each one of the series of image intelligence signals representing information concerning a portion of said territory adjacent the point from which it is transmitted, employing directive reception methods at said freely movable radio receiving station to receive said image signals, and correlating the received information pictorially with respect to the time sequence of transmission to obtain a pictorial representation of surrounding territory at the spaced points contiguous to said line.

3. The method of furnishing information for the purpose of guiding a freely movable radio receiving station with respect to a predetermined significant line, comprising the steps of projecting pictorial information concerning the characteristics of territory constituting said line, said information being projected by transmitting directed image intelligence signals from a plurality of spaced points contiguous to said line, each directed intelligence signal representing pictorial information concerning a portion of said territory adjacent the point from which it is transmitted, receiving said signals at said freely movable television station, and correlating the received information pictorially and thereby to obtain pictorial representation of the portions of said significant line nearest said freely movable radio receiving station.

4. The method of furnishing information for the purpose of guiding a freely movable radio receiving station with respect to a predetermined significant line, comprising the steps of projecting pictorial information concerning the characteristics of territory constituting said line by transmitting a series of image intelligence signals in timed systematic relationship from a plurality of spaced points contiguous to said line, each one of the series of image intelligence signals representing information concerning a portion of said territory adjacent the point from which it is transmitted, employing directive reception methods to receive signals at said freely movable radio receiving station, and producing images from said received signals to indicate reception from one or more of said transmitting points, the number of points received being an indication of the distance of said freely movable radio receiving station from said significant line.

5. The method of guiding a television receiving station freely movable in three dimensions, comprising the steps of generating successive trains of electrical signals representing portions of territory along a significant path as viewed from a series of spaced points within given solid angles centered on a portion of the viewed territory in each instance, and projecting said wave trains from a plurality of locations spaced along said significant line, causing the location of the apexes

of said solid angles at points on said territory distributed along said path to be determined in accordance with profile and traffic concentration and direction of traffic motion conditions along said path, and affecting progression of said movable television station in the direction of said path in accordance with the location of the apexes of the solid angles.

6. The method of transmitting televisable guiding signals, comprising the steps of generating a series of image intelligence signals representing a portion of a significant line, and generating control signals for fixing the time of transmission of other image intelligence signals representative of other portions of said significant line, and transmitting said intelligence signals and said control signal so that all of said intelligence signals are transmitted successively in time relationship.

7. In a system for transmitting image signals delineatory of a significant line, means for generating image intelligence signals representing an area related to a portion of a significant line, means for generating other image intelligence signals representing other portions of said significant line, and means for generating predetermined sequences control signals for initiating the generation of said intelligence signals in succession in accordance with a predetermined equally-spaced and rapidly and regularly recurrent sequence of transmission.

8. In a system for transmitting image signals delineatory of a significant line, a plurality of means for generating image intelligence signals representative of points spaced successively along said significant line, means for generating timing signals for initiating generation and transmission of said image intelligence signals simultaneously from spaced points along said significant line, and means for causing generation and of transmission of image intelligence signals simultaneously from successive points located between said points at which transmission of image intelligence signals is first initiated simultaneously.

9. In a system for transmitting image signals delineatory of a significant line, means for scanning substantially successive portions of the significant line along a cyclically repeated sequence of angularly displaced horizontal directions radially inwardly to a series of centers of plane angles substantially centered in predetermined locations relative to the significant line, means for developing a train of electrical image signals characterizing substantially the scanning field for each radial direction of scanning, and means for transmitting the produced trains of electrical image signals directionally radially substantially instantaneously opposite to the corresponding chosen radial scanning directions.

10. A series of film records, each record of the series comprising a plurality of image areas, each area representing different cyclically repeated views of a significant line, said views being angularly displaced one from the other, a border area for each film frame having thereon indicia of the angular displacement from a predetermined reference direction, and indicia, representing the series, each record of the series having a plurality of inactive frames corresponding to a plurality of active frames in other records of the series.

11. In a system for transmitting image signals delineatory of a significant line, means for scanning substantially successive portions of the sig-

nificant line along a cyclically repeated sequence of angularly displaced horizontal directions radially inward to a series of centers of plane angles substantially centered in predetermined locations relative to the significant line, means for developing a train of electrical image signals characterizing substantially the scanning field for each radial direction of scanning, and means for transmitting the produced trains of electrical image signals directionally radially substantially instantaneously opposite to the corresponding chosen radial scanning directions the transmission of a complete angular series following the transmission of a previously transmitted series from an adjacent point.

