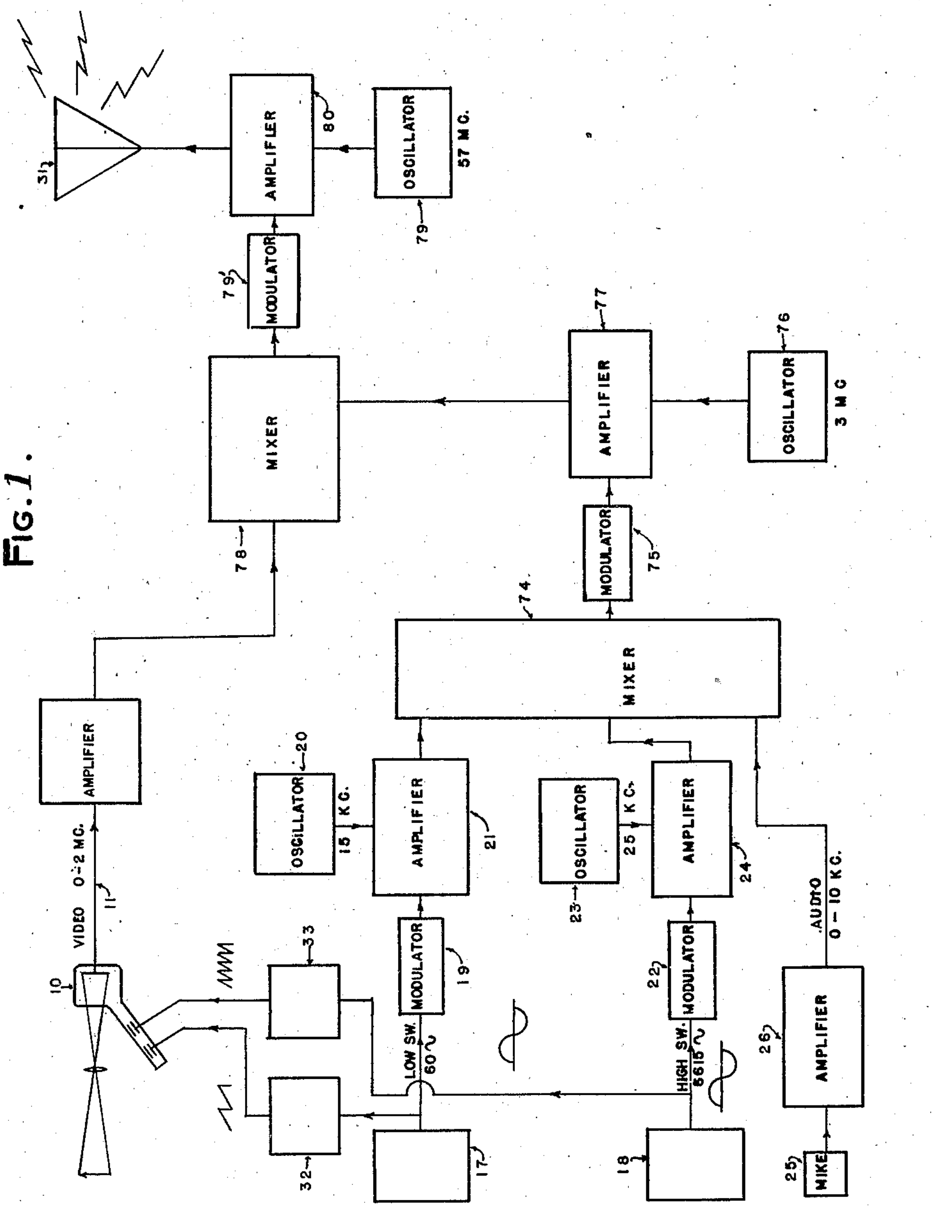
May 21, 1940. T. T. GOLDSMITH, JR 2,201,309

METHOD AND SYSTEM FOR TELEVISION COMMUNICATIONS

Original Filed March 12, 1938 3 Sheets-Sheet 1

FIG. 1.



