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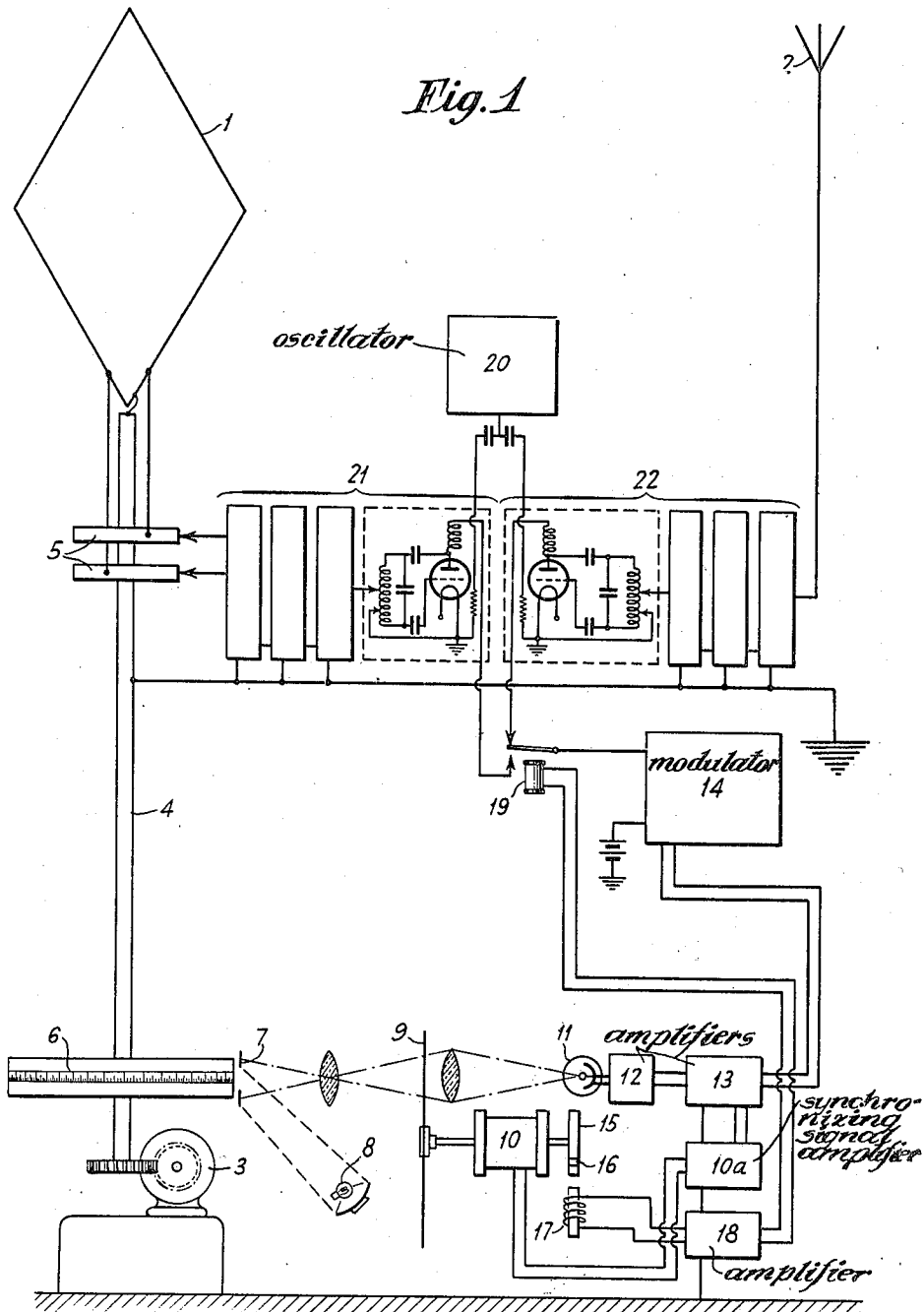
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RADIO DIRECTION FINDER

