

Oct. 12, 1937.

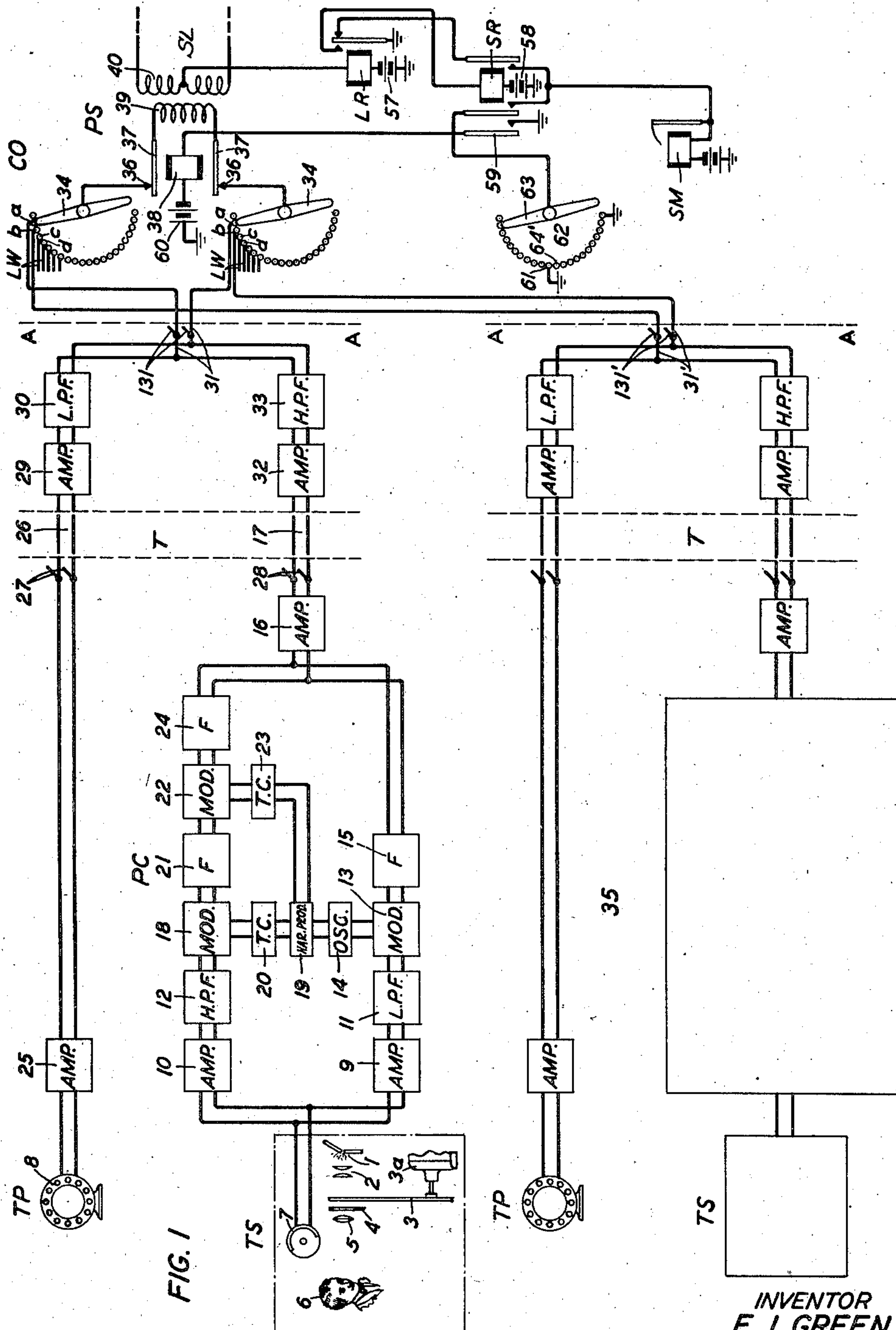
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2,095,360