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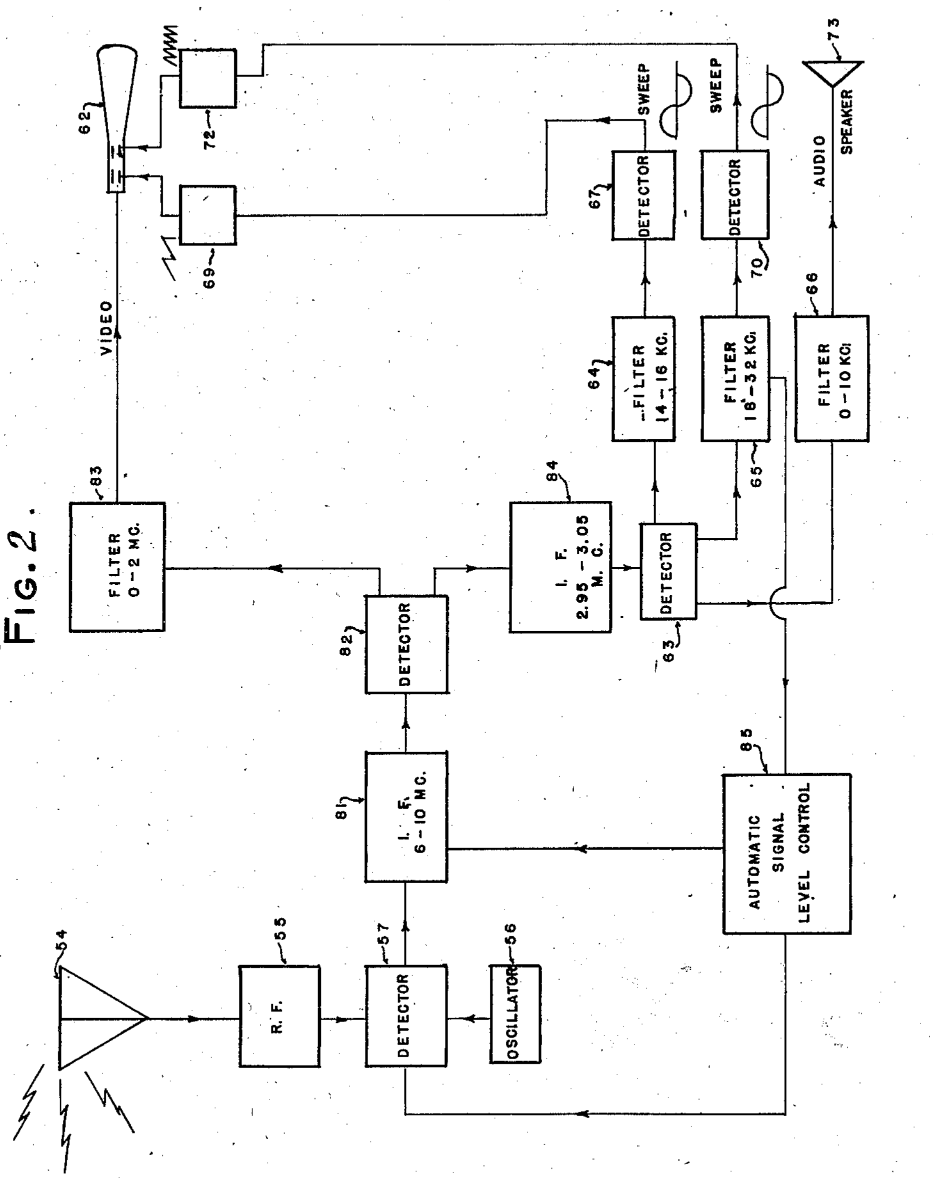
METHOD AND SYSTEM FOR TELEVISION COMMUNICATIONS

Original Filed March 12, 1938 3 Sheets-Sheet 2

FIG. 2.