Filed March 27, 1936

2 Sheets-Sheet 1



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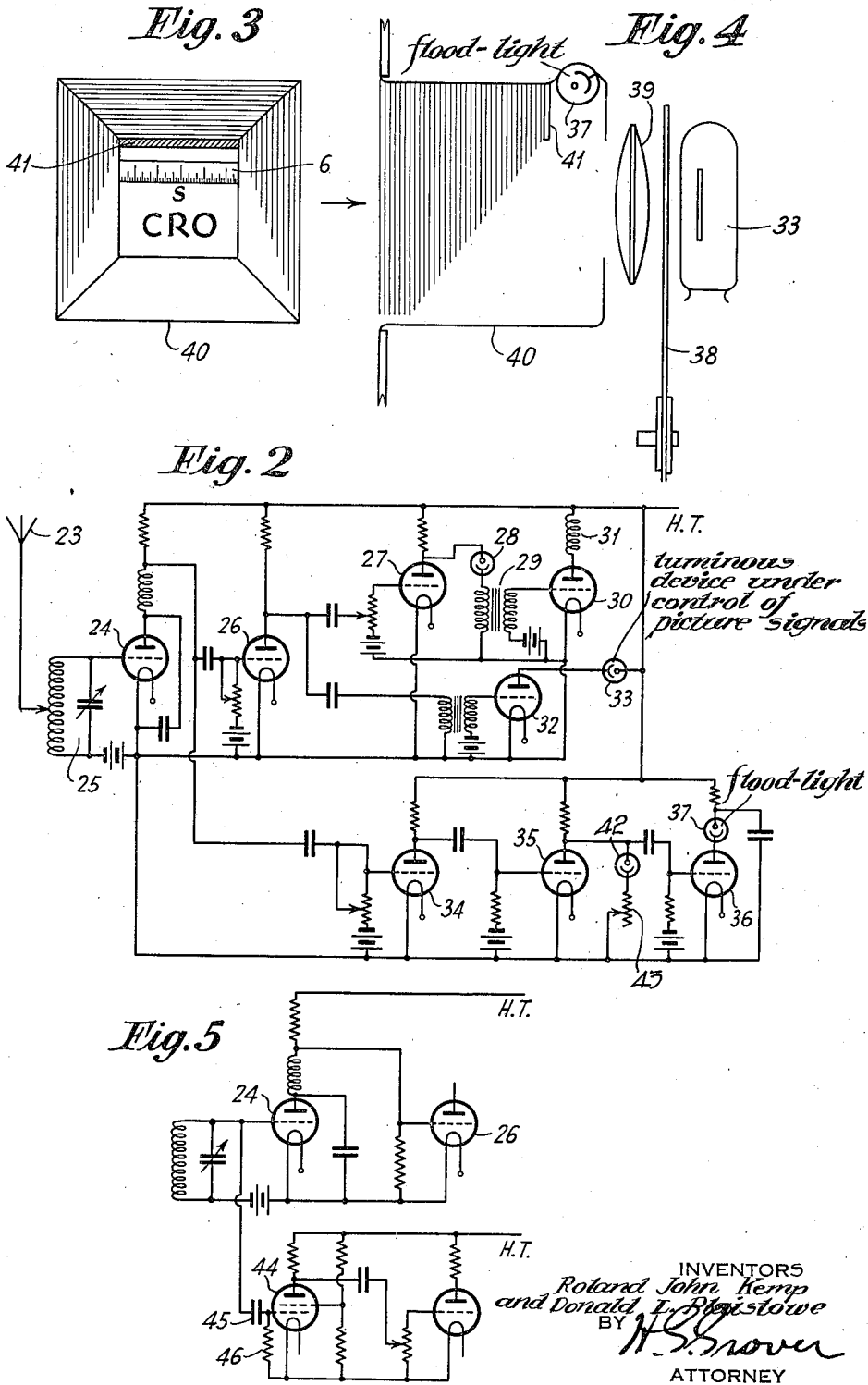
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UNITED STATES PATENT OFFICE

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RADIO DIRECTION FINDER

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This invention relates to navigation aiding di-
rectional radio systems and more particularly to
systems of the kind wherein the direction of a
receiver with respect to a transmitter of known
position is indicated at the receiver by means in-
cluding a television reproducer so that the re-
quired information as to direction is obtained by
direct visual inspection.

