

July 28, 1936.

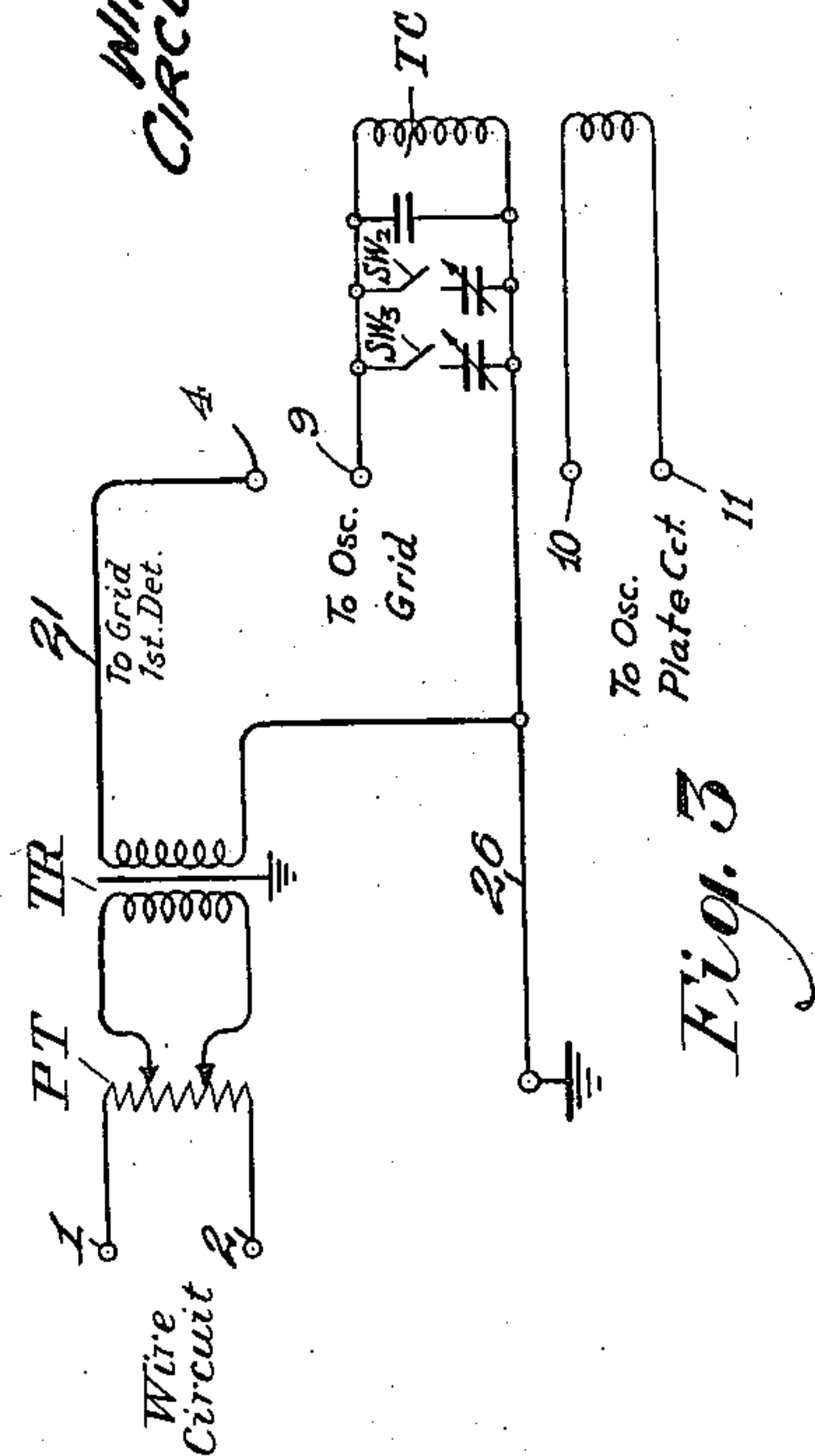
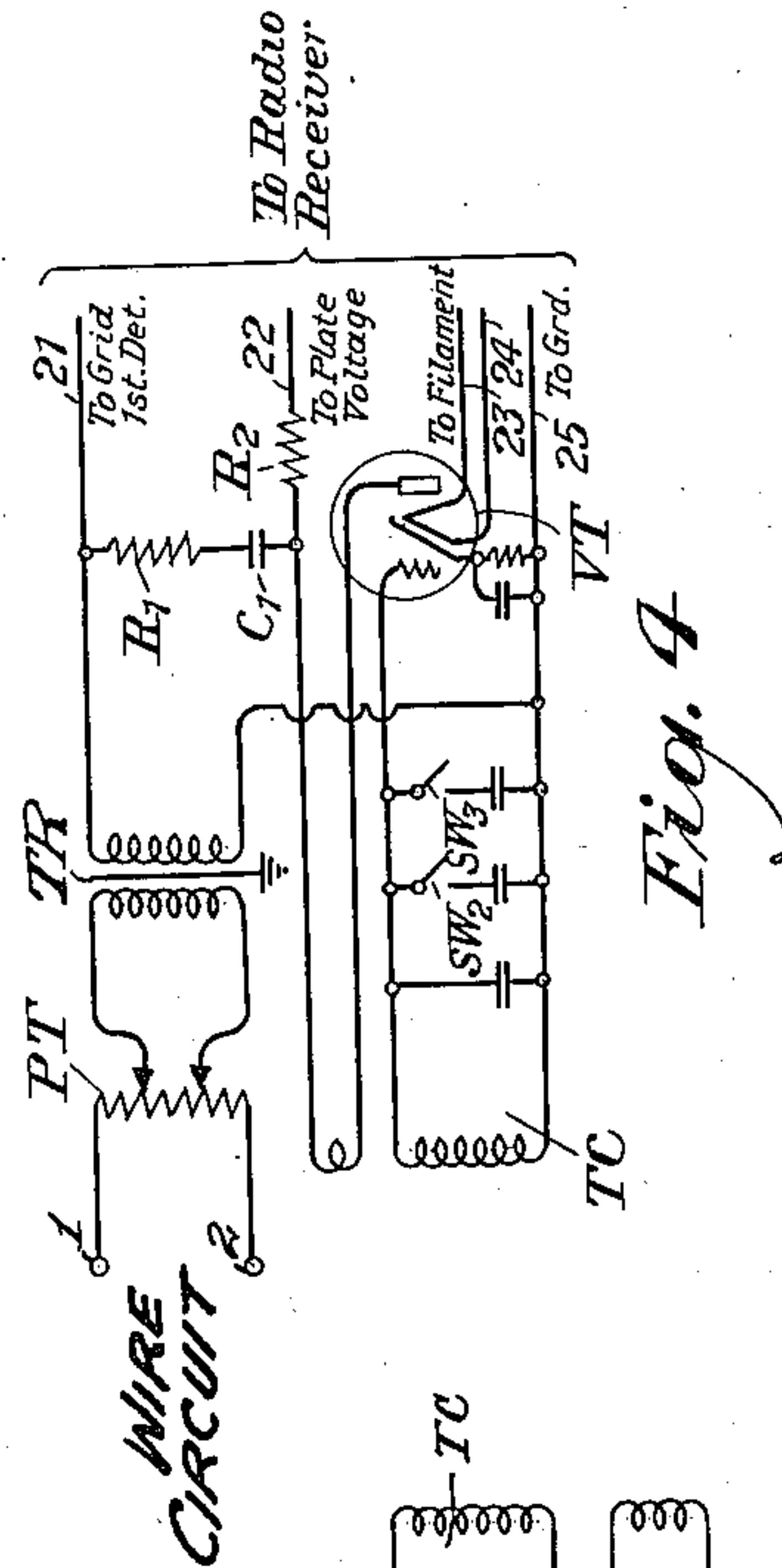