TELEVISION SYSTEM

Filed April 28, 1932

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

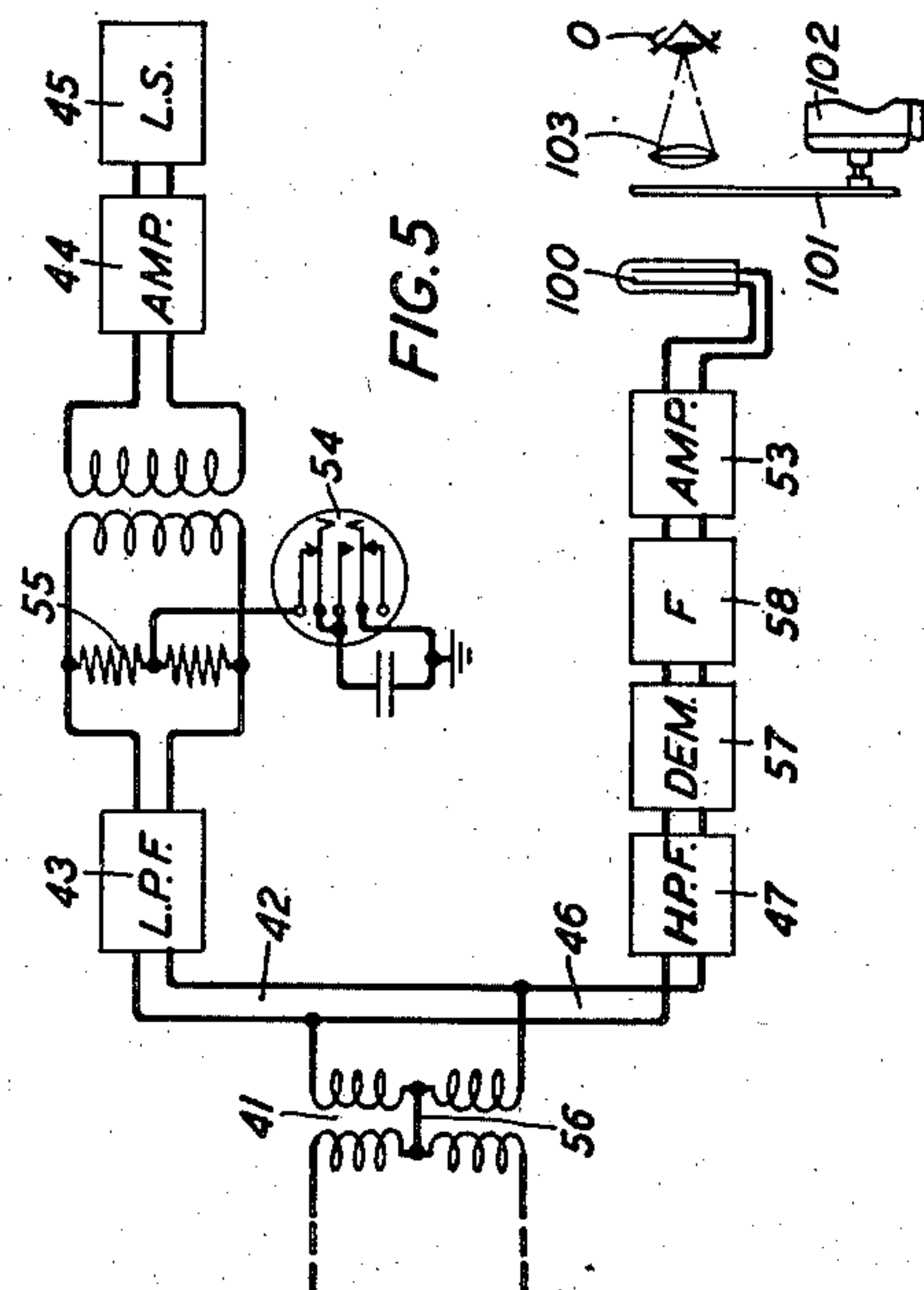


FIG. 5

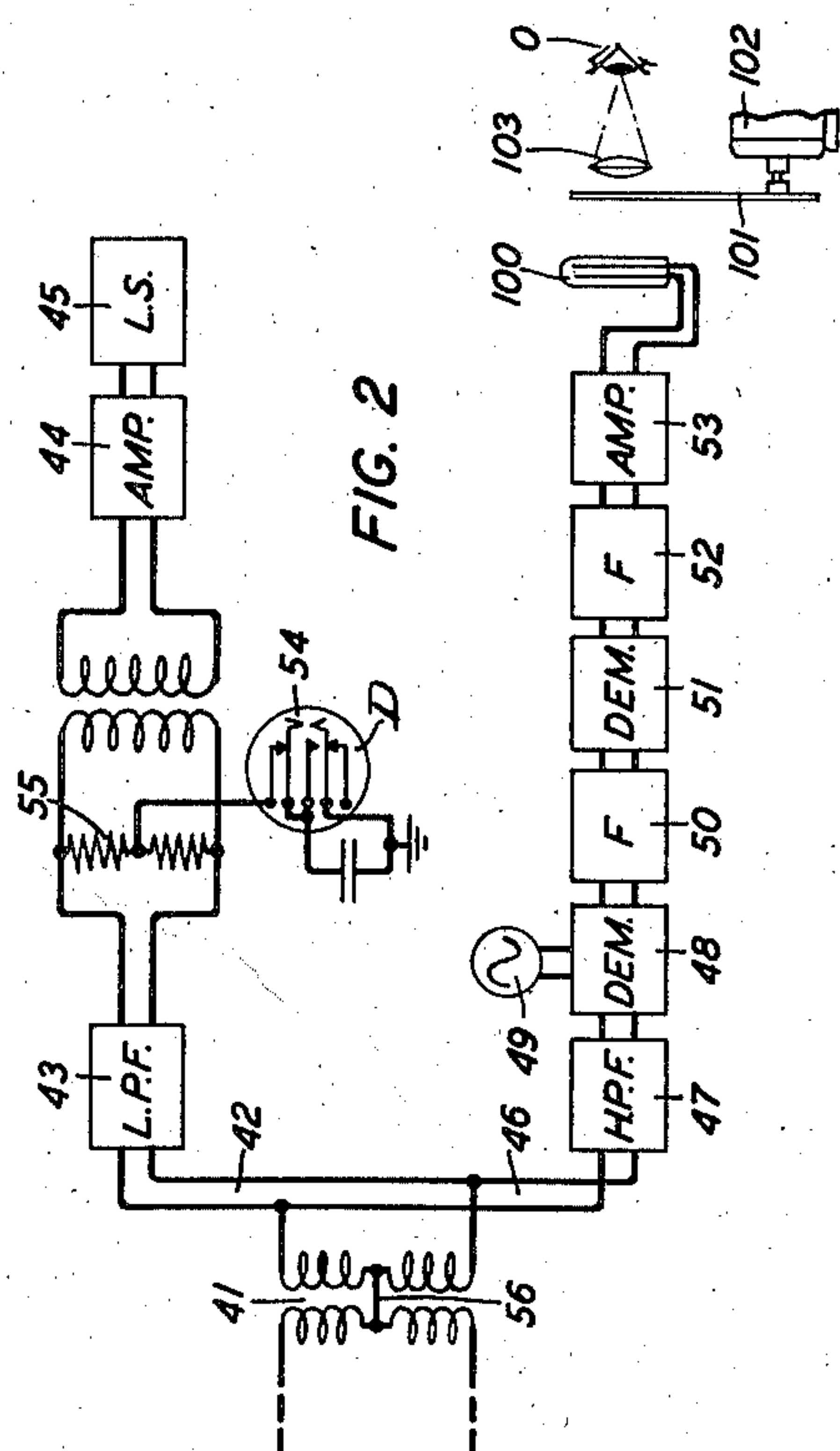


FIG. 2

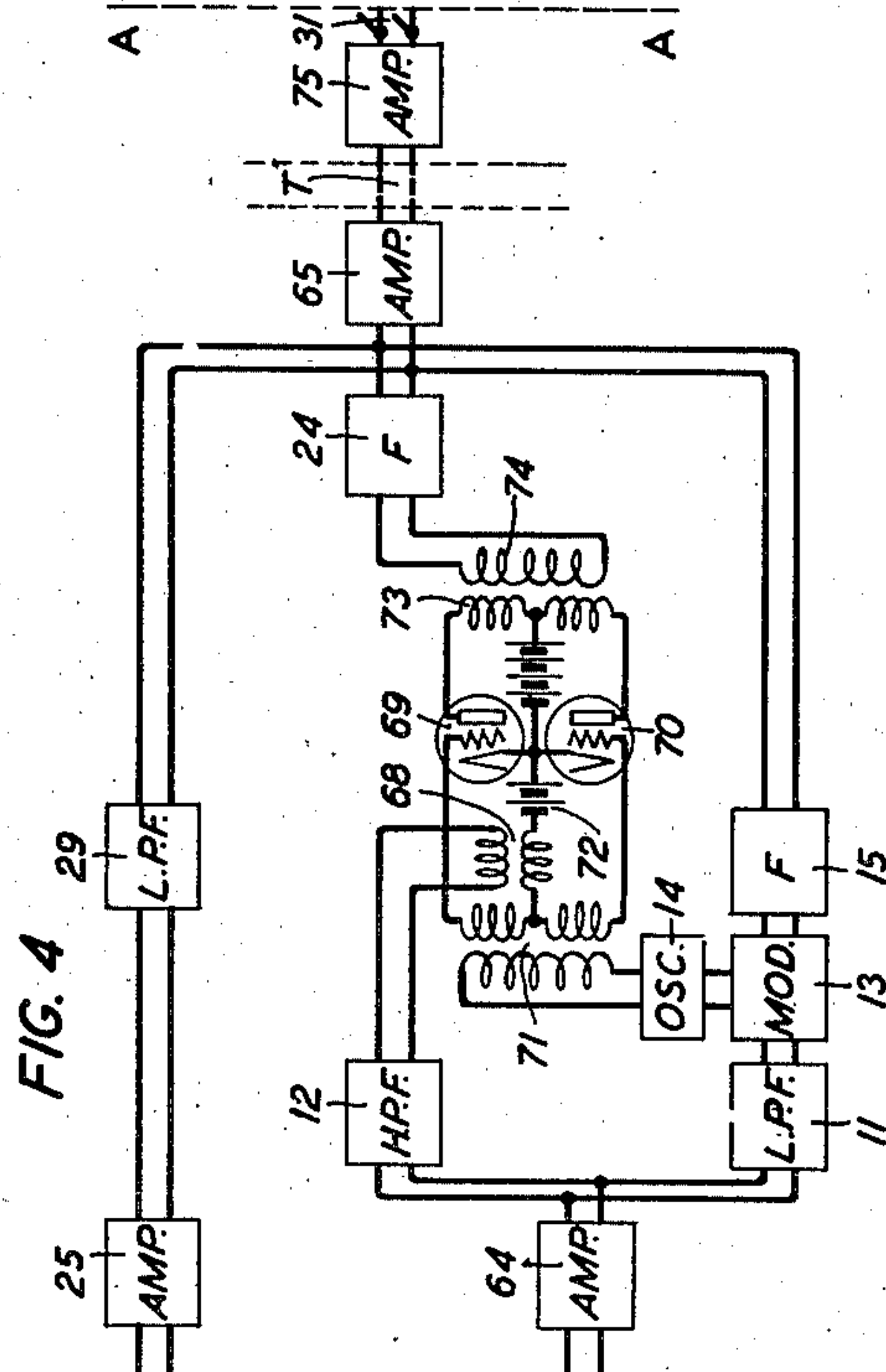


FIG. 4

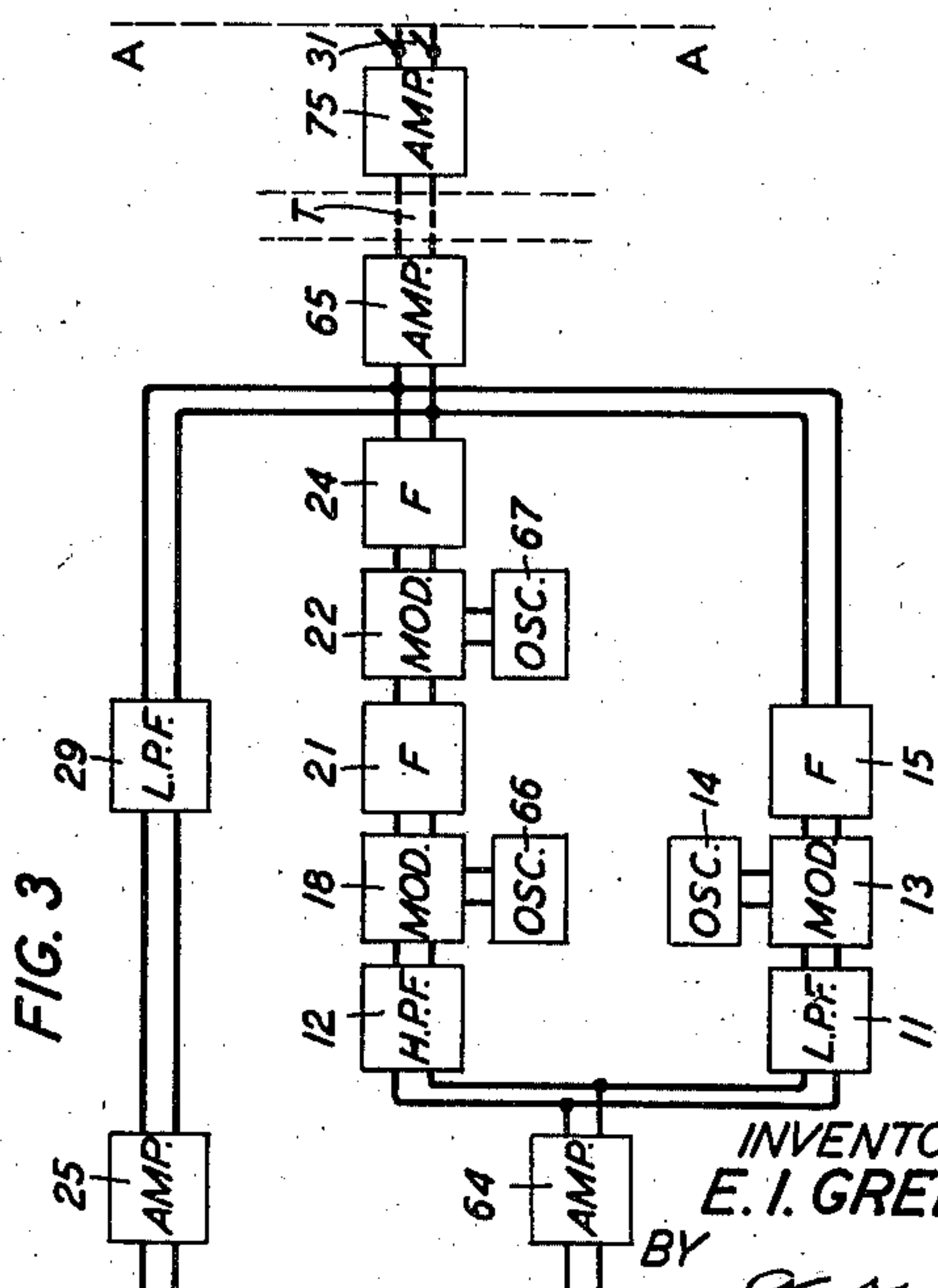


FIG. 3

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4 Sheets-Sheet 3



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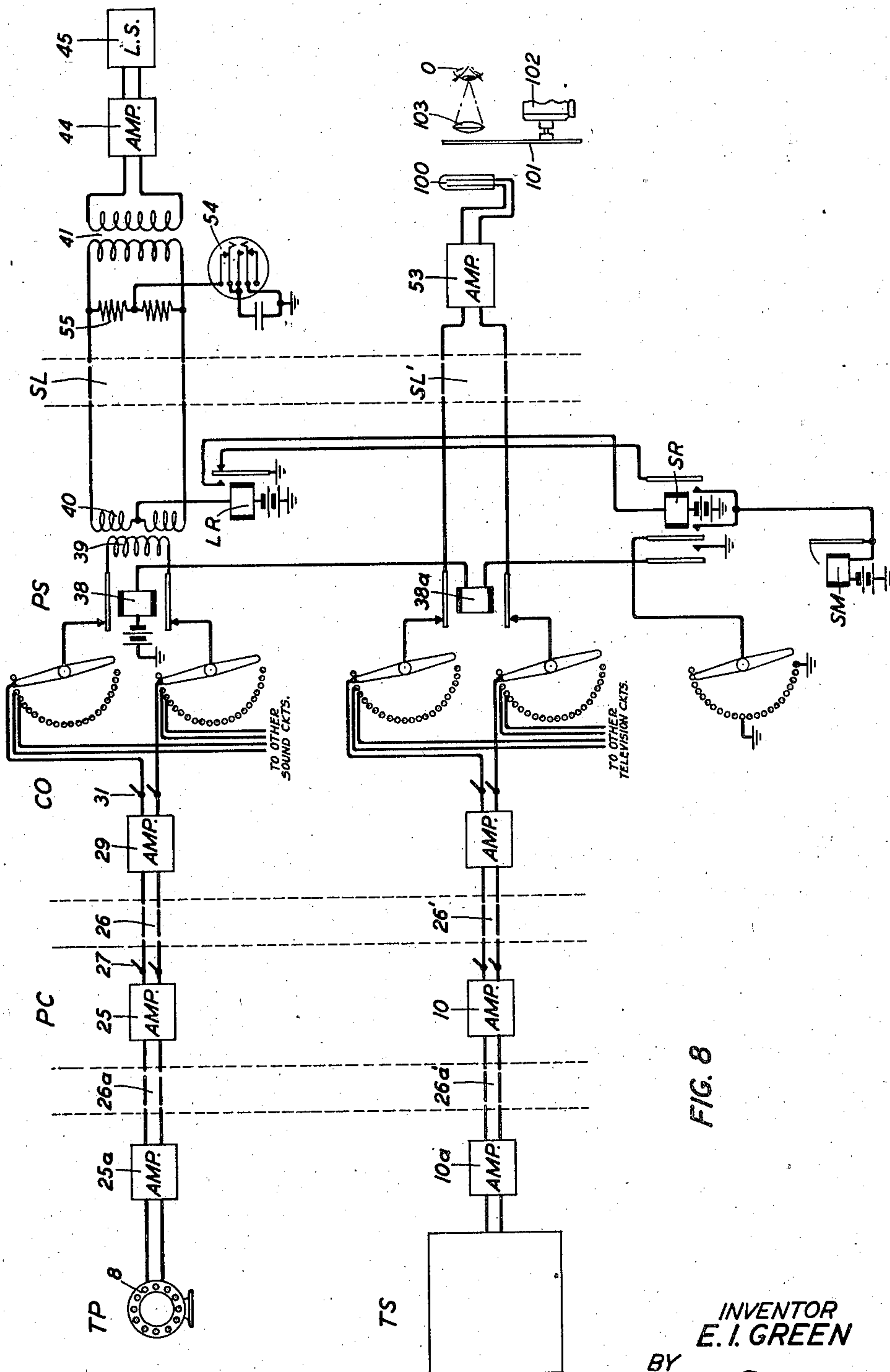
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TELEVISION SYSTEM

Filed April 28, 1932

4 Sheets-Sheet 4.



8/5/4

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2,095,360

TELEVISION SYSTEM

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Application April 28, 1932, Serial No. 608,113

26 Claims. (Cl. 178—5.6)

This invention relates to television systems and more particularly to methods and apparatus whereby an image band, which extends from substantially zero frequency to a frequency of considerable value, may be efficiently transmitted and faithfully reproduced at a receiving station.

In one aspect the invention is concerned broadly with systems for distributing to a number of subscribers one or more television programs, which may, if desired, be accompanied by sound programs. The arrangements described may be applied to a distributing network of the type commonly used for telephone purposes.

The invention is especially adapted for use in broadcasting systems, wherein a combined television and associated sound program may be transmitted over a single communicating channel.

A feature of the invention is the provision of apparatus at a central point for shifting the position of the television band, which point serves a large distribution area, whereby duplication of this apparatus is avoided.

The prior art includes a television system in which the image current band is separated by filters into two portions, the lower of which modulates a carrier wave of such frequency that the resultant modulation products occupy a position in the frequency spectrum above the highest frequency component included in the upper portion. The upper portion of the image band is transmitted to a receiving station along with the modulation products which are selected and detected to yield the lower portion of the image current band, which is passed through attenuating and phase correcting networks and the detected components are combined with the directly transmitted portion to faithfully reproduce the image current band.

There is also disclosed in the prior art, a system which produces an image band in which the energy is largely concentrated in a number of distinct frequency bands between which there is very little useful energy. This band is split into two sections, which are used to modulate carrier currents of respectively different frequencies, two sidebands and the carrier resulting from one modulation are transmitted along with one sideband of the other modulation. At the receiving station the incoming image modulated currents based on the respective carrier frequencies are separated by filters and separately detected to yield the respective portions of the image band and these portions are combined to produce the image current band.

In another system heretofore proposed, the transmitting terminal apparatus produces an image current band and also a carrier wave modulated by the image band both of which are amplified by an alternating current device, which operates to distort the low frequency components of the image current band. To compensate for this distortion a filter is used to select the mid-portion of the modulated wave and distort its components in a manner complementary to the distortion of the corresponding components of the image current band effected by the alternating current device, and the selected and distorted mid-portion of the modulated wave is translated to a point in the frequency spectrum adjacent the upper limiting frequency of the image band, whereby the composite current occupies a frequency range only slightly greater than the width of the image band. This composite current is transmitted to a receiving station, where the distorted mid-portion of the modulated wave is selected and stepped down in frequency so that one of its components is at zero frequency and its other components are in positions to respectively complement the distorted components of the portion of the image band directly transmitted, and the two sets of distorted components are combined whereby the image band is faithfully reproduced.