Numerous attempts have been made hitherto
to provide navigation aiding directional radio
systems wherein the necessary information as to
direction and identity of a transmitting station
may be indicated purely visually at the receiving
station so that there is no necessity for a skilled
operator at the said receiving station. Hitherto,
however, such attempts have not resulted in sys-
tems which are satisfactory from the practical
point of view. For example, in one proposed sys-
tem wherein a transmitting station transmits a
continuously radiated directional beam which is
modulated with television signals corresponding
to a picture of part of a compass card or the like
the picture corresponding to the instantaneous
direction of the directionally transmitting beam,
difficulties in securing satisfactory scanning syn-
chronism between the transmitting station and
the receivers are met with while, in general, in
what may be termed navigation aiding television
radio systems, it is found difficult to secure a
sufficiently accurate reading at the receiver if
changes in the intensity of the television picture
itself are relied upon for such indication.

The object of the present invention is to pro-
vide an improved system wherein the above men-
tioned difficulties or disadvantages are avoided
and wherein the following advantages are ob-
tained:—

- (1) Sharp discrimination at the receiver is as-
sured, i. e. the bearing of the transmitting
station is sharply indicated,
- (2) Only a single operating wave length is nec-
essary for the whole system, and
- (3) The receivers may be of the simple omni-di-
rectional type.

According to this invention there is direction-
ally transmitted from a transmitting station a
predetermined signal or series of signals (herein-
after to be referred to as the indicating signals)
and the direction of such transmission is contin-
uously changed, e. g. by rotating or oscillating the
directivity of the transmitting aerial and at the
same time there is omni-directionally transmitted
from the said station and upon the same wave
length, signals corresponding to a television pic-

ture indicating the instantaneous directivity of
the directional transmission. At the receiving
end of the system the various signals are omni-
directionally received and the omni-directionally
transmitted signals are utilized to reconstruct
television pictures, the indicating signals being
utilized at the receiver to bring about sharp
changes in the general illumination of the recon-
structed television pictures whereby the televi-
sion picture as it exists at the instant of such a
sharp change will indicate directly the direction
of the transmitter. It will thus be seen that di-
rectional indication is not obtained by relying
upon change of intensity or form of some par-
ticular part of the television picture itself and
accordingly good discrimination at the receiver
can be obtained for the said indication is given
by a general change in illumination.

The invention is illustrated in and further ex-
plained in connection with the accompanying
drawings, in which

Figure 1 shows diagrammatically a preferred
embodiment of transmitting terminal equipment
suitable for carrying out our invention,

Fig. 2 is a circuit diagram of the receiving ap-
paratus,

Figs. 3 and 4 illustrate an image-producing
device to be used at the receiver, and

Fig. 5 shows a portion of the receiving circuit
when modified in certain respects.

There will now be described a complete system
embodying the present invention. For the sake
of convenience in description one transmission
station and one receiving station only will be
described although, of course; it is to be under-
stood that there may be any number of receiving
stations, the transmitting station being of the
nature of a wireless beacon or lighthouse.

The transmitting station, which is illustrated
in general schematic diagram form in Fig. 1 com-
prises two transmitting aerials 1, 2, the former
being a frame aerial and the latter an omni-di-
rectional or open aerial. The frame aerial is
continuously rotated at a predetermined speed by
an electric motor 3 or the like and on the ro-
tating shaft 4 upon which the said frame aerial
is mounted are a pair of slip rings 5 via which
energy is transferred to the frame aerial. Also
mounted on this shaft is a compass card or scale
6 having a fixed window or template 7 associated
therewith and so positioned in relation thereto
that the portion of the scale appearing at any
time through the window corresponds to the
"minimum" radiation direction of the frame
aerial relative to true north. The template is

marked with letters or some other indication of the identity of the station and is illuminated from any convenient light source 8. Light from the picture constituted by the template or window and the portion of the scale appearing therethrough is focussed upon a suitable television scanning device shown as constituted by a Nipkow disc 9 driven by a motor 10. Light passed by the disc 9 is projected on to a photoelectric cell 11 so that the electrical output from said cell will consist of signals corresponding to the light and shade values of the picture consisting of the window or template and the scale portion appearing therethrough. As any known form of television scanning arrangement may be employed, it is not thought necessary to describe this part of the apparatus in any further detail.