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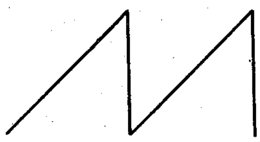

Fig. 3.

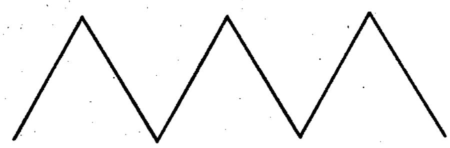

Fig. 4.

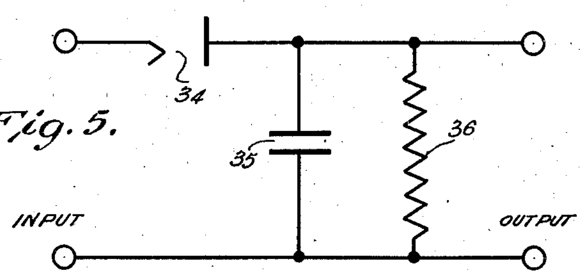

Fig. 5.

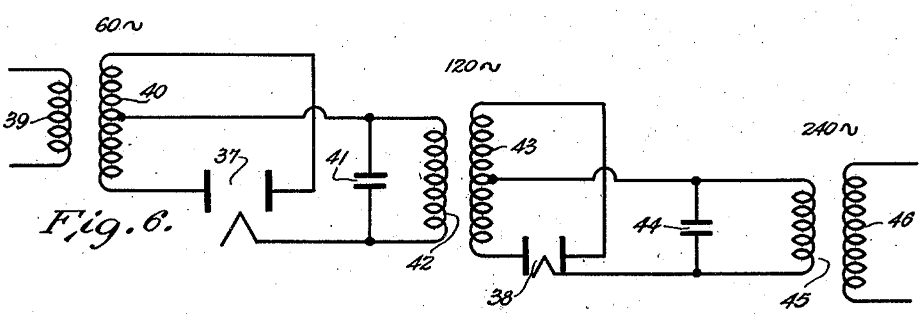

Fig. 6.

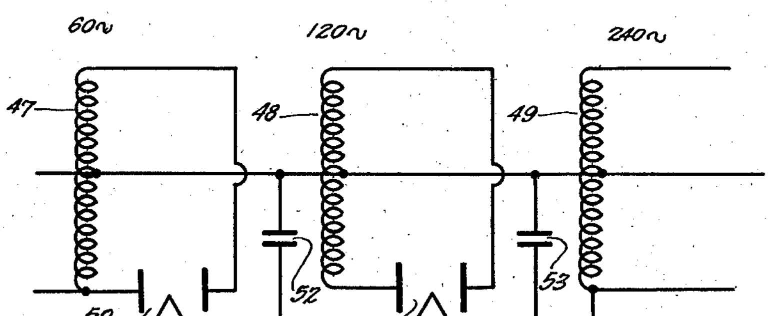

Fig. 7.

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Patented May 21, 1940 2,201,309

UNITED STATES PATENT OFFICE

2,201,309

METHOD AND SYSTEM FOR TELEVISION COMMUNICATIONS

Thomas T. Goldsmith, Jr., Montclair, N. J., assignor to Allen B. Du Mont Laboratories, Inc., Passaic, N. J., a corporation of Delaware

Original application March 12, 1938, Serial No. 195,441, now Patent No. 2,164,176, dated June 27, 1939. Divided and this application March 22, 1939, Serial No. 263,510

2 Claims. (Cl. 178—5.6)

My invention relates to improvements in methods and systems for television communication.

This application is a division of my application Serial No. 195,441, filed March 12, 1938.