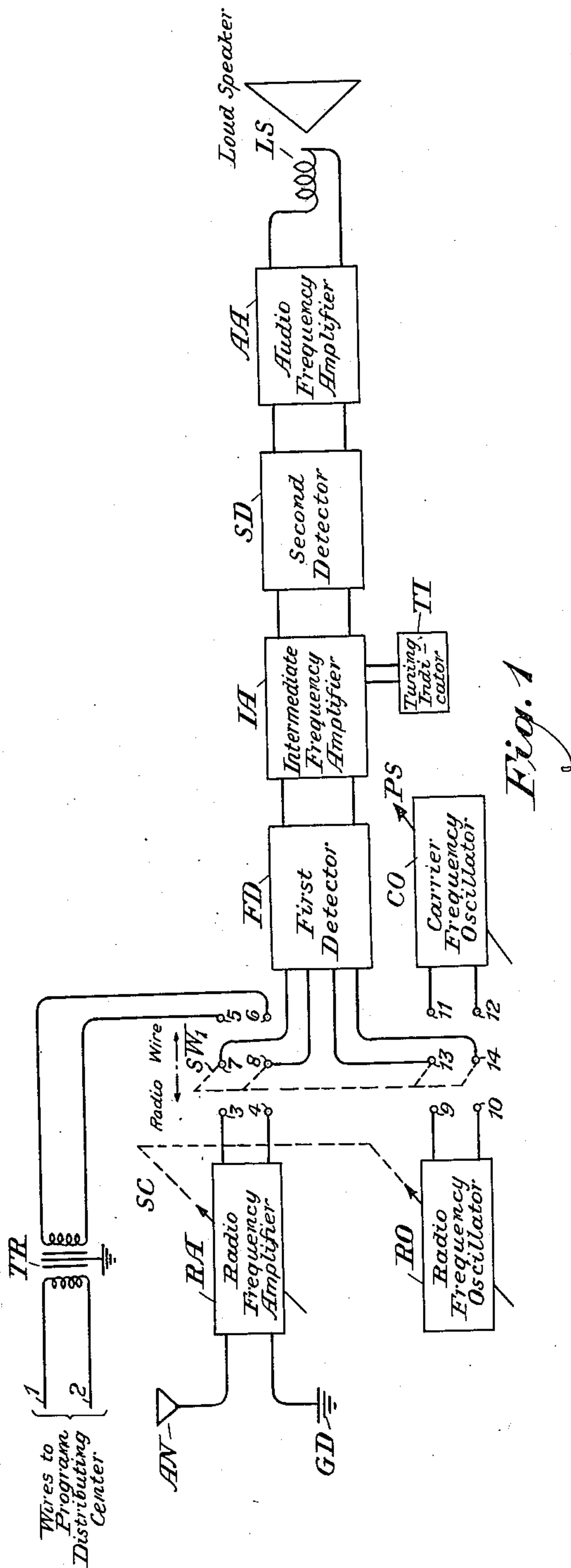
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2,048,828