The output from the photocell is amplified at 12 and 13 and fed to a modulator unit 14 to which is also fed via amplifier 10a synchronizing signals, for example at the scanning line frequency, which signals may be obtained in any known convenient way not shown, e. g., from a winding upon the motor 10. The synchronizing signals are of large amplitude relative to the peak picture signals. Mounted upon the shaft of the motor 10 is a member 15 carrying a ferromagnetic segment 16 which, as the motor rotates, is brought repeatedly adjacent the core of a ferromagnetically cored inductance coil 17 so that once per revolution of the motor a pulse will be introduced into the coil, i. e. the coil will have induced therein pulses at the frame or picture frequency. These pulses, after suitable amplification at 18 are utilized to control a distributor relay device 19 whereby a high frequency drive unit 20—that is to say, a source of oscillations of the wave length to be radiated—is alternatively associated as shown with one of two amplifier channels 21, 22, one of which (21) leads to the frame aerial 1 and the other (22) to the open aerial 2. The modulator unit 14 is associated as shown via the distributor relay 19 with the high frequency drive unit 20. The whole arrangement is such that the following sequence of operations is performed:—for a short period there is no radiation; then for a somewhat longer period there is radiated from the rotating frame aerial 1 carrier wave energy modulated with a series of pulses at the predetermined frame frequency; then for a further similar short period there is no radiation; and then for a period which is longer than any of the periods so far mentioned there is omni-directional radiation from the open aerial 2 of carrier wave energy modulated with the television picture signals. For example, if the television scanning be effected at the rate of 10 pictures per second, approximately $\frac{5}{8}$ of each tenth of a second may be occupied by the transmission of television signals and approximately $\frac{1}{4}$ of each tenth of a second may be occupied by the directionally transmitted pulse modulated carrier, the remainder of each tenth of a second being divided equally between the short periods of zero transmission which precede and succeed each period of directional transmission.

At the receiver, which is represented in Fig. 2 all the signals, which are transmitted on the same wave length, are received omni-directionally by an ordinary open aerial 23 and applied between grid and cathode of a valve 24 which is adjusted to act as an anode bend detector and has the usual tuned grid circuit 25. The output from this valve is sub-divided into two channels hav-

ing their input circuits in parallel, one channel selecting and utilizing the television and synchronizing signals, and the other selecting and utilizing the indicating signals, i. e. the directionally transmitted signals.

Dealing with the first mentioned channel first this includes a first valve 26 the output from which is shared between two further sub-channels having their input circuits in parallel. One of these sub-channels utilizes the synchronizing signals and the other utilizes the picture signals proper. The synchronizing signal selecting sub-channel includes a valve 27 in whose plate circuit is a neon or other glow discharge tube 28 in series with the primary of a transformer 29 the secondary of this transformer feeding into a valve 30 in whose plate circuit is the synchronizing winding 31 of a synchronous motor (not shown) driving a Nipkow disc (not shown in Fig. 2) or other television scanning device at the receiver. The valve 27 is so adjusted that it responds only to the television synchronizing signals, which, as above stated, are of a predetermined amplitude which is greater than the peak picture signal amplitudes. The other sub-channel includes a valve 32 in whose plate circuit is connected a picture reproducing flat plate anode neon or similar tube 33 of the type commonly employed for building up television pictures. This tube is positioned behind the Nipkow disc or like scanning device so that the said tube and scanning device operate in manner well known per se to reproduce the received pictures.