In the more successful methods and systems proposed heretofore for television communication, and employing a cathode-ray pick-up tube at the transmitter and a cathode-ray viewing tube at the receiver, it has been required that there be at each station two circuits for deflecting the scanning ray at the line and field frequencies, respectively. Also, it has been required that line and field pulses be transmitted on the same carrier wave as the video signals, and these pulses have been used at the receiver for synchronization. In these prior methods and systems, not only has difficulty been encountered in holding the deflecting circuits at the receiver locked in step with those at the transmitter, but a substantial portion of the transmitted energy has been expended in transmitting the synchronizing pulses.

With the foregoing in mind, it is one of the objects of my invention to provide an improved method and system for television communication employing cathode-ray tubes at both stations, and in which no synchronizing pulses are required to be transmitted to the receiver, and in which either the deflection circuit at the line frequency or both deflection circuits at the line and field frequencies, respectively, can be omitted at the receiver.

Another object of my invention resides in the provision of an improved method and system for television communication which has advantages over those proposed heretofore in the way of greater simplicity of construction and manner of operation, and higher efficiency.

Another object of my invention resides in the provision of an improved method and system for television communication by which the various necessary signals can be transmitted by wireless over substantially greater distances than it has been possible with the various methods and systems proposed heretofore, the possible range of wireless transmission from the transmitting station directly to a receiving station being of the order of hundreds of miles.

Other objects and advantages will hereinafter appear.

In accordance with my invention, voltage waves at the respective line and field frequencies are generated at the transmitter and transmitted by radio to the receiver. These same waves are applied to cause or at least govern scanning action of the pick-up tube at the transmitter and scanning action of the viewing tube at the receiver, so that the electron ray in the tubes must of necessity be always in step during the scanning action. Because of the impossibility of this system getting out of synchronization as to both line and frame or field frequencies, a much higher interlace ratio is possible. This allows a given detail picture to be transmitted over a much narrower frequency band. Likewise, the transmission of much higher definition pictures over the same frequency band can also be accomplished.

Another advantage of this system is that it will receive pictures of transmitters operating at any desired line and frame frequencies. With the present systems, it is necessary that all transmitters operate with exactly the same respective scanning frequencies if all receivers are to be capable of receiving from any one of the transmitters.

My invention resides in the improved method and system of the character hereinafter described and claimed.

For the purpose of illustrating my invention, an embodiment thereof is shown in the drawings, wherein

Figures 1 and 2 are simplified, diagrammatic views of a television transmitting station and a television receiving station, respectively, constructed and operating in accordance with my invention;

Figs. 3 and 4 are graphical representations of electrical wave forms possible for use in my improved system for governing the scanning action; and

Figs. 5, 6 and 7 show circuit details for use in my improved system.

In Fig. 1, the reference numeral 10 designates a cathode-ray pick-up tube of a conventional construction, and comprising a mosaic, photoelectric screen on which a light image of the object is projected, an electron gun for generating a ray of electrons directed at the screen, and two sets of deflecting plates for deflecting the electron ray at the line and field frequencies respectively so that it is caused to scan the screen. The picture or video signals are thereby developed, and fed by an output connection 11 to a modulating amplifier 12.

In my improved system, but one ultra-high frequency carrier is used for all four signals, i. e., the horizontal and vertical sweep signals and the video and sound signals.

The reference numerals 17 and 18 designate generators of voltage waves of sine form for the sweeps and which are, respectively, at the desired field and line frequencies. The low-frequency sweep, by means of the amplifier 19, modulates the sub-carrier oscillator 20 in its amplifier stage 21. The high-frequency sweep, by means of the amplifier 22, modulates the sub-carrier oscillator 23 in its amplifier stage 24.

The audio or sound signals from the microphone 25 are passed through an amplifier 26.

The two modulated sub-carriers are combined with the audio signal in the mixer 74 and the combination is fed through the modulator 75 to modulate the output of the oscillator 76 at the amplifier 77. The composite signal upon the sub-carrier from oscillator 76 is mixed with the video signal in the mixer 78, after which, through modulator 79′, the single, ultra-high frequency carrier produced by the oscillator 79 is modulated at the amplifier 80 and radiated from the antenna 31.