According to one embodiment of the present invention, the image current band is divided into upper and lower portions, the lower portion modulates a carrier current whereby there are produced two sidebands and an unmodulated component of carrier frequency, the upper portion of the image band may be combined with a second carrier having a frequency different from the first mentioned carrier but of such value that the resultant sidebands are spaced apart sufficiently to permit a filter to select one sideband while substantially suppressing the other, the selected sideband is used to modulate a third carrier which results in the production of two side bands spaced apart sufficiently to permit their being separated by a filter and having modulated components based on the same frequency as the unmodulated component of the modulated current including the lower portion of the image band, or the upper portion may be used to modulate a carrier of the same frequency as that modulated by the lower portion of the image band, but separately therefrom, to produce two sidebands spaced apart sufficiently to permit a filter to select one sideband while substantially suppressing the other. In either case one sideband of the products includ-

ing the upper portion of the image band is selected and transmitted along with the modulation products including the lower portion of the image band and the unmodulated carrier component.

5 In accordance with the above described embodiment of the present invention there is produced for transmission an image modulated carrier current which, while having a much narrower band width than a wave comprising two sidebands, 10 comprises modulated components and an unmodulated component that are directly combinable by detection to faithfully reproduce the image current.

This invention utilizes a method for producing 15 an image-modulated carrier current which permits the use of a simple type of receiving set or, in other words, one which does not require technical training to operate.

A more detailed description of the invention 20 follows and is illustrated in the attached drawings, in which,

Figures 1 and 2, with the latter at the right of Fig. 1, diagrammatically illustrate a system in which a number of combined television-sound 25 programs may be supplied to one or more central offices each provided with selecting mechanisms adapted to be controlled from subscribers' stations, to permit selection of any one of the programs which a subscriber desires to receive;

30 Fig. 3 shows a terminal apparatus for the combined television-sound program, which may be substituted for that shown in Fig. 1;

Fig. 4 illustrates another terminal apparatus which may be substituted for that shown in Fig. 1 35 or in Fig. 3;

Fig. 5 illustrates receiving apparatus which may be substituted for that shown in Fig. 2;

Fig. 6 illustrates an arrangement of transmitting terminal apparatus which may be substituted for that shown in Fig. 1; 40

Fig. 7 illustrates yet another arrangement of transmitting terminal apparatus which may be substituted for that shown in Fig. 1; and

45 Fig. 8 illustrates an embodiment of the invention in which separate subscribers' circuits may be employed for the sound signals and the television signals.

As shown in Figs. 1 and 2, the latter being placed to the right of Fig. 1, the system comprises a program center PC at which are produced currents corresponding to a number of programs, each comprising a field of view to be transmitted by television and accompanying sound. This center includes a number of related mechanisms, each including a television scanning 55 mechanism TS and a telephone pickup TP adapted to respectively produce an image current and related sound currents, which may be transmitted over a trunk T (circuits 17 and 26) to a central office CO. This office includes a program selector PS associated with each subscriber's loop or line SL and controllable thereover from a subscriber's station, whereby a subscriber may connect his line through circuits, such as 31, to any 60 one of the trunks T to select the program, comprising the respective image and related sound currents, which he may desire to receive.