RADIO AND WIRE BROADCASTING SYSTEM

Filed May 20, 1933

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

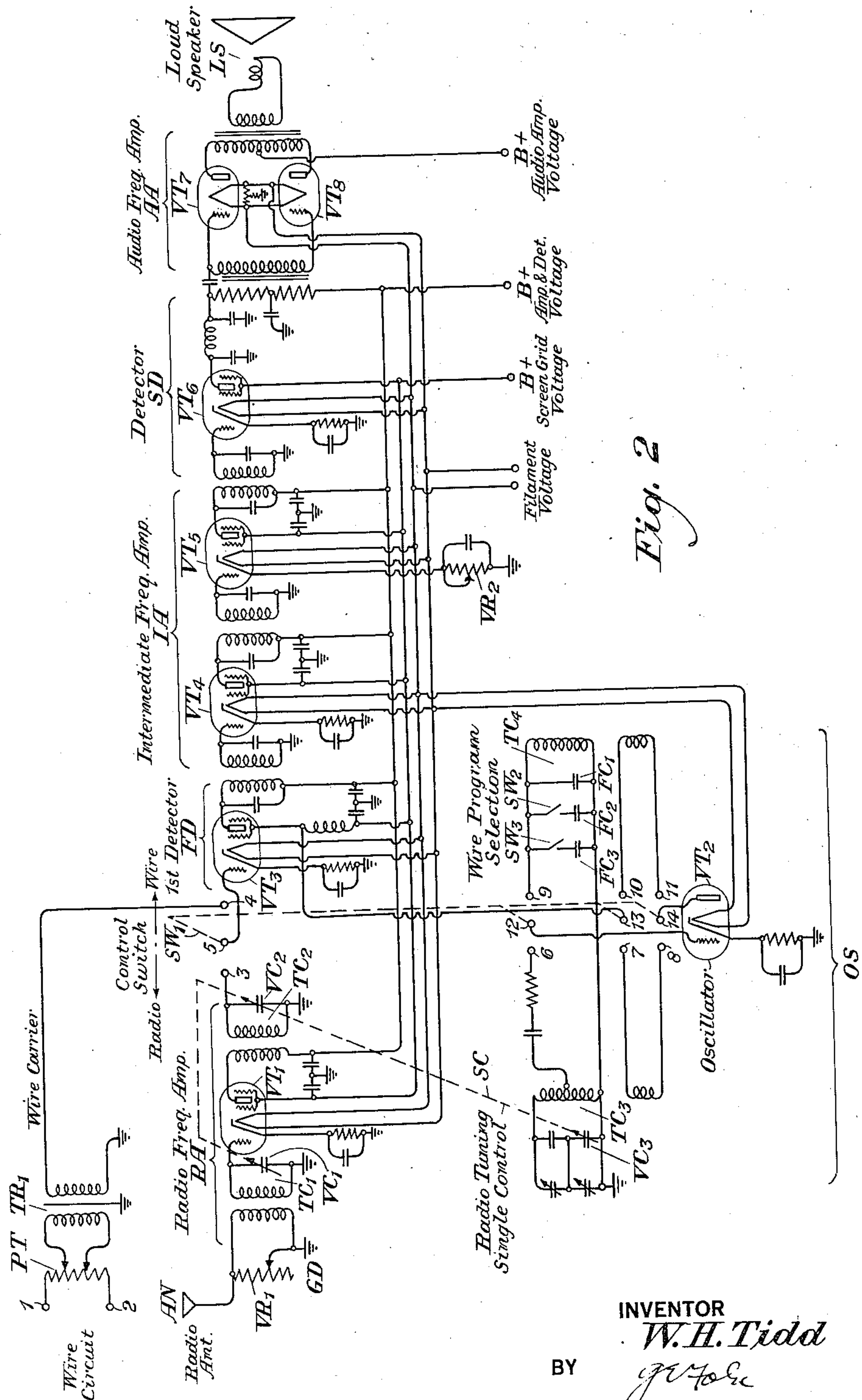


Fig. 2

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3 Sheets-Sheet 3

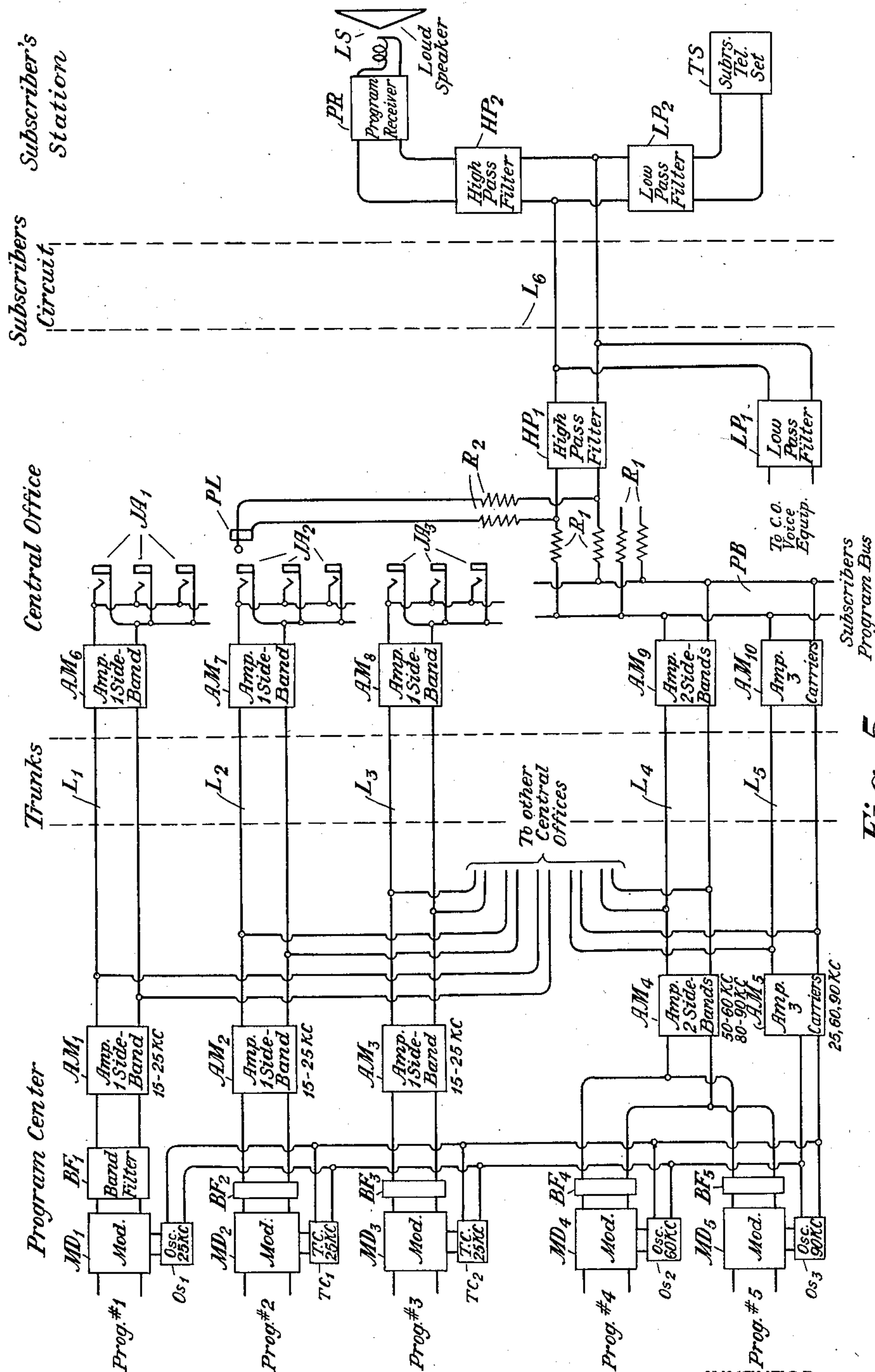


Fig. 5

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RADIO AND WIRE BROADCASTING
SYSTEM

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Application May 20, 1933, Serial No. 672,077

18 Claims. (Cl. 179—2.5)

This invention relates to radio broadcast and wire distributing systems, and more particularly to a receiver having common amplifying and frequency translating circuits for the reception of both wire transmitted and radio broadcast programs.

The distribution of programs for entertainment or instruction by means of radio broadcasting has become well established. Systems have also been developed for distributing programs by means of wire circuits, such as those employed for telephone service or power distribution. With the further development of these latter systems and particularly systems using carrier frequencies for the transmission of program material over wire circuits, it will be desirable to have a receiver capable of receiving programs distributed by either radio or wire systems. Such an arrangement avoids the duplication of apparatus which would occur if separate receivers were used for the reception of programs distributed by the two systems. It is, therefore, a purpose of this invention to provide a receiver of the superheterodyne type which is capable of receiving both radio programs and programs transmitted over wire circuits at carrier frequencies, said receiver having amplifying, frequency translating and sound reproducing apparatus common to both the radio and the wire circuits. The superheterodyne receiver is the type most generally used at the present time for the reception of radio programs. In accordance with the principles of the invention there may be incorporated in such receivers apparatus to enable them to receive also carrier frequency wire programs.

Another object of the invention is to eliminate filters or other selecting apparatus usually associated with a wire program receiver for selecting a band of frequencies representing a single program, using for this purpose instead the filter circuits associated with a radio receiver of the superheterodyne type.