Although the two sweep signals are transmitted in the form of sine waves, in Fig. 1 they are not used as such for direct application to the two respective sets of electrostatic deflecting plates, but are first changed or modified to waves of saw-tooth form by wave-form modifying means or networks 32 and 33. An example of such a network is shown in Fig. 5, in which the sine-wave input is fed through a rectifier 34 to a filter section consisting of a condenser 35 and a resistance 36, from which section is delivered the desired output wave of saw-tooth form.

In Fig. 1 it is proposed to use a frequency-multiplying method for the purpose of maintaining constant, particularly where interlaced scanning is used, the relation of line frequency to field frequency. A system or circuit for such purpose is shown in Fig. 6, in which a low-frequency voltage wave of sine form, such as the 60-cycle power main frequency, is fed through successive full-wave rectifiers 37, 38, etc., followed by filters, as shown, to allow passage of the double-frequency harmonics. In this way there is produced a final and much higher frequency which can be utilized for the high-frequency sweep coordinated with the original low-frequency sweep for the two respective deflections for scanning. In Fig. 6 there is shown only two stages of the frequency-multiplication scheme. A transformer primary 39 is excited by 60 cycles, and the tapped secondary 40 supplies the full-wave rectifier 37 which delivers 120 cycles to the tuned filter comprising the condenser 41 and the next transformer primary 42. The 120-cycle signal is supplied by the tapped secondary 43 to the full-wave rectifier 38 and thence at the double frequency of 240 cycles to the condenser 44 and the next succeeding transformer primary 45. The tapped secondary 46 delivers signals to the next stage, and so on until the required high frequency for line-scanning is obtained. In event the resistances of the transformers are too low, resistances may be inserted in the rectifier circuits for the purpose of limiting the direct current.

An alternative and simplified system or circuit, for the same purpose as that shown in Fig. 6, is shown in Fig. 7. In Fig. 7, the reference numerals 47, 48 and 49 designate transformer windings, connected as shown with respect to full-wave rectifiers 50 and 51 and condensers 52 and 53.

In Figs. 6 and 7, conventional amplifier stages may be employed when needed. Also, if it is desired to produce a phase relation of the final frequency, phase-shifting networks may be inserted in one or more stages of the frequency-multiplication system. In cases where it is desired, as in interlaced scanning, that the final, high frequency be an odd multiple of the original low frequency, rather than an even multiple of the latter, it is proposed to use an excess number of doubler stages and then to employ one or more conventional multivibrator frequency-reduction stages to obtain the desired odd-scanning frequency for the line sweep.

At the receiver, as shown in Fig. 2, a superheterodyne circuit is employed, preceded by the radio-frequency amplifier stage 55 fed from the antenna 54. The detector 57 combines the received carrier with the output of the local oscillator 56. A wide-band, intermediate-frequency amplifier 81 provides sufficient gain, and detector 82 then delivers signals to the two channels shown. The filter 83 passes only the video signal. The intermediate-frequency stage 84 selects exclusively the sub-carrier of 3Mc, then detects its modulation at 63, and then delivers the two sweeps and the audio signal to their respective channels through the filters 64, 65 and 66, and the detectors 67 and 70.

The low-frequency sweep signal, still in the form of modulation upon its carrier, is detected at 67 to produce in the output line a voltage wave of sine form which is changed, by a wave-form modifying network 69, to a saw-tooth voltage wave which is applied across the corresponding deflecting plates. Likewise, the high-frequency sweep signal, still in the form of modulation upon its carrier, is detected at 70 to produce in the output line a voltage wave of sine form which is changed by a wave-form modifying network 72, to a saw-tooth voltage wave which is applied across the corresponding deflecting plates.

The audio signal, in its original form from the filter 66, is fed to a loudspeaker 73.