The terminal apparatus for one television sound channel is shown in more or less detail, a second 70 is schematically illustrated and a number of others are indicated by lead wires LW.

The television scanning apparatus TS at the program center may include an optical system comprising a source of light 1, radiations from 75 which are concentrated into a beam by a lens

system 2 and applied to the face of a disc 3, provided with a series of apertures arranged in a spiral line, whereby there is produced a moving beam of light of great intensity which passes through the opening in a mask 4 and a lens 5 to 5 illuminate successive elemental areas of adjacent parallel lines of a field of view 6 herein shown as the face of a speaker or entertainer. The opening in mask 4 determines the size of the field to be scanned, the apertures are of such size that 10 the field is completely scanned during each revolution of the disc, and motor 3a drives the disc at such speed that each scanning is effected within the period of persistence of vision. Light is reflected from the successive elemental areas of 15 the field of view to the light sensitive device 7, herein illustrated as a photo-electric cell, which is thereby activated to produce an image current varying in amplitude as the tone values of the successive elemental areas of the subject scanned. 20 This scanning apparatus operates in the manner disclosed in United States application Serial No. 227,649 of F. Gray, filed October 21, 1927.

The resultant image current comprises current components constituting a frequency band 25 which extends from substantially zero frequency to an upper limiting frequency, the width of which depends largely upon the amount of detail to be transmitted and may be many kilocycles.

Associated with the television scanning mechanism is a microphone 8 arranged to pick up the speech delivered by a speaker or the vocal sounds or instrumental music produced by an entertainer or other appropriate sounds. Current corresponding to this portion of the program may 35 extend from 30 cycles to about 10 kilocycles.

Since the image and sound currents constituting a program occupy overlapping portions of the frequency spectrum and are simultaneously transmitted over a single channel from the central office to a subscriber, and the separate programs are transmitted from the program center to the central office over adjacent trunks, between which cross-talk may occur, two problems are 40 involved. The image and sound currents must be transmitted so as to avoid interference of one with the other, and the several programs must be transmitted in such manner that cross-talk between trunks does not cause objectionable interference and distortion. In view of the fact that 50 the requirement as to cross-talk between different sound channels appears to be more severe than in the case of television channels, it is desirable to displace the image current to a position in the frequency spectrum outside the range of the audible current. That is, the sound should be transmitted in the lower frequency range where cross-talk is less liable to cause interference and distortion. Also it may be desirable to avoid using the lower frequencies for television transmission because of the phase difficulties encountered, due to the fact that the phase shift of the transmission line or channel is not uniform for the current components of different frequencies 65 within the image band.

The simplest method for shifting the television signals, to a frequency position above that of the sound signals is to combine them with a carrier current and transmit both sidebands and the unmodulated carrier component. Since this expedient is uneconomical of the frequency spectrum, the system to be herein described embodies an arrangement for producing an image modulated carrier current having a band width only slightly greater than that involved in single side- 75

band transmission, whereby either the frequency range required for transmission with a given amount of detail may be reduced, or greater detail may be provided while using a frequency range corresponding to that required for double sideband transmission.

The use of single sideband transmission per se presents a difficulty due to the fact that the minimum input frequency of the image band is substantially zero, (it may be of the order of 10 cycles or less) and as a consequence the frequency spacing between the two sidebands, resulting from modulating a carrier current with the image current, will be only 20 cycles or thereabouts. Again, since modulators operate to repeat the current impressed on their input circuits and the presence of such repeated components may result in distortion, it is desirable to use a carrier current of such frequency that the modulation products occupy a position in the frequency spectrum outside the range of the image current band which may comprise components of many kilocycles. This necessitates the use of a carrier current of such high frequency that it is impracticable, with present day technique, to provide a carrier frequency band filter which will select one sideband of the modulated current and suppress the other sideband, when the frequency spacing between the sidebands is so small. Complete suppression of the sideband is desirable, because if any components of the undesired sideband are not suppressed, they will, upon demodulation, coincide with the corresponding frequency components of the useful sideband and, because of their varying phase relation with respect to the desired components of corresponding frequencies, they may produce an irregular transmission characteristic for the lower frequencies of the image band.

Uniform transmission of the various components of the image band, while only slightly increasing the frequency range over that occupied by the band itself, is accomplished by splitting the band into two unequal portions, effecting separate modulations with these portions, and combining the modulation products including the smaller portion of the image band with one sideband of the modulation products including the larger portion of the image band. This is effected by supplying the image current, produced by the photo-electric tube 7 over branch circuits respectively including amplifiers 9 and 10 to a low pass filter 11 and a high pass band filter 12, respectively included in the output circuits of the amplifiers 9 and 10.

Low pass filter 11 is designed to freely transmit, substantially without attenuation, current components extending from zero frequency to an upper limiting frequency, for example, 500 cycles, and to suppress current components of higher frequencies. On the other hand, band filter 12 freely transmits, substantially without attenuation, current components extending from the cut-off frequency of filter 11 to ∞ and suppresses those within the transmission range of filter 11. At a frequency as low as 500 cycles, filters 11 and 12 can be designed to cut off with extreme sharpness, and hence they will serve to effect the desired separation of the image band into lower and upper portions, respectively including current components from 10 cycles or less up to 500 cycles and 500 cycles to an upper limiting frequency. Furthermore, the nature of the television signals occurring in the low frequency range is such that practically all of the useful energy is concentrated in certain parts of the

frequency range, the location of these parts being determined by the number of pictures transmitted per second, the number of apertures in the scanning disc, and similar factors. Between these points of energy concentration, there are other points of the frequency range in which there is substantially no energy, and it is intended that separation of the image band is to be effected at some one of these points where the energy is substantially zero.

The lower portion of the frequency band is supplied by filter 11 to a modulator 13 in which it is combined with a carrier current whose frequency is assumed to be 15 kc. supplied by a source 14, to produce modulation products comprising two sidebands and an unmodulated carrier component. These products, comprising a side band (14.5 kc. to 15 kc.), an unmodulated carrier component of 15 kc. and a sideband (15 kc. to 15.5 kc.), are transmitted through the filter 15 and, after being amplified by the amplifier 16, are supplied to a trunk circuit 17.

When it is desired to shift the original wide band of television frequencies upwardly in the frequency range by an amount which represents only a fraction of its total width and to use only a single sideband of the modulation products produced during the shifting operation, it may be advantageous to effect this shift in two stages of modulation. This mode of operation makes it possible to avoid difficulties which might arise when a single stage of modulation is used, due to transmission through the modulator of input frequencies which overlap the desired output band, as well as difficulties which might result if the sideband to be suppressed included current components lying within the frequency range occupied by the side band to be transmitted, as will be hereinafter explained.

In accordance with the scheme employing two stages of modulation, the upper portion of the image band, transmitted through filter 12, is supplied to a modulator 18 in which it is combined with a carrier current which is assumed to be 180 kilocycles. This frequency may be supplied by a harmonic producer 19, which in turn is supplied with current of 15 kilocycles from the source 14. The path connecting the harmonic producer with the modulator includes a circuit 20, tuned to the 12th harmonic of the current supplied by source 14.

The energy flowing through the output circuit of modulator 18 comprises two sidebands and an unmodulated component of carrier frequency (180 kilocycles). The two sidebands are separated from each other by a frequency spacing of 1000 cycles and each is separated from the carrier component by a spacing of 500 cycles and by a greater spacing from the repeated current components of the upper portion of the image band.

The two sidebands, associated carrier and other components supplied by modulator 18, are impressed upon a filter 21 which freely transmits the upper sideband and suppresses the unmodulated component, the lower sideband and the repeated components of the image band. As a matter of fact, filter 21 may transmit some of the unmodulated carrier component and certain components of the lower sideband adjacent the carrier, without causing any detrimental effect in the operation of the system, as will be explained later.

The single sideband transmitted by the filter 21 is combined in modulator 22 with a current

of, for example, 165 kilocycles, supplied by the harmonic producer 19 over a path including a circuit 23 tuned to the 11th harmonic of the current supply by source 14, to produce modulation products comprising two sidebands, an unmodulated carrier component of 165 kilocycles and other components, including the single sideband impressed upon the input circuit of modulator 22 and perhaps certain other components which were not suppressed by filter 21. This energy is supplied to the band-pass filter 24 adapted to select the lower sideband, comprising current components having frequencies extending from 15.5 kilocycles to an upper limiting frequency which for present purposes may be assumed to be 100 kilocycles. Any current components of the undesired sideband repeated by the modulator 22 without modulation, or which combine with the 165-kilocycle carrier current to produce modulation products, will be so far removed from the cut-off frequency of filter 24 that they will be suppressed thereby. For example, the carrier component of 180 kilocycles and the sideband components adjacent thereto in frequency will be sufficiently far removed from the upper cut-off frequency of filter 24 to assure that such undesired components will be suppressed. The 15-kilocycle current component, produced by combining the carrier of 180 kc. passed by filter 21 and the carrier of 165 kc. supplied to modulator 22, will be removed from the lower cut-off of filter 24 by 500 cycles, which is ample at this point in the frequency spectrum to assure that it will be suppressed by this filter. Likewise the components lying below 15 kc. which result from incomplete suppression in filter 21 will be readily suppressed.