Still another object of the invention is the provision of a high quality wire program channel utilizing for reception apparatus associated with radio broadcast receivers of the superheterodyne type.

It is also an object of this invention to provide a radio receiver of the superheterodyne type which receives only a carrier frequency and single sideband.

In the patent to Espenschied and Fetter, No. 1,853,117, which also relates to a system for the reception of space and wired radio programs,

there is disclosed an arrangement (Fig. 3) in which the band of frequencies passed by the intermediate frequency amplifier is wide enough to admit any of the carrier-frequency wire program channels as well as the translated radio-frequency signals. This necessitates that all of the selectivity for radio reception must be included in the radio-frequency amplifier. Also filters are used to select the carrier-frequency wire programs before impressing them on the intermediate frequency amplifier. In the present invention an intermediate frequency amplifier is contemplated which passes a band of frequencies only wide enough to accept a single program channel, either wire or radio, the program frequencies being suitably translated to this band. In this way the adjacent channel selectivity is entirely accomplished by the intermediate frequency amplifier, for either wire or the radio reception. The radio-frequency amplifier, therefore, need only suppress so-called image interference, a much less severe requirement. Also no filters are necessary for selecting the wire programs.

These as well as other objects and features of the invention will now be apparent from the following description when read in connection with the accompanying diagrams, of which Figure 1 shows an arrangement of apparatus for a receiver of the superheterodyne type capable of receiving both radio broadcast and wire distributed programs, and Fig. 2 shows in greater detail a circuit arrangement which might be employed for such a receiver; Figs. 3 and 4 illustrate adapters or converters which might be connected to a radio receiver to permit the reception of wired radio programs; Fig. 5 shows an arrangement which might be used for distributing programs over wire circuits at carrier frequencies, in which alternative programs are available in lieu of those already on a subscriber's circuit, and with which a combined radio and wire program receiver of the superheterodyne type might be used.

Fig. 1 shows an antenna AN and ground GD for intercepting radio signals from a transmitting station. Also, two wires, 1 and 2, are shown which may be any type of wire circuit over which carrier-frequency signals are received from some program distributing point. A switch SW is provided to connect the apparatus for reception of either the radio or the wire program. When switch SW is closed to the left, radio programs may be received, and when closed to the right, the carrier-frequency wire programs may be heard.

With the switch SW closed to the left, the oper-

ation of the system is as follows: Radio signals are intercepted by means of the antenna AN and the ground GD. These signals are selectively amplified in the radio-frequency amplifier RA and passed to the first detector or modulator FD by means of contacts 3, 4, 7 and 8 of the switch SW. A radio-frequency oscillator RO generates a single frequency which is introduced to the first detector FD by contacts 9, 10, 13 and 14 of the switch SW. This frequency is adjustable and may be made to differ from the frequency of the incoming radio carrier by an amount equal to the frequency to which the intermediate frequency amplifier is tuned, so that the band of incoming radio frequencies representing the desired program may be translated in frequency to the band passed by the intermediate frequency amplifier IA. A single control SC varies the frequency generated by the radio-frequency oscillator RO and the tuning of the selective circuits in the radio-frequency amplifier RA so that the desired program may be selected.

With the switch SW in Fig. 1 closed to the right the carrier frequencies from the wire line 1, 2 are passed by the transformer TR to the first detector FD by contacts 5, 6, 7 and 8 of the switch SW. Contacts 11, 12, 13 and 14 pass a signal generated by the carrier-frequency oscillator CO to the modulator FD. The frequency of this signal differs from that of the incoming wire carrier by such an amount that a frequency band representing a carrier-frequency program may be translated in frequency so that it will be transmitted and amplified by the intermediate frequency amplifier IA. A program selector PS varies the frequency generated by the carrier oscillator CO so that any of the wire programs may be selected.

In the modulator or first detector FD the incoming signal frequencies from either the antenna AN and radio-frequency amplifier RA or the wire line 1, 2 are intermodulated with the beat frequency from either the radio-frequency oscillator RO or the carrier-frequency oscillator CO, respectively. This effectively translates the band of frequencies representing the desired program, whether radio broadcast or wire transmitted, to the frequency band accepted by the intermediate frequency amplifier IA. The intermediate frequency amplifier IA contains tuned circuits which are adjusted to pass a fixed band of frequencies just wide enough to accept a single program, and to reject all other frequencies. This amplifier IA selects from the modulation products produced in the first detector FD a single band of frequencies which represents, in the case of radio reception, the two sidebands and carrier frequency translated to the intermediate frequency band and in the case of wire program reception, the carrier frequency and either one or two sidebands, also translated in frequency to the same intermediate frequency band. Sufficient discrimination is provided in the intermediate frequency amplifier IA to prevent any undesired signals from being amplified, so that a single program may be received from either the wire program distributing center or the radio broadcasting station without interference from adjacent frequencies.

A tuning indicator TI is shown connected to the intermediate frequency amplifier. This is to indicate to the person operating the receiver the position of the selection controls for optimum reception. This comprises chiefly a sharply selective tuned circuit, possibly including a piezoelectric resonator, a rectifier which may be a

vacuum tube or some passive device, and a visual indicator, such as a meter or variable light source. The resonant frequency of this tuned circuit is that frequency in the intermediate frequency band to which the carrier frequency of the received program signals should be translated for optimum reception. When the tuning controls have been adjusted so that the translated carrier frequency equals the resonant frequency of the tuned circuit, some of this frequency is diverted. This portion of the carrier is rectified and utilized to actuate the meter or other indicating device.

The demodulator or second detector SD in Fig. 1 demodulates the signals which have been amplified in the intermediate frequency amplifier IA and delivers the resulting audible frequencies to the audio-frequency amplifier AA. These are further amplified and delivered to a sound reproducer which may be the loudspeaker LS shown in Fig. 1.

In the usual receiver of this type the intermediate frequency amplifier will pass a band of frequencies about 10 kilocycles wide. If two sidebands are received the maximum audible modulating frequency is limited to 5 kilocycles. However, in accordance with the invention it is proposed to translate the incoming frequencies from the wire line so that only the carrier and a single sideband occupy the band passed by the intermediate frequency amplifier. In this way a modulating frequency of the wire program as high as 10 kilocycles may be received.

Fig. 2 shows in greater detail a possible circuit arrangement which might be employed for a receiver of the type described in connection with Fig. 1. The radio signals from a broadcasting station are intercepted by the antenna AN and ground GD. A variable resistance VR_1 may be shunted across the input transformer of the radio-frequency amplifier RA to control the strength of the signal applied to it. This amplifier RA is tuned by means of tuned circuits TC_1 and TC_2 to discriminate in favor of signals corresponding to the desired program. Amplification of these signals is accomplished by means of vacuum tube VT_1 with its associated circuits. The radio-frequency amplifier may be of any suitable type and may comprise more than the one vacuum tube shown.