The video signal is applied to a scanning device 62. The device 62 is represented as being in the form of a cathode-ray tube of a common construction, and comprising a fluorescent screen, an electron gun for developing a ray of electrons directed at the screen, and two sets of electrostatic plates for deflecting the electron ray at the respective line and field frequencies to cause it to scan the screen. The video signals are applied to a control electrode of the electron gun whereby the intensity of the electron ray is made to vary with the picture or video signals.

In Fig. 2, the unit 85 represents an automatic signal-level control circuit which, in the well known manner, utilizes a rectified portion of the received signal to adjust the bias on previous stages to aid in maintaining substantially constant signal output. In the present case, signal for the unit 85 is taken from the high-frequency sweep signal, will be steady and independent of background variations of the video signal. As shown, the output control signal from the unit 85 is applied to control bias in the first detector stage 57 and in the intermediate-frequency channel 81.

Instead of transmitting sinusoidal sweeps as in Fig. 1, the generators 17 and 18 may be made to develop saw-tooth sweep wave forms, as shown in Fig. 3. Such a sweep wave form is characterized by having a relatively wide frequency band necessary for faithful transmission. Its fundamental frequency and also its harmonics up to about the tenth should be provided for. This type of scanning provides systematic and uniform coverage of the screen, and though high in harmonic content can still be used with this system by proper design of the intermediate-frequency filters.

Another wave shape, illustrated in Fig. 4, may be transmitted, in which case the generators 17 and 18 are designed accordingly. It is characterized by equal slopes of the forward and return traces, thus containing a much lower harmonic content, simplifying the transmission problem considerably. Interlace here takes on a somewhat different interpretation, but pictures produced in this manner prove to be very satisfactory.

The advantage of using the sine wave, as described, resides in the fact that the signals are transmitted while still in the sine-wave form, thereby requiring the simplest band-pass system in the selective circuits at the transmitter and receiver.

It will be understood that the actual frequencies indicated in Figs. 1 and 2 are by way of example only, and that these might vary widely to meet particular requirements.

In case the other shapes of scanning signals are desired, it will be necessary to choose other frequency bands than here shown, but the general principles will be the same and are believed to have been sufficiently disclosed for those skilled in the art.

A feature of my improved system of television is the exclusive generation of the sweeps at the transmitter and actual transmission of these sweeps to the receiver, thus insuring perfect synchronism of scanning. No sychronization is required. The interlace can be quite complex, with a high interlace ratio such as 4, for example, and yet will remain in adjustment. Receiver controls are greatly simplified.

Another feature of my improved system is the use of sweeps of simple wave form, thereby providing a narrow frequency band and consequent simplified amplification and transmission of the sweeps.

Still another feature of my improved system resides in the reduced video-frequency band possible with the multiple interlace or high interlace ratio, yet giving high definition pictures. With this reduced video-band width and its relatively narrow associated band containing the audio and the sweeps, it is practical to utilize other and lower carrier frequencies than those suggested in Figs. 1 and 2, and thus to employ carriers which are not limited to an optical horizon for satisfactory coverage.

The frequency width of the video signals illustrated in Figs. 1 and 2 has been shown as those characteristic of a picture of about 600-line definition and the carriers chosen are merely suggestive. One can see that even with this provision for a video channel of higher definition than provided in a unit with the 441-line standards with 2 to 1 interlace, the ultra-high frequency band still is not increased over that required for the 441-line 2 to 1 interlace pictures. Now if only 441 lines are desired, using the system herein disclosed of multiple interlace, and by very stringent selectivety in closely spaced channels, it is possible to reduce the channel band width to approximately 1 megacycle each side of the ultra-high frequency carrier, thus making practical the utilization of carriers in the range of 30 megacycles, with their consequent potential coverage over large areas and to great distances. This is a very marked advantage of the present improved method and system.