12. In a system for the transmission and reception of image signals for reception by a mobile television station to limit approach to, and to provide guiding intelligence to said mobile station substantially to the limits of quasi-optical reception from an established significant line, means for scanning substantially successive portions of the significant line along a cyclically repeated sequence of angularly displaced horizontal directions radially inward to a series of centers of plane angles of less than 90° substantially centered in a predetermined location relative to the significant line so that adjacent angular sectors overlap, the points of intersection of the limits of adjacent angular sectors defining said approach limit to said significant line, means for developing a train of electrical image signals characterizing substantially the scanning field for each radial direction of scanning, and means for transmitting the produced trains of electrical image signals directionally radially substantially instantaneously opposite to the corresponding chosen radial scanning directions the limit of said transmissions being substantially the visible horizon.

13. A film record comprising a plurality of image areas, each area representing different views of a portion of a significant line, said views being angularly displaced one from the other, a border area for each film frame having thereon indicia of the angular displacement from a predetermined reference direction, the said record being in the form of an endless band and having a plurality of inactive frames, the number of which bears a definite numerical relationship to the number of active frames in said endless band.

14. In a television transmitting system, a series of transmittable records comprising a plurality of recorded portions, each recorded portion representing different cyclically repeated views of a significant line, said views being angularly displaced one from the other, each record of the series having active-section divisions and blank-section divisions, and means for operatively deriving signals from said plurality of records in phase-displaced relationships with reference to said active-section divisions thereof.

15. In a television transmitting system, a series of film records comprising a plurality of image areas, each area representing different cyclically repeated views of a significant line, said views being angularly displaced one from the other, each record of the series having active-section portions and blank-section portions, and means for operatively scanning said plurality of records in phase-displaced relationships with reference to said active-section portions thereof.

16. A system for guiding a freely movable television station with respect to a predetermined significant line, comprising plurality of trans-

mitting stations for projecting an apparently spacially continuous image of territory constituting said line, each station comprising means for transmitting directed television signals, said stations being spaced apart but contiguous to said line, and a receiver at said freely movable television station comprising means to reproduce a portion of said apparently spacially continuous transmitted image and means to indicate the direction from which the portion of said image is received.

17. A system for guiding a freely movable television station comprising a plurality of stations for projecting an apparently spacially continuous image of territory constituting a significant line, each station comprising means for transmitting a series of panoramic television signals in timed relationship, said stations being spaced apart but being contiguous to said line, means for producing said signals so that each one of said series of television signals represents an image of a portion of said territory as viewed toward the station from which it is transmitted at a given instant during the time of transmission, a directionally receptive television receiver at said freely movable television station having means to reproduce at least one portion of said apparently spacially continuous transmitted image, and means capable of reproducing additional portions of said apparently spacially continuous transmitted image, the number of portions of said image received being an indication of the distance of said freely movable television station from said significant line.

18. A television transmitting station, comprising means to generate electric wave signals representing a series of views, means for generating synchronizing signals for transmission with said view delineating signals, means for generating electrical timing signals indicative of the time at which said view delineating signals are initiated, and means for generating additional electrical timing signals for transmission at predetermined time intervals between the transmission of said view initiating signals and means for radiating said electrical timing signals together with said view initiating signals.

19. The combination of claim 16 wherein said means for producing selective operation of said picture reproducing devices comprises a plurality of electronic counting devices, one for each of said picture reproducing devices, signal separating means, and means to provide said electronic devices with timing signals from said signal separating means.

20. The combination of claim 16 wherein said means for producing selective operation of said picture reproducing devices comprises a plurality of electronic counting devices, one for each of said picture reproducing devices, means interconnecting each of said timing devices with its respective picture reproducing device, signal separating means, means to provide said electronic devices with timing signals from said signal separating means, and means for selectively interchanging the connections between said timing devices and said picture reproducing devices.

21. A system for depicting territory contiguous to a predetermined significant line, comprising a plurality of transmitting stations for projecting an apparently spacially effectively continuous image of territory constituting said line, said stations being spaced apart but contiguous to said line, each station comprising means for transmitting television signals representing a portion

of said line adjacent thereto, a receiving station comprising means to receive signals from said transmitting stations, a plurality of television reproducing devices at said receiving station, means for connecting said reproducing devices to said signal receiving means, and selective means for selectively interchanging the connections between said receiving means and said image reproducing devices whereby the images reproduced by said image reproducing devices will be in correct spacial relationship with respect to the spacial relationship of said transmitting stations, said selective means comprising a multi-point multiple circuit switch having the switch points thereof for each circuit assigned to said reproducing devices in a progressively changing order.

22. In a system for transmitting image signals delineatory of a significant line, a plurality of means for generating a series of radiant energy intelligence signals representative of points spaced successively along said significant line, means for generating radiant energy reset signals prior to each generation of said series of intelligence signals, a receiving station, a plurality of image reproducing devices at said receiving station responsive to said radiant energy intelligence signals, and means for controlling said image reproducing devices comprising a plurality of electronic-counters, one for each of said image reproducing devices, means responsive to said reset signals for resetting said counters prior to initiation of the generation of a series of intelligence signals.