The switch SW_1 is closed to the left when radio reception is desired. Contacts 3 and 5 of SW_1 transmit the amplified radio signals from RA to the grid of vacuum tube VT_3 in the first detector FD. These signals comprise frequencies corresponding to the desired program and other relatively attenuated frequencies which were intercepted by the antenna AN. Contacts 6 and 12, 7 and 13, 8 and 14 of the switch SW_1 connect the local oscillator circuit OS so that it can generate a range of frequencies suitable for translating bands of signals, representing radio-frequency programs, to the band passed by the intermediate frequency amplifier IA. The beat frequency is adjusted by the control SC which varies the value of variable condenser VC_3 in the tuned circuit TC_3 of the oscillator OS. This control also adjusts the frequency band to which the radio-frequency amplifier RA is tuned by simultaneously varying condensers VC_1 and VC_2 . The band to which the amplifier RA is tuned bears a fixed relation to the frequency generated by the local oscillator, such that said band is translated in frequency to the band passed by the intermediate frequency amplifier by intermodulation with said locally generated frequency.

The modulator FD is shown as a vacuum tube VT₃ which is so operated that it performs as a second order modulator. Instead of a vacuum tube any suitable type of modulator might be used, such as the cuprous oxide or thyrite units. The radio frequencies representing the desired program and other radio frequencies somewhat attenuated present on the control grid of vacuum tube VT₃ are intermodulated with the signal from the local oscillator OS, which is applied to the screen grid. The output of the first detector FD contains principally, therefore, the sum and difference of the locally generated frequency with the received radio frequencies.

The intermediate frequency amplifier is essentially a high-gain amplifier with a band-pass characteristic, cutting off unwanted frequencies very sharply. As shown in Fig. 2, the intermediate frequency amplifier IA comprises two vacuum tubes of the screen-grid type, VT₄ and VT₅, coupled by tuned transformers. The tuning of these circuits may be so adjusted that the desired band-pass characteristic will be obtained. This amplifier may, of course, have any number of stages of amplification and employ any of several well-known circuit arrangements. The grid bias of the tubes in this amplifier is adjustable by varying the resistance VR₂, which alters the gain of the amplifier. Thus, resistance VR₂ may be used in conjunction with VR₁ across the input to control the volume level of the audible-frequency output. These may be adjusted by a single external control if desired.

The demodulator or second detector SD comprising the vacuum tube VT₆ may be of any suitable type and the circuit arrangements are well known in the art. The function of the detector is to demodulate the signals passed by the intermediate frequency amplifier IA and deliver to the audio-frequency amplifier AA the resulting frequencies in the audible range. The D. C. component of the rectified current from the second detector SD may be utilized to control the gain of some other part of the receiver, usually the intermediate frequency amplifier IA, so that the volume level of the output is independent of the magnitude of the incoming carrier.

The low frequencies produced in the second detector SD are further amplified by the audio-frequency amplifier AA to a suitable level and impressed on the sound reproducing unit or loudspeaker LS.

The circuit arrangement for the reception of wire programs is substantially the same. Signals coming over the wires 1, 2 from the central distributing point are impressed on the potentiometer PT which controls the signal voltage applied to the first detector FD through the transformer TR₁. Switch SW₁ is, of course, closed to the right, and contacts 4 and 5 connect the wire program signals to the grid of vacuum tube VT₃. Contacts 9 and 12, 10 and 13, 11 and 14 connect tuned circuit TC₄ into the oscillator circuit. The frequency generated by VT₂ in the oscillator OS is now controlled by this tuned circuit TC₄. Switches SW₂ and SW₃ change its resonant frequency by adding condensers FC₂ and FC₃ to FC₁. These three frequencies must bear such a relation to the frequency bands representing the three programs, which are assumed present in the wire circuit, that these latter may be translated in frequency by intermodulation to the band passed by the intermediate frequency amplifier. Any number of programs may, of course, be transmitted, and the tuned circuit TC₄ must be capable

of producing a corresponding number of frequencies.

The program signals are intermodulated in FD with the frequency generated in the local oscillator OS. As in the case of radio reception, the intermediate frequency amplifier IA selects and amplifies the frequency band corresponding to the desired program, produced in FD by the intermodulation of the carrier frequencies from line 1, 2 with the signal from the local oscillator OS.

The operation of the receiver for the reception of both radio and wire programs will now be explained using definite frequencies for purposes of illustration. The frequency band between 550 and 1500 kilocycles is at present used for radio broadcasting. The carrier frequencies of broadcasting stations are allocated at 10-kc. intervals, allowing a theoretical maximum modulating frequency of 5 kilocycles. An intermediate frequency, that is, the mid-band frequency of the intermediate frequency amplifier, IA in Fig. 2, of 175 kilocycles, will be assumed. This means that the intermediate frequency amplifier IA should pass a band of frequencies from 170 to 180 kilocycles, attenuating considerable frequencies outside of this band. The frequency generated by the local oscillator OS for radio reception must be such that it will change the frequency of the incoming program to pass the intermediate frequency amplifier. If the frequency generated by the local oscillator OS is always kept higher than the radio signals being received, the resonant frequency of TC₃ must be variable between 725 and 1675 kilocycles.

In order to receive a radio broadcast program on a carrier frequency of 1000 kilocycles, for instance, the tuned circuits TC₁ and TC₂ must be adjusted so that the radio-frequency amplifier RA discriminates in favor of the band of frequencies between 995 and 1005 kilocycles. Tuned circuit TC₃ must be tuned so that the local oscillator OS will at the same time generate a frequency of 1175 kilocycles. In the first detector FD, which will be assumed a second order device, the frequencies from the radio-frequency amplifier will be intermodulated with the frequency of 1175 kilocycles from the local oscillator. The desired program will be represented by two frequency bands—one, 2170 to 2180 kilocycles, and the other, 170 to 180 kilocycles. Obviously, the higher frequency band will be excluded by the intermediate frequency amplifier IA, as will be products of the modulation other than the 170 to 180-kc. band which now represents the desired program. This consists of a carrier frequency of 175 kilocycles, and the original modulating frequencies up to 5 kilocycles represented as sidebands. This band of frequencies is further selected and amplified in the intermediate frequency amplifier IA, demodulated in SD and the resulting low frequencies amplified and reproduced by the loudspeaker LS.