Another advantage of my improved system is that a receiver of the type illustrated would be versatile in its ability to accept transmissions from different stations utilizing different degrees of detail up to a certain limit. Given a specified band pass in each channel, then pictures of any detail up to a certain limit could be accepted by simply tuning to the appropriate R. F. carrier of the station in question, without necessity of local adjustment to duplicate their particular sweep system. It will facilitate public field installation of television systems without the fear of equipment becoming immediately obsolete when definition changes are desired.

Another advantage of my improved system is the possibility of the use of automatic volume control, or automatic signal-level control by application from one or the other fixed signals in the sweep circuits. Automatic control based on this signal will be steady and independent of background variations of the video signal.

It has been found that excellent pictures may be obtained when integral ratios between the scanning frequencies are purposely avoided. The television system herein disclosed allows practically any type of interlacing to be employed. For example, assume that there is employed a vertical sweep of sixty fields per second, which is well beyond the flicker limit. Now a horizontal frequency of 3000 cylces per second would give fifty lines with exact progressive scanning. Now an increase to 3030 cycles will provide 101 lines in the complete picture with a two to one interlace ratio. The picture repetition rate is reduced to 30 per second, but there is still no appreciable loss in picture continuity. Now use some horizontal sweep such as 3002 cycles per second and the scanning will return to a given configuration only after half a second. This produces an effect of lines drifting by when the pattern is greatly magnified, but on the conventional viewing screen, the use of this scheme employing other than integral ratios between sweep frequencies, makes the line structure practically indiscernable. Use of this peculiar ratio of sweeps is practical with the herein described television system, as it is necessary to regulate the sweeps only at the transmitter.

A feature of my improved system resides in the utilization of actual scanning wave shape transmission suitable for electrostatic cathode-ray deflection, though with proper amplifiers, the use of electromagnetic deflection is also possible. It is obvious that utilization of electrostatic deflection at the receiver would allow the same to follow the changes in scanning frequency or wave-form, when these might be varied at the transmitter. It would be more difficult to design an electromagnetic system having this same flexibility.

Another feature of my improved system is the possibility of further simplification of the receiver equipment if operated on a common power main with the transmitter, for then the power mains frequency may be employed for the low sweep, reducing the complexity of the receiver in that locality. However, the transmitter carrier may still contain this low sweep component even when exciting such a receiver, for no disturbance will be experienced if units 64 and 67 in Fig. 2 are omitted and replaced by suitable attachments to the power mains. In the light of this modification, it would be most practical to secure the automatic signal-level control voltage from the high sweep channel which will be present in all receivers.

Still another advantage of my improved system is that its receivers will be versatile enough to receive both the highest definition pictures and the low definition pictures even of the amateur experimenters where cost of transmitter equipment is a limit of the definition which can be provided.

It will be understood that various modifications are possible without departing from the spirit of my invention or the scope of the claims.

I claim as my invention:

1. In the art of television communication wherein it is required that electrical sweep waves of low frequency and high frequency respectively be supplied to the receiver for governing the scanning action thereat, the steps in the method of operation which consist in generating video signals, modulating a sub-carrier with the high-frequency sweep wave, modulating a second sub-carrier with the modulated first-named sub-carrier, mixing the video signal and the modulated second sub-carrier, modulating a main ultra-high frequency carrier with the resulting composite signal, and feeding said modulated main carrier to radio transmission means.

2. In the art of television communication wherein it is required that electrical sweep waves of low frequency and high frequency respectively be supplied to the receiver for governing the scanning action thereat, the steps in the method of operation which consist in generating video signals, modulating a first sub-carrier with the low-frequency sweep wave, modulating a second sub-carrier with the high-frequency sweep wave, mixing the modulated first and second sub-carriers with audio signals, modulating a third sub-carrier with the resulting composite signal, mixing the modulated third carrier with the video signal, modulating a main ultra-high frequency carrier with the final composite signal, and feeding said modulated main carrier to radio transmission means.

THOMAS T. GOLDSMITH, JR.