The remaining channel which, as above stated, is branched out from the output circuit of the anode bend detector 24 includes valves 34, 35 and 36 and selects the pulses which are uni-directionally transmitted and the output of this channel feeds an indicator neon lamp 37 the arrangement being such that the said lamp remains lit except when the strength of the directionally transmitted signals at the receiver becomes zero or nearly so, i. e. except when the direction of the receiver with respect to the transmitter is the "minimum" direction of the latter. This indicating neon lamp is arranged in front of the Nipkow disc so as generally to flood-light, and hence to obscure the reproduced television pictures. The picture indications alone are, therefore, observed when the lamp 37 is extinguished. A convenient arrangement is represented schematically in Figs. 3 and 4 which are mutually perpendicular views. Here the picture neon tube 33 is immediately behind the Nipkow disc 38 which is in turn immediately behind a viewing lens 39 the viewing lens being at the back of a tunnel-like screen 40 which is provided for preventing extraneous light falling upon the television pictures. Immediately in front of the viewing lens and partly recessed into the top of the tunnel-like screen 40 is the indicating neon lamp 37 and immediately in front of this indicating neon lamp is a mask 41 which extends a short distance across the tunnel-like screen so that the indicating neon lamp 37 cannot be directly seen from the front of the said tunnel-like screen but serves only to provide a certain amount of general illumination upon the television pictures. With this arrangement a person looking into the tunnel-like screen in the direction of the arrow in Fig. 4 will see at the back thereof a picture of the nature shown in Fig. 3 and consisting of letters or the like identifying the station being received and a continuously changing portion of

a scale or compass card, the portion at any time in the reproduced picture corresponding to the portion being at that time scanned at the transmitter. In Figs. 3 and 4 the shading represents a "black" area due to the mask 41.

When the incoming indicating signals fall to zero or nearly so, that is to say, when the receiving station is in or near the "minimum" direction of the transmitting station—and only when this happens—the indicating neon lamp 37 will become extinguished, the general illumination of the picture will thus disappear and the scale reading upon the picture at such time will be a direct indication of the bearing of the transmitting station.

The indicating pulse signals are of suitable amplitude and low frequency to be selected by their appropriate channel at the receiving station. Any convenient expedient may be resorted to, for ensuring that the indicating neon lamp remains lit except when the indicating signal strength received is at or about zero, intensity. For example, as shown in Fig. 2, one of the valves (35) in the channel leading to the indicating neon lamp 37 may include in its plate circuit a further neon or like glow discharge lamp 42 which functions in such manner as not to pass on to the succeeding valve 36, in whose plate circuit is the indicating neon lamp 37, signals below a predetermined value. Furthermore the said channel may include circuits of time constant values suitably selected to match and therefore to be predominantly responsive to the pulse frequency of the directionally transmitted signals. The neon lamp 42 may be connected as shown in series with an adjustable resistance 43 and thus a desired degree of amplitude selection may be achieved. By suitably adjusting the value of the said series resistance, it is possible so to arrange matters that the amplitude selection is such as to cause the indicating neon lamp 37 to be extinguished and be re-lit very rapidly indeed. In practice probably the most convenient adjustment is that which will allow the indicating neon lamp to be extinguished over about 2° of bearing angle. In such a case, of course, there will be two sudden changes of general illumination of the indicating television pictures, one when the indicating lamp is extinguished and the other when it re-lights. The true bearing will be that given by the reading which occurs midway between these two sudden changes.

In a slightly modified and preferred form of receiver part of which is shown in Fig. 5 a separate detector is employed in the channel leading to the indicating lamp. In this modified form of receiver the first detector 24 is an anode bend detector as before and the output from this valve is utilized to feed the synchronizing apparatus and picture reproducing apparatus (not shown) at the receiver as before. The output circuit of the first valve is, however, not branched out to the indicating lamp channel as in Fig. 2 but instead the input end of the said channel is connected across the input circuit of the first valve 24. In this case the first valve of the indicating lamp channel—which valve has its input circuit, as stated, in parallel with that of the anode bend detector—may conveniently be constituted by a screened grid valve 44 having a grid condenser 45 and a grid leak 46 and adjusted to operate as a grid detector with as high a leak valve as possible. The valve is also so adjusted that the working point on the anode current (ordinates) anode voltage (abscissae) characteristic is near