The 15.5 kc. to upper limiting frequency band transmitted by filter 24 after being amplified by the amplifier 16, is supplied to the trunk 17 over which it is transmitted to the central office. Since this operation occurs simultaneously with the modulation by the lower portion of the image band, previously described, trunk 17 will be supplied with a modulated wave made up of two side bands lying between 14.5 kc. and 15.5 kc., a single sideband extending from 15.5 kc. to an upper limiting frequency, determined by the frequency width of the upper portion of the image current, and an unmodulated carrier component of 15 kc., with which the two sidebands, including the lower portion of the image band, and the single sideband including the upper portion of the image band, may be combined to produce the image current band.

Speech current, or current corresponding to audible sounds, produced by the pickup device or microphone 8 are amplified by the amplifier 25 and are transmitted over the trunk 26 to the central office.

The circuit conveying the audible frequency current to its trunk 26 and that connecting the amplifier 16 to the trunk 17, respectively, may be connected to other trunks over circuits indicated by the taps 27 and 28, respectively; whereby the program initiated at the program center may be transmitted to any number of other central offices for distribution to subscribers associated with these offices. At the central office the incoming audible frequency current is amplified by amplifier 29 and transmitted through the low-pass filter 30 to the circuit 31. At the same time, the composite image modulated current is amplified by the amplifier 32 and transmitted through the high-pass filter 33 to circuit 31, the

conductors of which are connected to contacts *a* of two banks of contacts respectively associated with movable wipers 34 of a step-by-step switching device forming part of the program selector PS.

Contacts *b* of the contact banks are connected to the conductors of a second circuit 31' over which a second program, represented by an image modulated carrier current and audible frequency current corresponding to associated sound, similar to those of the first program, may be received from a second transmitting apparatus 35 (Fig. 1), situated at the program center, which is identical with that described above. Other similar transmitting apparatuses at the program center may be connected over similar circuits to the successive contacts *c*, *d*, etc., of the bank, as indicated by the leads LW.

Circuits 31, 31', etc., may be connected to other similar step-by-step switching devices each associated with a different subscriber's line, as indicated by the taps 131 and 131'. The step-by-step switching device comprising wipers 34 and contacts *a*, *b*, *c*, *d*, etc., may be controlled by impulses transmitted from a subscriber's station, in a manner to be hereinafter described, to connect his loop or line circuit SL to any desired one of the several trunks and there-through to a desired program transmitter.

Wipers 34 are connected by contacts 36 and armatures 37 of a cut-off relay 38 to the primary winding of a repeating coil 39 having its secondary winding 40 included in the loop or line circuit SL extending to a subscriber's station and terminating thereat in a repeating coil 41 (Fig. 2) having its secondary winding connected to a branched circuit. One branch 42 of this circuit includes a low-pass filter 43, adapted to freely transmit the audible frequency current and prevent the passage of the image modulated current. The audible frequency current is amplified by the amplifier 44 and the amplified current is supplied to sound reproducing device 45, herein shown as a loud speaker.

The other branch 46 includes a high-pass filter 47 which prevents transmission of the audible frequency current, but permits the image modulated and unmodulated carrier current to pass to a demodulator 48.

While the modulated and unmodulated components of the incoming wave may be directly combined to reproduce the image current, this method of operation may be undesirable. The reason for this is that the incoming modulated current may be repeated in the output circuit of the demodulator and since the modulated current and image current occupy overlapping portions of the frequency spectrum, there will be present in the output circuit of the demodulator two groups of current components having identical frequencies, which tend to interfere with each other. To overcome this objection and thereby eliminate all possibility of interference, it is preferable to use a receiving apparatus utilizing double detection.

By employing oscillations of the proper frequency in the first stage of demodulation, the output current of the respective demodulators may be caused to occupy different frequency ranges from that of the current impressed upon their input circuits.

In accordance with this method of operation the demodulator 48 is supplied by an oscillator 49 with oscillations which combine with the image modulated current to step it up in frequency

to a position in the frequency spectrum such that the frequency band produced in its output circuit lies outside the frequency range of the received image modulated wave impressed upon its input circuit and also outside the frequency range of the image current. The stepped-up wave is selected by the filter 50 and transmitted to the demodulator 51 in which its sideband components combine with its unmodulated component to yield the image current. This current is selected by filter 52 and after amplification in 53, if desirable, is supplied to a television receiver, which is diagrammatically shown as comprising a discharge lamp 100, supplied with the image current, associated with a rotating disc 101, similar to disc 3 at the transmitter, which is driven by a motor 102 to produce an image of the subject scanned for transmission within the period of persistence of vision. The television receiver operates to produce an image which is directly viewed by an observer. Any other suitable receiver for this purpose, or for projecting the image on a screen, may be used in place of the receiver described above.

To produce an image of the subject scanned at the program center, it is essential that the scanning disc 101 be operated in synchronism and in phase with the scanning disc 3 of the television pickup TS. Any suitable means may be used for this purpose, as for example, that disclosed in U. S. Patent 1,874,200 of E. C. Manderfeld, issued August 30, 1932. Briefly described, this system operates as follows: At the transmitter, the opening in the mask 4, in the direction of the scanning lines, may be made less than the distance between centers of adjacent apertures in the scanning disc, so that the scanning light beam is periodically interrupted at the end of each line before the scanning of the succeeding line is initiated, or the width of the opening in the mask 4 may be made such that the last element of one line and the first element of the succeeding line are scanned simultaneously, thus periodically increasing the light which activates the photosensitive device 7 to a high value. In either case, there will be introduced into the image current a corresponding frequency component of relatively high value, which is selected at the receiving station and utilized to control the speed of motor 102. For a complete disclosure of the operation of this synchronizing system, reference may be made to the above mentioned Manderfeld patent.

The advantage of utilizing successive modulation and demodulation at the program center and at the receivers, respectively, will be evident from a consideration of the following numerical example. Let it be assumed that the television pickup at the program center operates to produce an image current occupying the frequency range from approximately 10 cycles to 85 kilocycles and that the program is to be transmitted over a channel having a frequency capacity of 100 kilocycles. As stated above, the audible signal current extends from 30 cycles to about 10 kilocycles and, in order to provide the required frequency spacing to permit this current to be separated from the image modulated carrier current, by filters at the receiver, the image band modulates a carrier current of 15 kilocycles.

If, as described above, the upper portion of the image band is used to effect modulation in one step, there will be present in the output circuit of the modulator, used to combine this portion (500 cycles to 85 kilocycles) with the carrier current, a sideband extending from about 15.5 kilocycles to

100 kilocycles, and a sideband extending from 14.5 kilocycles down to zero frequency and upward to 70 kilocycles, and due to the repeating action of the modulator, an image band extending from about 10 cycles to 85 kilocycles, together with an unmodulated component of 15 kilocycles. Although the amplitudes of the repeated components may be made small, compared with those of like frequency in the modulation products, by utilizing a carrier current of large amplitude; the components of the unwanted sideband which overlap those of the wanted sideband may cause interference, resulting, after demodulation, in distortion of the image.

However, by first combining the upper portion of the image band with a carrier of 180 kilocycles, the modulation products occupy a different frequency range from that of the impressed image band, and the two sidebands are so spaced that a filter may be used to select the upper sideband and to suppress the lower sideband as well as any repeated components of the image band. By selecting the upper sideband (180.5 to 265 kilocycles) of the resultant modulation products and combining it with a carrier of 165 kilocycles in a second modulator the output current of this modulator will contain an unmodulated carrier component of 15 kilocycles and two sidebands respectively comprising a lower sideband extending from 15.5 kilocycles to 100 kilocycles and an upper sideband extending from 345.5 kilocycles to 430 kilocycles, and the lower band may be selected by a filter.

At the receiving station, by supplying oscillations of, for example, 210 kilocycles to the first demodulator, its output circuit will include demodulation products lying between 110 kilocycles and 310 kilocycles, which are so spaced in the frequency spectrum with respect to the incoming wave of 14.5 kilocycles to 100 kilocycles impressed upon the input of the demodulator that a filter may be used to select these products and suppress the repeated wave, or to select one sideband thereof and suppress the other sideband as well as any repeated components of the incoming wave. In either case, the energy impressed upon the second demodulator occupies a position in the frequency spectrum such that a filter in its output circuit will select the reproduced image current and suppress the repeated current components.

In the preceding explanation, relating to modulation and demodulation, the effect of harmonics produced by the modulators and demodulators has not been referred to, since they result in the production of currents which will be suppressed by the filters and, in any event, are of negligible amplitudes.

Each subscriber's receiving equipment includes a dial D, which is connected over a simplex circuit of the line SL to control a suitable line relay LR, through which impulses for actuating the stepping magnet SM may be relayed. Briefly described, the program selecting means is controlled by actuating dial D to the digit identifying the program it is desired to receive.

As the dial D is moved off-normal, its off-normal contact 54 is closed, so that the midpoint of the bridge 55 is grounded, and the circuit is completed through the low-pass filter 43 to the midpoint of the secondary winding of transformer 41, conductor 56 to the midpoint of the primary winding of transformer 41, over the two sides of the line SL in parallel to the midpoint of the secondary winding 40, and thence through the

winding of line relay LR and battery 57 to ground. Line relay LR upon being energized, completes a circuit over its front contact for slow release relay SR, from ground, armature of relay LR, its front contact, relay SR, battery 58 to ground. Relay SR, upon being energized completes a control circuit for relay 38 which operates to disconnect the primary winding of transformer 39 from the switching apparatus during the switching operation. This circuit extends from ground through the left hand front contact and armature 59 of slow release relay, winding of relay 38, battery 60 to ground. This prevents the dialing impulses, when the dial is released, from being transmitted over the various switching contacts to other subscribers' lines which may be connected to other program circuits wired to these contacts.