23. A system for detecting the proximity of a randomly movable conveyance to a movable conveyance guided with respect to a predetermined significant line by a series of televisable signals transmitted from spaced points contiguous to said significant line, comprising televisable image receiving and reproducing means carried by said guided conveyance, transmitting means upon said randomly movable conveyance for transmitting radio signals in a direction fixed with respect to the direction of instantaneous movement of said randomly movable conveyance, said radio signals from said randomly moving conveyance when it is moving toward said guided conveyance being effective to produce a recognizable pattern resulting from interference between said televisable signals and said radio signals.

24. The method of furnishing information for the purpose of guiding a freely movable television station with respect to a predetermined significant line comprising the steps of generating a series of panoramic television signals, causing each one of the series of signals to represent an image of a portion of territory as viewed toward the point from which it is transmitted at a given instant during the time of transmission, projecting an apparently spacially-continuous image of territory constituting said line by transmitting said series of panoramic television signals in timed successive relationship from a plurality of spaced points contiguous to said line, employing directive reception methods to receive signals at said freely movable television station in a manner to reproduce one or more portions of said apparently spacially-continuous transmitted images, and indicating the distance of said freely movable television station from said significant line in accordance with the number of portions received.

25. The method of furnishing information for the purpose of guiding a freely movable television

station with respect to a predetermined significant line comprising the steps of generating a television signal representing an image of a portion of territory constituting said line as viewed toward the point from which it is to be transmitted, projecting an apparently spacially effectively continuous image of territory constituting said line by transmitting said signals as directed television signals from a plurality of spaced points contiguous to said line, receiving said signals at said freely movable television station in a manner to reproduce images from one or more of said transmitting points, and indicating the distance of said freely movable television station from said significant line in accordance with the number of images reproduced within the limits of transmission.

26. The method of furnishing information in televisable form for the guidance of a television receiving station freely movable in three dimensions with respect to a predetermined significant line, comprising the steps of scanning substantially the same portion of the territory adjacent said line comprising said significant surface along a cyclically repeated sequence of angularly displaced directions inwardly toward the center of a plurality of solid angles substantially centered at predetermined points relative to said significant line, projecting a train of electrical image signals representative of views obtained by said scanning, and concomitantly transmitting synchronizing signals for determining the rate of reproduction of the trains of electrical image signals and also for predetermining the time of the beginning of each train of image signals from one of said points with respect to the time of transmission of other trains of transmitted signals from other points adjacent said significant line.

27. The method of furnishing information in televisable form for the guidance of a television receiving station freely movable in three dimensions with respect to a predetermined significant line, comprising the steps of scanning substantially the same portion of the territory adjacent said line along a cyclically repeated sequence of angularly displaced directions inwardly toward the center of a plurality of solid angles substantially centered at predetermined points relative to said significant line, projecting a train of electrical image signals representative of views obtained by said scanning, and concomitantly transmitting synchronizing signals for determining the rate of reproduction of the trains of electrical image signals, and transmitting other signals for initiating transmission of each train of image signals from one of said points with respect to the time of transmission of other trains of transmitted signals from other points adjacent said significant line.

28. The method of furnishing information for the purpose of guiding a freely movable radio receiving station with respect to a predetermined significant line, comprising the steps of projecting information concerning the characteristics of territory constituting said line by transmitting a series of intelligence signals in timed systematic relationship from a plurality of spaced points contiguous to said line, causing each one of the series of intelligence signals to represent information concerning a portion of said territory adjacent the point from which it is transmitted, and employing directive reception methods at said freely movable radio receiving station to receive signals in a manner to obtain spacial correlation between the received information and

29

the surrounding territory at the spaced points contiguous to said line.

29. In a system for the transmission and reception of image signals delineatory of a significant line, means for scanning substantially successive portions of the significant line along a cyclically repeated sequence of angularly displaced horizontal directions radially inward to a series of centers of plane angles of less than 90° substantially centered in a predetermined location relative to the significant line so that adjacent angular sectors overlap, the points of intersection of the limits of adjacent angular sectors being determined by considerations requiring avoidance of too close approach of a mobile receiver station to said significant line, means for developing a train of electrical image signals characterizing substantially the scanning field for each radial direction of scanning, and means for transmitting the produced trains of electrical image signals directionally radially substantially instantaneously opposite to the corresponding chosen radial scanning directions so that adjacent angular sectors served by said transmissions overlap at said predetermined points.

30. In a system for transmitting image signals delineatory of significant territorial volume, means for generating image signals representing a series of closely adjacent volumetric sections

30

spaced in a chosen order within said territorial volume, means for generating control signals, means for time spacing said control signals so that the signals are regularly recurrent, and means for applying said control signals to the control of said image signal generating means in a systematic and determinate order.

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