the top bend thereof. With such a setting the screen grid valve detector 44 will be very sensitive to small high frequency inputs so that when the incoming directional signals are at or near their minimum value sharp discrimination is obtained. The output from the screen grid detector valve is taken off and fed through a suitable series of valves (only the first valve 34 is shown) as above described in connection with Fig. 2 to operate the indicating neon lamp (not shown). It will be appreciated that by reason of the setting and adjustment of the screen grid detector valve 44 which now constitutes the first valve in the channel to the indicating neon lamp, the efficiency of the said valve will be low when the signals to be handled thereby are strong, but when the signals approach their minimum value the efficiency will be improved and, accordingly, the anode current will rise and the indicating lamp will become brighter—only to be extinguished, of course, when the incoming directional signals fall below a predetermined minimum. This fact is of considerable practical advantage since the result will be that the general illumination of the receiving television pictures will first increase and then disappear this temporary increase giving, as it were, a warning that the bearing should shortly be read.

We claim:

1. A navigation aiding directional radio system comprising, at a transmitting station, means for directionally transmitting indicating signals, means for changing the direction of the null-point of such transmission in a predetermined manner, means for omni-directionally and continuously transmitting upon the same wave length as said indicating signals signals corresponding to television pictures indicative of the instantaneous directivity of said null-point in the directional transmission; and, at a receiving station, means for continuously receiving the transmitted television picture signals, means for reproducing images in response to the reception of said picture signals, means including a light source for at times flood lighting and concealing the reproduced images, and means operative when released by the arrival at said receiving station of the null-point of the directional diagram of said directionally transmitted signals for extinguishing said light source, thereby to disclose the then transmitted television picture.

2. The combination with a receiving station of a navigation aiding radio transmitting station comprising a directional aerial, means for varying the directivity of the null point of said aerial in a predetermined manner, means for transmitting from said aerial indicating signals, an omni-directional aerial, and means for transmitting from said omni-directional aerial signals corresponding to television pictures indicative of the instantaneous directivity of the directional transmission, all said signals being transmitted upon the same wave length, said receiving station having means responsive to the omni-directionally propagated signals for continuously reproducing picture images, flood lighting means at times effective for obscuring said images, and means rendered operative by aiming the null-point of directivity of said directional aerial toward the receiving station for suppressing the effectiveness of said flood lighting means, thereby to bring out a definite picture image.

3. A navigation aiding radio receiving station suitable for use in cooperation with a transmitting station having means for propagating an

omni-directional television picture signal and a directional indicating signal, said receiving station comprising an omni-directional receiving aerial, an amplifying channel energized from said aerial and adapted to amplify the television picture signals, means for translating said picture signals into television pictures, a second amplifying channel also energized from said aerial for amplifying the indicating signals, and a luminous gas discharge lamp energized by said second amplifying channel, said lamp being so positioned as to flood-light the reproduced television pictures.

4. A receiving station according to claim 3 and having means for shielding said luminous gas discharge lamp from direct observation by a television picture observer.

5. A direction indicating system comprising radio transmitting and receiving stations, the transmitting station including means for omnidirectionally transmitting a periodically repeated

succession of television picture signals, and means for radiating an indicating signal, this means comprising a directive antenna adapted to produce a null-point in its radiation diagram, and means for rotating said diagram in synchronism with the periodicity of the picture signal repetitions, said receiving station comprising means responsive to the reception of the picture signals for reproducing the pictures represented thereby, this means including a picture screen, means for flood-lighting said picture screen thereby to obscure the pictures, and means under control of said indicating signals only so long as received, for maintaining said flood-lighting means effective, whereby the pictures are made observable on said picture screen only during the non-effectiveness of said flood-lighting means, as when the null-point of said radiation diagram is directed toward said receiver.

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