As soon as the dial is released, it returns and sends interrupted impulse to the line relay LR, the slow release relay SR holds up during the interruptions, and each time the line relay falls off, a circuit is completed over its back contact, the right hand front contact of the slow release relay SR to the stepping magnet SM, which steps the wipers 34 of the switch banks in a counter-clockwise direction until the wiper rests on the particular contact desired. Shortly after the last impulse is received the slow release relay is deenergized to open the circuit through the stepping magnet and relay 38, whereby the subscriber's line is connected to the desired program trunk.

If the subscriber desires to select a different program, he first manipulates the dial D to dial O. As soon as the dial is off-normal, the line relay LR is energized to pull up the slow release relay SR and operate the relay 38. Upon releasing the dial, the pulses are transmitted to the line relay which operates the stepping magnet to advance the wipers to the next zero contact of each bank. This will in general require less than all of the ten pulses of the zero group. When this point is reached, ground is applied over the zero contact 61 of row 62, the inner left hand contact of slow release relay SR, winding of stepping magnet SM and battery to ground. This holds the stepping magnet locked up while the remaining impulses of the zero group are being transmitted. After the last impulse is received, the slow release relay SR releases and disconnects ground from the stepping magnet, which, upon release, advances the wiper 63 to the next or normal contact 64. The selecting mechanism diagrammatically illustrated and briefly described above, corresponds in design and operation to that disclosed in United States Patent 1,685,835, issued October 2, 1928 to Bascom et al., to which patent reference may be made for a complete description of its construction and mode of operation. If desired, the dial and locking key of Fig. 2 of that patent may be substituted for the dial D for the purpose of controlling the program selector in the manner therein described.

Fig. 3 illustrates a simplified transmitting terminal apparatus which may be substituted for that shown in Fig. 1, to the left of section line A—A. In this arrangement, the sound and television pickup devices TP and TS of Fig. 1 are respectively connected to the sound amplifier 25 and a television amplifier 64. The audible sound currents are transmitted through the filter 29 to the amplifier 65. The television band is split into two portions by the low and high pass filters 11 and 12 and the lower portion is supplied to the modulator 13 in which it is combined with a 15

kc. carrier current supplied by the source 14, the two sidebands and the unmodulated carrier being transmitted through filter 15 to the amplifier 65. Simultaneously, the upper portion of the image band transmitted by the filter 12 is combined in the modulator with oscillations of 180 kc. supplied by the source 66. One sideband of the modulation products thus produced is selected by filter 21 and combined in modulator 22 with oscillations of 165 kc. supplied by the oscillator 67. Filter 24 serves to select one sideband, extending from 15.5 kc. to an upper limiting frequency, which is also supplied to the amplifier 65. The amplified image modulated currents and sound currents are supplied over a trunk T to the amplifier 75 and program selector PS at the central office as shown in Fig. 1.

Fig. 4 illustrates a second form of program transmitting apparatus which, with proper selection of frequencies, may be substituted for that shown to the left of section line A—A of Fig. 1. In this arrangement the sound and television pickup devices TP and TS are respectively connected to the sound amplifier 25 and television amplifier 64. As in the preceding systems, the sound currents after being amplified by amplifier 25 are transmitted through filter 29 and the image band is split into lower and upper portions by the low and high pass filters 11 and 12. The lower portion is supplied to the modulator 13 in which it is combined with a carrier frequency supplied by source 14 to produce two sidebands and an unmodulated component which are transmitted through filter 15.

The upper portion of the image band is applied through a transformer 68 connected in the common connection extending from the filaments of two space discharge devices 69 and 70 to their grids. The discharge devices 69 and 70 are connected in push-pull relation and are included in a balanced circuit. The grids of these devices are connected by a circuit including the secondary winding of a transformer 71, the primary of which is supplied with carrier current by the source 14. The grids of the devices 69 and 70 are polarized from a source 72 to cause them to operate as a modulator as disclosed in United States Patent 1,343,307, issued June 15, 1920 to Carson. The upper portion of the image band, being applied through a transformer 68 will be combined with the oscillations supplied through the transformer 71 to produce in the winding 73, included in its output circuit, two sidebands and an unmodulated component of the frequency of the oscillations supplied by source 14. However, with the circuits of the two devices accurately balanced, no components of the portion of the image band applied through transformer 68 will flow through winding 73.

One sideband of the modulation products, induced in the winding 74, is selected by the filter 24 and is supplied, along with the sound currents and the modulation products transmitted by filter 15, to the amplifier 65, which, as in Fig. 3, is connected by a trunk T to the amplifier 75, connected by circuit 31 to program selector PS at the central office.

The transmitter of Fig. 4 constitutes a simplified arrangement in which the image current components repeated by the discharge devices 69 and 70, constituting the modulator, are balanced out and hence are not transferred to the circuit including the filter 24.

For a complete disclosure of the operation of the balanced modulator, briefly described above,

reference may be made to the above mentioned Carson patent.

Modulators 13, 18 and 22 may be of the balanced type and may have the image and carrier currents applied thereto as shown in Fig. 4. In place of the synchronizing system of Manderfeld, the transmitting scanning and receiving discs may be held in synchronism as disclosed in United States Patent 1,860,936 of W. A. Marrison et al., issued May 31, 1932. Again, synchronous operation of the discs 3 and 101 may be secured by providing synchronous motors 3a and 102 and supplying them with 60 cycle current from a commercial network, in accordance with present day practice in television broadcasting systems.

Figure 5 illustrates an alternative receiving apparatus which may be substituted for that shown in Fig. 2, and might well be associated with the transmitting arrangement shown in Fig. 4. The arrangement shown in Fig. 5 is identical with that of Fig. 2 except that in the part of the receiving circuit lying between the high-pass filter 47 and the television receiver, only a single step of demodulation is employed. In the arrangement of Fig. 5, the image modulated currents and the unmodulated carrier current are passed through the high-pass filter 47 to a demodulator 57 in which the sideband components combine with the unmodulated component to yield the image current. This current is then selected by filter 58, amplified by 53 and supplied to the television receiver. The demodulator 57 may be of the balanced type, i. e., similar to the modulator described in connection with Fig. 4.

It should be noted in connection with Fig. 4 and Fig. 5 that in order to employ a single step of modulation or demodulation in connection with a wide signal band, it is desirable that the frequency of the carrier current employed should not be too low. If the upper limiting frequency of the carrier sideband is more than three times its lower limiting frequency, it will be found that the unwanted sideband, resulting from the modulation process or to be demodulated, will overlap the wanted sideband in such a manner that interference may result. For example, if a signal band of 10 cycles to 40 kc. is used to modulate a carrier of 15 kc. the upper sideband will extend from 55 kc. to 15.1 kc. and the lower sideband will extend from 14.9 kc. to zero and from zero to 25 kc. Hence both sidebands will include current components in the frequency range between 15.1 kc. and 25 kc. This difficulty may be avoided by suitable selection of frequencies. Thus, in the arrangements of Figs. 4 and 5 if the upper limiting frequency of the single sideband representing the television image were selected as 100 kc., the lower frequency of this band should be at least 33.3 kc.

Fig. 6 illustrates a simplified arrangement of the transmitting terminal apparatus which may be substituted for that shown in Fig. 1 to the left of the section line A—A. In this arrangement, which does not involve splitting the television band, one sideband of the image modulated wave is selected and transmitted to the central office over a trunk which is shown as common to both television and sound currents.

The sound and television pickup devices TP and TS of Fig. 6 are connected respectively to the sound amplifier 25 and a television amplifier 64. The audible sound currents are transmitted through the filter 29 to the amplifier 65, from which point they pass to the trunk T and thence to the central office. The television image band,

after being amplified by amplifier 64, is stepped up in frequency by modulator 80 to a frequency range well above its original position and of such frequency as to permit a filter to select one sideband. A filter 81 selects the upper sideband and may also afford partial transmission of some components of the lower sideband. The output of this filter is passed on to modulator 82 where it is combined with a carrier frequency to produce, among other components, an image modulated sideband lying in the frequency range slightly above the audible sound frequencies. Modulator 82 is supplied with current of suitable carrier frequency from oscillator 87 through a harmonic producer 86 and tuned circuit 85. The carrier frequency for modulator 80 is supplied from the same oscillator 87 through a harmonic producer 86 and tuned circuit 84. In the output of the modulator 82, the image modulated sideband, just above the audible frequency range (with possibly certain partially suppressed components of the opposite sideband), is selected by filter 83 and is combined with the audible frequency band and both sound and television signals are impressed upon amplifier 65. From amplifier 65 the sound and image modulated bands are transmitted over a common trunk 17 to the central office where they are amplified by means of amplifier 75 and supplied over wires 31 to the program selector PS. For purposes of illustration, a method of operation involving the use of certain frequencies is indicated in connection with Fig. 6, but it should be understood that the arrangement is not limited to these frequencies, nor to the use of an upper or a lower sideband precisely as described in each case.

In the arrangement of Fig. 6 the desired sideband is produced by two steps of modulation as a preferred arrangement, but with proper selection of frequencies one step of modulation may be used to obtain the desired sideband.