In the carrier-frequency program system carrier frequencies of 25, 60 and 90 kilocycles will be assumed with only the lower sidebands present. If it is desired to locate the carrier frequency in the center of the band passed by the intermediate frequency amplifier IA, the local oscillator OS should generate frequencies of 200, 235 and 265 kilocycles, respectively. However, in order to obtain a better quality program it is proposed in this invention to adjust tuned circuit TC₄ to frequencies of 195, 230 and 260 kilocycles, respectively. This would place the translated carrier frequencies at one side of the frequency

band passed by IA, that is, at 170 kilocycles. The sideband could now extend from 170 to 180 kilocycles. Thus the highest modulating frequency that could be received would be 10 kilocycles. In order to effectively accomplish this result the frequency characteristic of the intermediate frequency amplifier IA must be quite flat in the passed band. Also, the audio system and sound reproducer must be capable of responding to frequencies up to 10 kilocycles. In this way a program band 10 kilocycles wide may be handled without any major changes in the design of the intermediate frequency amplifier, as it is used in many present day radio receivers.

With a receiver of this type it might also be desirable to improve the quality of received radio programs. Radio broadcasting stations could be equipped to transmit a band of program frequencies up to 8 or 10 kilocycles; in fact many transmitters are so equipped already. In order to receive such high quality transmissions with a receiver such as has been described, it will be necessary to receive only a single side band and carrier, rather than both sidebands as has been customary heretofore. The frequency band favored by the radio-frequency amplifier, RA in Fig. 1, is theoretically at least 10 kilocycles wide and should accept the radio carrier and one 10-kc. sideband. Its frequency response should be quite uniform over the 10-kc. band, to avoid distortion. The frequency generated by the local oscillator, RO in Fig. 1, will now be changed by 5 kilocycles since the tuning and oscillator controls are coupled together. This will place the translated radio carrier at one edge of the frequency band passed by the intermediate frequency amplifier, and one sideband, 10 kilocycles wide, will be accepted and amplified by it.

In order to indicate when the tuning controls are properly set to enable reception of a single sideband in the manner just described a special sharply tuned circuit may be connected to some point in the intermediate frequency amplifier. This circuit might include a piezo-electric resonator to improve the sharpness of tuning. The resonant frequency of this tuned circuit would be that frequency in the intermediate frequency band to which the radio carrier frequency should be translated for reception in the manner desired.

To illustrate the reception of a single sideband a radio broadcasting station having a carrier frequency of 1000 kilocycles will again be assumed. However, the side-bands will now extend from 990 to 1010 kilocycles, since modulating frequencies up to 10 kilocycles are assumed. The intermediate frequency amplifier will be assumed to pass the frequency band from 170 to 180 kilocycles. In order to receive the lower sideband, 990-1000 kilocycles, the radio-frequency amplifier must be tuned to this band, and the beat frequency oscillator must at the same time generate a frequency of 1170 kilocycles. Thus, by intermodulation, the radio carrier would be translated to 170 kilocycles and the lower sideband to the 170-180-kc. band passed by the intermediate frequency amplifier. The upper sideband, 1000-1010 kilocycles, would be translated to 170-180 kilocycles, and this band would be rejected by the intermediate frequency amplifier. The resonant circuit in the tuning indicator would be tuned to 170 kilocycles, so that when the carrier is translated to this frequency, proper tuning will be indicated.

In order to receive the upper sideband of the radio-frequency transmission, 1000-1010 kilocycles, the local oscillator must generate 1180

kilocycles. The radio carrier frequency will now be translated to 180 kilocycles, and the sideband to the 180-170-kc. band. The unwanted side band, 990-1000 kilocycles, will be translated to 180-190 kilocycles and will thus be eliminated. The tuning indicator will be adjusted to 180 kilocycles.

In accordance with the present invention a radio receiver of the superheterodyne type may be adapted so that it will also receive carrier frequency programs transmitted by wire, by the use of an adapter such as is shown in Fig. 3. Two terminals, 1 and 2, are provided to which the wire circuit transmitting the carrier frequency programs is connected. The potentiometer PT for volume control is connected to these terminals. A transformer TR similar to that in Fig. 2 is included. From this transformer one wire 21 transmits the carrier-frequencies to the grid of the modulator of the first detector of the radio set, the connection including the contacts of a switch, as in Fig. 2, by which the radio program circuit could be, at that time, disconnected from the said grid. Another wire 26 completes the circuit to the ground of the radio receiver.

The tuned circuit TC of the beat frequency oscillator for wire program reception is shown the same as that in Fig. 2 and proper connections are made through contacts 9, 10 and 11 of a suitable switching arrangement to the grid and plate circuits of the vacuum tube in the radio receiver local oscillator, the radio frequency tuning circuits being disconnected at that instant. The switching arrangement could be similar to the switch SW₁ in Fig. 2 inserted in the circuits of the radio receiver to accomplish the changeover from radio reception to wire program reception.

Another possible arrangement for adapting a superheterodyne radio receiver for the reception of carrier frequency wire programs is shown in Fig. 4. This adapter includes a vacuum tube VT to generate the beat frequency instead of utilizing the one associated with the radio receiver. The tuned circuit TC for determining the three beat frequencies is the same as shown in Figs. 2 and 3. Filament and plate voltages are supplied by the radio receiver by means of wires 23, 24 and 22. A resistance R₂ is connected in the plate supply lead to prevent the possible short circuiting of the local oscillator output. As in Fig. 3 the wire circuit is connected to the terminals 1, 2 of the input circuit which includes the potentiometer PT and the transformer TR. The incoming carrier frequencies and the local oscillator beat frequency are impressed on the grid of the first detector by means of lead 21. A lead 25 provides a connection to the receiver ground. A condenser C₁ is provided to exclude the plate voltage from the grid circuit. A resistance R₁ is inserted to regulate the amplitude of the beat frequency. Only one switch contact is necessary with this arrangement to connect the grid of the first detector to either the radio-frequency input and radio-frequency beat oscillator or the carrier frequency program adapter.

Other arrangements similar to those shown in Figs. 3 and 4 are obviously possible and are included in the scope of the invention. Such arrangements should make it possible to adapt most of the existing radio receivers of the superheterodyne type for reception of carrier frequency wire programs. In many cases the small amount of apparatus necessary for adapters of the type shown in Figs. 3 and 4 could be mounted within the cabinet of the radio receiver. How-

ever, this apparatus could be mounted separately if necessary.

The operation of the adapters shown in Figs. 3 and 4 together with a radio receiver of the super-heterodyne type is the same as that described in detail in connection with the combined receiver shown in Fig. 2. The controls necessary are a volume control such as PT and a program selector such as switches SW₂ and SW₃ associated with a tuned circuit TC.

Fig. 5 shows an arrangement which might be used to distribute carrier frequency programs to subscribers over wire circuits. Among the features of this system are the separate amplification of sidebands and carrier frequencies at distribution points and the arrangement whereby three programs may always be present on the wire circuit with other optional programs available. The wires used for the program service may be separate circuits or those used for regular telephone service. The receiver may be combined space radio and carrier frequency wire program receiver such as previously described herein but is not necessarily limited to this type.

Three carrier frequency channels are utilized in the program system shown in Fig. 5. At the program center three carrier frequencies, 25, 60 and 90 kilocycles, are generated by oscillators OS₁, OS₂ and OS₃. The 25-kc. carrier is introduced to modulators MD₁, MD₂ and MD₃, where it is modulated with programs 1, 2 and 3. Program 4 is modulated to the 60-kc. channel in MD₄ and program 5 is modulated to the 90-kc. channel in MD₅. The program material may be produced in studios at the program center or transmitted thereto from some outside pick-up point. Program material may also be produced by some process of electrical transcription.

The modulators are so arranged that the carrier frequency is suppressed. The band filters BF₁, BF₂, BF₃, BF₄ and BF₅ suppress in each case the upper sideband, passing only the lower sideband. There are, of course, other arrangements for obtaining a single sideband, any of which would be suitable. It might be desirable, rather than to suppress completely one sideband, to transmit vestiges of the carrier frequency and lower modulating frequencies. The modulators MD₁, MD₂ and MD₃, therefore, produce sidebands from 15-25 kilocycles, modulator MD₄, 50-60 kilocycles and modulator MD₅, 80-90 kilocycles. Sidebands corresponding to programs 1, 2 and 3 are amplified in AM₁, AM₂ and AM₃, respectively. The sidebands corresponding to programs 4 and 5 are amplified in a common amplifier, AM₄. The three carrier frequencies are amplified in a single amplifier AM₅. All of these amplifiers are designed to furnish power sufficient to feed a large number of lines.

The trunks L₁, L₂, L₃ and L₄ transmit the five program sidebands from the program center to a central office and the trunk L₅ transmits the three carrier frequencies to the same point. Additional lines transmit the programs to other central offices. At the central office shown in Fig. 5 amplifiers AM₆, AM₇, AM₈, AM₉ and AM₁₀, respectively, amplify the incoming program frequencies. Each of these is also capable of furnishing power for a large number of lines which, in this case, are subscribers' circuits.

One such subscriber circuit L₆ is shown in Fig. 5. In this case the line L₆ is the subscriber's regular telephone loop connecting the subscriber's telephone set TS with the voice-frequency equipment at the central office. However, a separate

wire circuit might be used. In order to prevent interference between the program service and voice-frequency message service, low-pass filters, LP₁ and LP₂, are necessary at the central office and at the subscriber's station, as shown. These permit telephone conversation at voice frequencies and exclude the program frequencies from the telephone apparatus. At the central office the programs at carrier frequencies are applied to the line L₆, through a high-pass filter HP₁ from the program bus PB. This bus PB is connected to the output of the amplifier AM₉ which supplies the sidebands for the 60 and 90-kc. channels corresponding to programs 4 and 5 and the amplifier AM₁₀ which furnishes the three carrier frequencies. Programs 1, 2 and 3 all of which occupy the same carrier frequency band, 15-25 kilocycles, are supplied by the amplifiers AM₆, AM₇ and AM₈ to the three jack multiples JA₁, JA₂ and JA₃. A plug PL is connected to the subscriber's line through resistances R₂ and by plugging it into a jack in the multiple one of the three programs may be transmitted to the subscriber. The 25-kc. carrier is present in the line being obtained from the program bus PB. Therefore, only the sideband corresponding to the desired program is required and this is obtained from one of the amplifiers AM₆, AM₇ or AM₈ through the jack multiple JA₁, JA₂ or JA₃ and the plug PL.

Since all of the subscribers' lines are connected to the common bus PB, transmission between the subscribers' lines on the 25-kc. channel must be prevented in order to prevent interference of the three programs in this channel. For this purpose resistances R₁ have been inserted in series with each line. These must have high enough values so that the attenuation of the network of four of them (two in each of two lines) with the low bus impedance shunted between them will prevent crosstalk between individual circuits. Similar resistances R₂ are placed in the circuit of the plug PL to prevent currents from the program bus PB from entering the jack multiples JA₁, JA₂ and JA₃.

At the subscriber's station a high-pass filter HP₂ admits the carrier program frequencies and excludes the voice frequencies. The program receiver PR is connected to the output of the high-pass filter HP₂. This receiver contains selecting circuits for choosing one of the three carrier frequency channels, amplifying circuits and demodulating circuits. The audible frequency output from the receiver PR, amplified to a suitable volume level, is applied to the sound reproducing unit or loudspeaker LS. This receiver PR may well be one of the type previously described herein, in which the carrier program frequencies are translated in frequency to pass through an intermediate frequency amplifier which is also used for the reception of radio programs.

In order to receive one of the alternate programs on the 25-kc. channel arrangements may be made by telephone with an operator at the central office to change the position of the plug PL to a jack in the multiple corresponding to the desired program. It is also possible to accomplish the same result mechanically, using the dial associated with the subscriber's telephone to select by a special code the desired program.

In the program system described in connection with Fig. 5 there are always three programs present at the subscriber's premises for instant selection at his receiver. These comprise the pro-

grams on the 60 and 90-kc. channels and one of the programs on the 25-kc. channel. The subscriber may, by telephone, request one of the other programs available on this channel. The number of programs available on the 25-kc. channel need not be limited to three, as shown, but any number may be provided. Also, instead of having only one program available on the 60 and 90-kc. channels there might be alternative programs available for these channels as well. These could be connected on request by telephone from the subscriber or mechanically as the result of a dialing operation at the subscriber's station.

While this invention has been disclosed as embodied in certain particular forms, it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. The method of receiving either space radio or wire distributed carrier frequency programs on a common receiver, consisting in translating either the space radio or the carrier frequency programs to an intermediate frequency band, selecting and amplifying the band of intermediate frequency, the said frequency translation being so controlled that the resultant band will be within the frequency range for which the amplifier is selective.

2. In combination, means for collecting space radio signals, a superheterodyne receiver including an intermediate frequency amplifier capable of passing a fixed band of frequencies, a wired radio line delivering signals at carrier frequencies, means for translating in frequency either said space radio signals or said carrier frequency wire transmitted signals to the band passed by the intermediate frequency amplifier.

3. A superheterodyne receiver for radio broadcast and wire distributed carrier frequency programs, including a modulator, intermediate frequency amplifier and associated band filter, demodulator, and audio system all common to the radio and wire receiving systems, and a local oscillator capable of generating a plurality of frequencies, said oscillator supplying a frequency to said modulator of such value that the incoming signals representing any single program, either wire or radio, are translated in frequency to the frequency band passed by said intermediate frequency amplifier and its associated band filter.

4. In combination, a collector of space radio signals, a receiver of the superheterodyne type including an intermediate frequency amplifier arranged to select a band of frequencies, a wire line delivering programs at carrier frequencies, means for translating in frequency either said space radio signals or said carrier frequency signals, means for connecting either said translated space radio signals or said translated carrier frequency signals to said intermediate frequency amplifier, said intermediate frequency amplifier selecting a band of frequencies corresponding to a single program.