Fig. 7 illustrates still another arrangement of the transmitting terminal apparatus which may be substituted for that shown in Fig. 1 to the left of section line A—A. In this arrangement, which also does not involve splitting of the television band, both sidebands of the modulated image band are transmitted to the central office over a trunk which is common for both image modulated and sound currents. According to this arrangement, sound and television pickup devices TP and TS as in Fig. 1 are respectively connected to the sound amplifier 25 and television amplifier 64. As before, the audible sound currents are transmitted through the filter 29 to the amplifier 65. The television image band, after being amplified by amplifier 64, is stepped up in frequency by modulator 80 to a frequency position well above its original position. The unmodulating component and both sidebands are then selected by filter 91 and passed to modulator 92 where they are combined with a carrier frequency which is of such value that one of the pairs of sidebands produced will be just above the audible frequency range. The modulator 92 is supplied by oscillator 97, which also is the source of carrier frequency for modulator 80, through the harmonic producer 96 and the tuned circuit 94. A filter 93 selects the lower pair of sidebands produced by the modulator 92, these sidebands being in the frequency range just above the audible frequency range as determined by the choice of a proper frequency for oscillator 97. The sidebands transmitted by filter 93 are combined with the voice band and passed through

amplifier 65 and over a common trunk T to the central office. At this point they are amplified by means of amplifier 75 and supplied over wires 31 to the program selector PS. Again in this case certain frequencies have been shown on the figure merely for purposes of illustration.

While in the arrangement illustrated in Fig. 7 the desired sidebands are produced by means of two steps of modulation, as the preferred arrangement, one step of modulation may be substituted if the frequencies are properly chosen.

Another form of the invention is illustrated in Fig. 8. In this arrangement the sound and television signals are transmitted from their source of origin over separate pickup circuits to the program center, at which point they are separately amplified and passed over separate trunks to the central office. At the central office they are individually amplified and transmitted through the necessary selecting equipment to the subscriber's loops. Two loops are associated with each subscriber and the voice signals are transmitted over one loop while the television signals are transmitted over a second loop. At the subscriber's premises these signals are separately amplified and reproduced in the form of audible sound and television images. A dial at the subscriber's station is operated to control the selection of the desired sound and television signals and to connect the trunks carrying them to the subscriber's loops.

In more detail, the audible program is picked up by the device TP, amplified through amplifier 25a and transmitted over a pickup circuit 26a to the program center at which it is amplified by amplifier 25. From this point it is transmitted over trunk 26 to the central office where it is amplified by amplifier 29 and selected by proper selecting equipment PS, similar to that already described. After passing through the selecting equipment, the voice-frequency signals are passed through transformer 39-40 and over the subscriber's loop SL to the subscriber's station. At this point, after passing through transformer 41, they are amplified by the sound amplifier 44 and transmitted to loudspeaker 45. A dial 54 at the subscriber's station controls the selecting apparatus over a simplex circuit on the subscriber's loop in a manner previously described.

The television signals, after being originated by means of the mechanism TS, are amplified through amplifier 10a and transmitted to the program center over a trunk 26a' separate from circuit 26a. At the program center, after being amplified by amplifier 10, the image signals are transmitted over trunk 26' to the central office and through appropriate selecting apparatus, working in common with the audible signal selecting apparatus to the subscriber's loop SL'. At the subscriber's station the signals are supplied through amplifier 53 to the television receiver which may be used for directly viewing the image, a suitable receiver for projecting an image upon a screen may be substituted therefor. The television circuit is selected simultaneously with the voice circuit under the control of dial 54, the switching apparatus for the television circuit being operated simultaneously with that for the voice circuit by means of stepping magnet SM in a manner already described. An additional relay 38a is included in series with relay 38 to remove the switching apparatus from the television circuit during the switching operation, and additional banks of contacts are provided to per-

mit the simultaneous switching of sound and television circuits.

The invention herein described is not confined to television images of stationary or moving objects, since by substituting a motion picture film at the television source the arrangement is suitable for the transmission of moving pictures.

The television and voice signals may be made to modulate carrier frequencies located in the frequency range above the audible range. Both voice and television modulated signals may then be superimposed upon a working telephone system without interfering in any way with the telephone conversations.

What is claimed is:

1. The method of producing carrier currents modulated with an image frequency band, having frequencies so low that when a carrier is modulated therewith the frequency separation between the two sidebands is too small to permit effective separation of the sidebands by filters, to effect substantially single sideband transmission, which comprises dividing the image band into lower and upper portions, modulating a carrier current with the lower portion of the image band to produce two sidebands and an unmodulated component of carrier frequency, effecting separate modulation with the upper portion of the image band to produce modulation products including two sidebands, the lower frequency component of the lower sideband having the same frequency as the upper limiting frequency of the upper sideband of the first modulation and with the sidebands of said separately produced modulation products so spaced that they may be selectively separated from each other, selecting from said separately produced modulation products said lower sideband, and combining said selected sideband with the modulation products of said first modulation to produce for transmission modulation products including modulated components and an unmodulated component which combine to faithfully reproduce said image current band.

2. The method of producing carrier currents modulated with an image frequency band, having frequencies so low that when a carrier is modulated therewith the frequency separation between the two sidebands is too small to permit effective separation of the sidebands by filters, to effect substantially single sideband transmission, which comprises dividing the image band into lower and upper portions, modulating a carrier current with the lower portion of the image band to produce two sidebands and an unmodulated component of carrier frequency, modulating a carrier of high frequency, compared with the first mentioned carrier, with the upper portion of the image band to produce sidebands which are readily separable by filters, selecting one of the sidebands of said high frequency modulation, combining said selected sideband with a wave of such frequency as to produce sidebands, the frequency of the lowermost component of which is that of the upper limiting component of the modulation products of said first modulation, selecting the lower of said last mentioned sidebands and combining it with the modulation products of said first modulation to produce for transmission modulation products including modulated current components and an unmodulated current component which may be combined to faithfully reproduce said image current band.

3. An apparatus for producing a carrier cur-

rent modulated with an image current band having frequencies so low that when a carrier is modulated therewith the frequency spacing between the two sidebands is too small to permit effective separation of the sidebands by filters, comprising means for separating the image band into two portions, means for modulating a carrier current with the lower portion of said image band to produce a carrier modulated current including two side bands, means for separately modulating said carrier with said upper portion of the image band to produce sidebands spaced apart so that one may be selected while the other is suppressed, means for selecting one of said sidebands and combining it with the two first mentioned sidebands to produce a modulated current of substantially the same band width as the image current and including modulated and unmodulated components which combine to faithfully reproduce said image current band, and means for supplying said combined current to a transmission circuit.

4. A combined television-sound system comprising a program center including a plurality of simultaneously operable program producing devices each having means for producing image and audible frequency currents corresponding to related sound, means for producing an image modulated wave including an unmodulated carrier component, having substantially the same frequency band width as the image current and occupying a different frequency range than the audible frequency current, a central office remote from said program center, a plurality of program trunks, equal in number to said program producing devices, connecting said program center and said central office, means for transmitting a program comprising said image modulated and associated audible currents over each of said trunks to said central office, switching means at said central office for connecting any one of said trunks to any subscriber's line of the system, and each subscriber's station including a program receiving equipment comprising means for separating said image modulated and audible frequency currents, means controlled by said modulated wave for producing an image of a subject scanned at said program center, and means for reproducing the related sound, and, in addition, means for controlling the actuation of said switching means to connect the subscriber's line at any time to a desired program trunk.

5. A combined television-sound system comprising a program center including a plurality of simultaneously operable program producing devices each having means for producing image and audible frequency currents corresponding to related sound, means for producing an image modulated wave having substantially the same frequency band width as the image current and an unmodulated carrier component combinable with the modulated components to reproduce the image current and lying in a different frequency range than the audible frequency current, a central office remote from said program center, a plurality of program trunks, equal in number to said program producing devices, connecting said program center and said central office, means for transmitting a program comprising said image modulated and associated audible currents over each of said trunks to said central office, switching means at said central office for connecting any one of said trunks to any subscriber's line of the system, and each subscriber's station comprising a program receiving equip-

ment including means for separating said image modulated and audible frequency currents, means controlled by the modulated and unmodulated components of said modulated wave to produce said image current, image producing means supplied with said image current, and sound producing means supplied with said audible frequency currents, and, in addition, means for controlling the actuation of said switching means to connect a subscriber's line to a desired program trunk.

6. In a system for distributing programs each comprising television and related sound signals, a central office, means, remote from said central office and including transmission paths equal in number to the number of said programs, for supplying a plurality of different programs thereto, circuits extending from said central office to a plurality of subscribers' stations respectively, switching means located at said central office for controlling the application of any of said programs to any of said subscribers' circuits at any time, means at each subscriber's station for controlling the actuation of said switching means, and means at each subscriber's station for reproducing a sound program and a television program.

7. In a system for distributing sound and television programs, a plurality of lines terminating at subscribers' stations respectively, a plurality of program trunks, equal in number to the number of said programs, over which program transmission is effected, switching means remote from the sources of said programs, for connecting any of said lines to any of said trunks at any time, and means at each subscriber's station for controlling the actuation of said switching means to connect his line to a program trunk carrying a desired combined television and sound program.

8. A system for distributing television programs which comprises a plurality of sources of television signals, transmission circuits extending from said sources to a central distributing station, means for amplifying the television signals at said central distributing station, trunks, equal in number to the number of said programs, extending from said central distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying said programs to the trunks respectively individual to each of said intermediate distributing stations, means at each intermediate station for amplifying the television signals, circuits extending from each intermediate station to a plurality of subscribers' stations, and means at each subscriber's station for reproducing a television image.

9. A system for distributing television programs which comprises a plurality of sources of television signals, transmission circuits extending from said sources to a main distributing station, means for amplifying the television signals at said main distributing station, trunks, equal in number to the number of said programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying said programs to the trunks respectively individual to each of said intermediate distributing stations, means at each intermediate station for amplifying the television signals, circuits extending from each intermediate station to a plurality of subscribers' stations, means at each subscriber's station for reproducing a television image, and means under the control of each subscriber whereby his line may be

switched to select any one of said television programs.

10. A system for distributing television programs which comprises a plurality of sources of television signals, transmission circuits extending from said sources to a main distributing station, means for amplifying the television signals at said main distributing station, trunks, equal in number to the number of said programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying said programs to the trunks respectively individual to each of said intermediate distributing stations, means at each intermediate station for amplifying the television signals, circuits extending from each intermediate station to a plurality of subscribers' stations, switching means located at each intermediate distributing station by which each subscriber's circuit may be connected to a desired television program, means at each subscriber's station whereby said switching means may be actuated, and means at each subscriber's station for reproducing a television image.

11. A system for distributing sound and television programs which comprises sources of sound signals and of television signals, circuits extending from said sources to a main distributing station, means for amplifying the television signals and the sound signals at said main distributing station, trunks, equal in number to the number of said programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying said programs to the trunks respectively individual to each of said intermediate stations, means at each intermediate distributing station for amplifying the television signals and the sound signals, circuits extending from each intermediate distributing station to a plurality of subscribers' stations, and means at each subscriber's station for reproducing a sound program and a television program.

12. A system for distributing sound and television programs which comprises sources of sound signals and of television signals, circuits extending from said sources to a main distributing station, means for amplifying the television signals and the sound signals at said main distributing station, trunks, equal in number to the number of said programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying said programs to the trunks respectively individual to each of said intermediate stations, means at each intermediate distributing station for amplifying the television signals and the sound signals, circuits extending from each intermediate distributing station to a plurality of subscribers' stations, means at each subscriber's station for reproducing a sound program and a television program, and means under the control of the subscriber for selecting a television and associated sound program.

13. A system for distributing sound and television programs which comprises sources of sound signals and of television signals, circuits extending from the respective sources to a main distributing station, means at said main distributing station for separately amplifying the sound signals and the television signals, means at said main distributing station for shifting the tele-

vision signals to a frequency range above that of the sound signals, trunks, equal in number to the number of programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying said programs to the trunks respectively individual to each of said intermediate stations, means at each intermediate distributing station for separately amplifying the television signals and the sound signals, means at each intermediate distributing station for associating each set of television signals with a corresponding set of sound signals in a common circuit, circuits extending from each intermediate distributing station to a plurality of subscribers' stations, and means at each subscriber's station for reproducing a sound program and a television program.

14. A system for distributing sound and television programs which comprises sources of sound signals and of television signals, circuits extending from the respective sources to a main distributing station, means at said main distributing station for separately amplifying the sound signals and the television signals, means at said main distributing station for shifting the television signals to a frequency range above that of the sound signals, trunks, equal in number to the number of programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying said programs to the trunks respectively individual to each of said intermediate stations, means at each intermediate distributing station for separately amplifying the television signals and the sound signals, means at each intermediate distributing station for associating each set of television signals with a set of sound signals in a common circuit, circuits extending from each intermediate distributing station to a plurality of subscribers' stations, means at each subscriber's station for reproducing a sound program and a television program, and switching means under the control of the subscriber for automatically selecting a particular television and associated sound program for his station.

15. The method of transmitting a band of television signals extending from substantially zero frequency to some upper limiting frequency which consists in dividing the television band into two parts, transmitting the lower of said parts as a double sideband of a carrier frequency, and transmitting the upper of said parts as a single sideband of the same carrier frequency.

16. The method of transmitting a band of television signals extending from substantially zero frequency to some upper limiting frequency which consists in dividing the television band into two parts, passing the lower of said parts through a single stage of modulation and transmitting this part as a double sideband of a carrier frequency, passing the upper of said parts through two stages of modulation and transmitting this part as a single sideband of the same carrier frequency.

17. In a system for distributing sound and television programs, a plurality of sources of television and sound currents, a central distributing point, a plurality of subscribers' stations, means for transmitting the television currents in their original frequency position to said central distributing point, means for transforming the television currents to a higher frequency position and

for transmitting them from the central distributing point to the subscribers' stations, and means for transmitting the sound currents from said sound sources to the subscribers' stations without change of frequency position.

18. In a system for distributing sound and television programs, a plurality of sources of television and sound currents, a central distributing point remote from said sources, a plurality of subscribers' stations, means for separately transmitting the sound currents and the television currents from said sources respectively to the central distributing point, means at said central distributing point for associating the respective television and related sound currents to constitute a plurality of different programs, and means for connecting said subscribers' stations so that any of said programs may be transmitted from said central distributing point to any of said subscribers' stations.

19. A system for distributing associated sound and television programs which comprises sources of sound signals and sources of television signals, circuits extending from each of said sources of sound signals to a main distributing station, separate circuits extending from each of said sources of television signals to said main distributing station, means for amplifying separately the sound signals and the television signals at said main distributing station, separate trunks for each of the sound and each of the television signals extending from said main distributing station to each of a plurality of intermediate distributing stations, means at each intermediate distributing station for separately amplifying the sound signals and the television signals, a separate circuit for the sound signals and a separate circuit for the television signals extending from each intermediate distributing station to each of a plurality of subscribers' stations, means at each subscriber's station for reproducing a sound program and a television program, and means under the control of the subscriber for, at all times, automatically and simultaneously selecting any one of said television and associated sound programs.

20. A system for distributing television programs which comprises a plurality of sources of television signals, transmission circuits extending from said sources to a main distributing station, means for amplifying the television signals at said main distributing station, trunks, equal in number to the number of said programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main distributing station for simultaneously supplying each program to associated trunks respectively individual to said intermediate stations, means at each intermediate station for amplifying the television signals, circuits extending from each intermediate station to a plurality of subscribers' stations, switching means located at each intermediate distributing station by which each subscriber's circuit may be connected to a desired television program, means at each subscriber's station whereby said switching means may be actuated at any time to effect the connection of his circuit to a desired television program.

21. A system for distributing sound and television programs which comprises sources of sound signals and of television signals, circuits extending from said sources to a main distributing station, means for amplifying the television signals and the sound signals at said main distributing station, trunks, equal in number to the number of said programs, extending from said main distrib-

uting station to each of a plurality of distributing stations, means at said main distributing station for simultaneously supplying each program to associated trunks connected to the respective intermediate distributing stations, means at each intermediate distributing station for amplifying the television signals and the sound signals, circuits extending from each intermediate distributing station to a plurality of subscribers' stations, means at each subscriber's station for reproducing a sound program and a television program, and means under the control of the subscriber for selecting at any time one of said television and associated sound programs.

22. A system for distributing sound and television programs which comprises sources of sound signals and of television signals, circuits extending from said sources to a main distributing station, means at said main distributing station for separately amplifying the sound signals and the television signals, means at said main distributing station for shifting the television signals to a frequency range above that of the sound signals, trunks, equal in number to the number of said programs, extending from said main distributing station to each of a plurality of intermediate distributing stations, means at said main transmission stations for simultaneously supplying the respective programs to a plurality of trunks each extending to one of said intermediate distributing stations, means at each intermediate distributing station for separately amplifying the television signals and the sound signals, means at each intermediate distributing station for associating each set of television signals with a set of sound signals in a common circuit, circuits extending from each intermediate distributing station to a plurality of subscribers' stations, means at each subscriber's station for reproducing a sound program and a television program, and switching means under the control of the subscriber for automatically selecting a particular television program and associated sound for his station at any time.

23. A system for distributing associated sound and television programs which comprises sources of sound signals and sources of television signals, circuits extending from said sources of sound signals to a main distributing station, separate circuits extending from said sources of television signals to said main distributing station, means for amplifying separately the sound signals and the television signals at said main distributing station, separate trunks for the sound and television signals extending from said main distributing station to each of a plurality of intermediate distributing stations, means at the main distributing station for simultaneously supplying the respective television signals to a plurality of trunks respectively extending to said intermediate distributing stations and the respective sound signals to a plurality of trunks respectively extending to said intermediate distributing stations, means at each intermediate distributing station for separately amplifying the sound signals and the television signals, separate circuits for the sound signals and the television signals extending from each intermediate distributing station to a plurality of subscribers' stations, means at each subscriber's station for reproducing a sound program and a television program, and means under the control of the subscriber for automatically and simultaneously selecting a particular television and associated sound program at any time.

24. Means for utilizing an image current to control the production of an image modulated carrier wave extending over a continuous frequency band comprising means for splitting the
5 image current into a plurality of portions, means controlled by one of said portions for producing a group of modulation products extending from a lower limiting frequency to an upper limiting frequency, means controlled by another portion
10 for producing a group of modulation products extending from a lower limiting frequency, which is the same as the upper limiting frequency of said first group of modulation products, to an upper limiting frequency, and means for combining
15 said first and second groups of modulation products.

25. Means for utilizing current representing a single communication and including current variations extending over a wide frequency range
20 to control the production of a signal modulated carrier wave extending continuously over a section of the frequency spectrum comprising means for splitting the signal band into a plurality of portions, means controlled by one of said portions
25 for producing a group of modulation products extending from a lower limiting frequency to an upper limiting frequency, means controlled by another portion for producing a group of

modulation products extending from a lower limiting frequency, which is the same as the upper limiting frequency of said first modulation products, to an upper limiting frequency, and means for combining said groups of modulation
5 products.

26. Means for utilizing an image current to control the production of an image modulated carrier wave extending over a continuous portion of the frequency spectrum which is substantially the same as the frequency range of
10 the image current comprising means for splitting the image current into a plurality of portions, the frequency range of one of said portions being small, means controlled by said
15 smaller portion of the image current for producing a group of modulation products including two side-bands, the upper limiting frequency of which has a predetermined value, means controlled by another portion of the image current
20 for producing a group of modulation products comprising a single side-band and having a lower limiting frequency of the same value as the upper predetermined frequency of the first group
25 of modulation products, and means for combining said first and second groups of modulation products.

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