5. A combined space radio and wired radio receiving system comprising, in combination, high-frequency circuits arranged to intercept space radio signals, a wire line conveying carrier frequency signals, frequency changing apparatus arranged to change the frequencies of either the space radio signals or the wired radio signals, an intermediate frequency amplifier transmitting a fixed band of frequencies arranged to select said

band of frequencies from the changed frequencies of either the space or the wire signals, a demodulator, audio-frequency amplifier and sound reproducing system arranged to convert to sound waves the band of frequencies selected by said intermediate frequency amplifier.

6. In a system for the reception of wire distributed and radio broadcast programs, the combination of a wire line transmitting a plurality of program channels each based on a carrier frequency differing from the others, a local oscillator capable of generating a plurality of frequencies, a collector of space radio signals, means for partially selecting and amplifying certain of said signals, a second local oscillator capable of generating a plurality of frequencies, switches to introduce to a modulator either the incoming carrier frequency signals and a frequency from said first local oscillator or said space radio signals partially selected and amplified and a frequency from said second local oscillator, means for selecting from the output of said modulator a fixed band of frequencies in the superaudible frequency range sufficiently wide to pass one program channel, means for amplifying and demodulating said frequencies, means for varying the frequency of either local oscillator so that a desired program may be selected, means for varying the radio-frequency selecting circuit accordingly, audio-frequency amplifying means and sound reproducing means.

7. In a combined space radio and wired radio receiver of the superheterodyne type including an intermediate frequency amplifier capable of selecting and passing a fixed band of frequencies, the method of receiving only a single sideband and carrier frequency of either the space or wired radio transmission, consisting in translating in frequency said transmission by modulation with a locally generated signal so adjusted that the translated carrier frequency is located at one edge of the band of frequencies passed by said intermediate frequency amplifier and one sideband is included in said band.

8. In a combined space and wired radio receiver of the superheterodyne type including an intermediate frequency amplifier capable of selecting and passing a fixed band of frequencies, means for translating in frequency the received signals, either space or wired radio, so that a carrier frequency and single side band are included in the band selected and passed by said intermediate frequency amplifier, and means for impressing upon said intermediate frequency amplifier the band of frequencies thus translated.

9. The method of receiving any desired one of a plurality of high quality wired radio programs with a space radio receiver of the superheterodyne type having an intermediate frequency amplifier passing a fixed band of frequencies, said receiver being so arranged that said intermediate frequency amplifier selects and passes a translated space radio program consisting of a carrier and two symmetrical sidebands, said method consisting in translating said wired radio program in frequency by an amount such that the translated carrier and one sideband are selected and passed by said intermediate frequency amplifier, the translated carrier being near one edge of the band passed by said intermediate frequency amplifier, and the translated sideband occupying the whole band.

10. The method of receiving with a space radio receiver of the superheterodyne type including an intermediate frequency amplifier passing a fixed

band of frequencies, any one of a plurality of carrier frequency programs transmitted over a wire line, consisting in translating in frequency the desired carrier frequency program to the fixed frequency band passed by said intermediate frequency amplifier and applying said band to said amplifier.

11. In combination with a space radio receiver of the superheterodyne type including therein an intermediate frequency amplifier having connected therewith a band filter passing a fixed band of frequencies substantially equal in width to that of a carrier program, a wire line conveying a plurality of programs at carrier frequencies, and frequency translating means connected to said wire line and having means for changing the frequency of any incoming program band to the fixed band passed by said intermediate amplifier and the filter connected thereto.

12. In combination, a radio receiver of the superheterodyne type including an intermediate frequency amplifier and tuned circuits for selecting a fixed band of frequencies, a wire line delivering a plurality of programs at carrier frequencies, and means for translating the signals from said wire line in frequency so that they may be selected and amplified by said intermediate frequency amplifier and said tuned circuits.

13. In combination, a radio receiver of the superheterodyne type including an intermediate frequency amplifier, so arranged as to be capable of passing a fixed band of frequencies, a wired radio receiving line conveying a plurality of programs on separate carrier frequency channels, a local oscillator capable of generating a plurality of frequencies, each to be beaten with one of the said carrier channels, a modulator adapted to translate each of said channels to the frequency band passed by the intermediate frequency amplifier when the said channel is beaten with its particular locally generated frequency.

14. In combination with a radio receiver of the superheterodyne type having included therein a local oscillator, a first detector, intermediate frequency amplifier and associated band filter, a wire line conveying signals at carrier frequencies, a second local oscillator of variable frequency, means for introducing into said first detector the incoming carrier frequencies from the wire line together with a frequency from said second local oscillator, the frequency of said second oscillator being adjusted in such a manner that a band of frequencies produced in the output of the first detector is passed by the intermediate frequency amplifier and associated band filter of said radio receiver.

15. In a system, by means of which wired radio

programs may be received with a space radio receiver of the superheterodyne type, the combination with a space radio receiver of the superheterodyne type having a modulator included therein, of an adapter including a generator for producing frequencies suitable to translate in frequency any one of the wired radio programs to the frequency band passed by the intermediate frequency amplifier of said space radio receiver, and means for introducing any one of said frequencies from said generator, together with the wired radio program frequencies, into the modulator of said space radio receiver.

16. A converter, by means of which wired radio programs may be received with a space radio receiver of the superheterodyne type, including tuned circuits for controlling the frequency of a local oscillator, means for introducing a frequency from said local oscillator together with the wired radio signals into the modulator of said space radio receiver arranged so that the wired radio signals are translated in frequency and a band of frequencies representing a single program is selected and passed by the intermediate frequency amplifier of said space radio superheterodyne receiver.

17. A receiver for radio broadcast and wire distributed carrier frequency programs comprising means for impressing upon said receiver either the incoming space radio frequency band or the wire carrier frequency band, means to change the frequency of those incoming signals to a single fixed superaudible frequency band, a selective amplifier and a detector connected thereto, the said fixed band comprising that frequency range for which the said amplifier is selective.

18. Means for adapting a superheterodyne receiver normally designed for the reception of space-radio programs only, to receive either the space-radio or wired-radio programs, the said adapting means including a group of tuned circuits designed for substitution, at will, for the space-radio frequency tuned circuit normally connected to the oscillator of the said receiver, and capable, when so substituted, of producing a plurality of discrete carrier frequencies, and switching means to connect said group of tuned circuits to the said oscillator in place of the space-radio tuned circuit, and to impress the wired-radio programs upon the said receiver simultaneously with the impression thereon of beating oscillations, the frequency of which is such as to produce that band of frequencies which the intermediate frequency amplifier is designed to pass.

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