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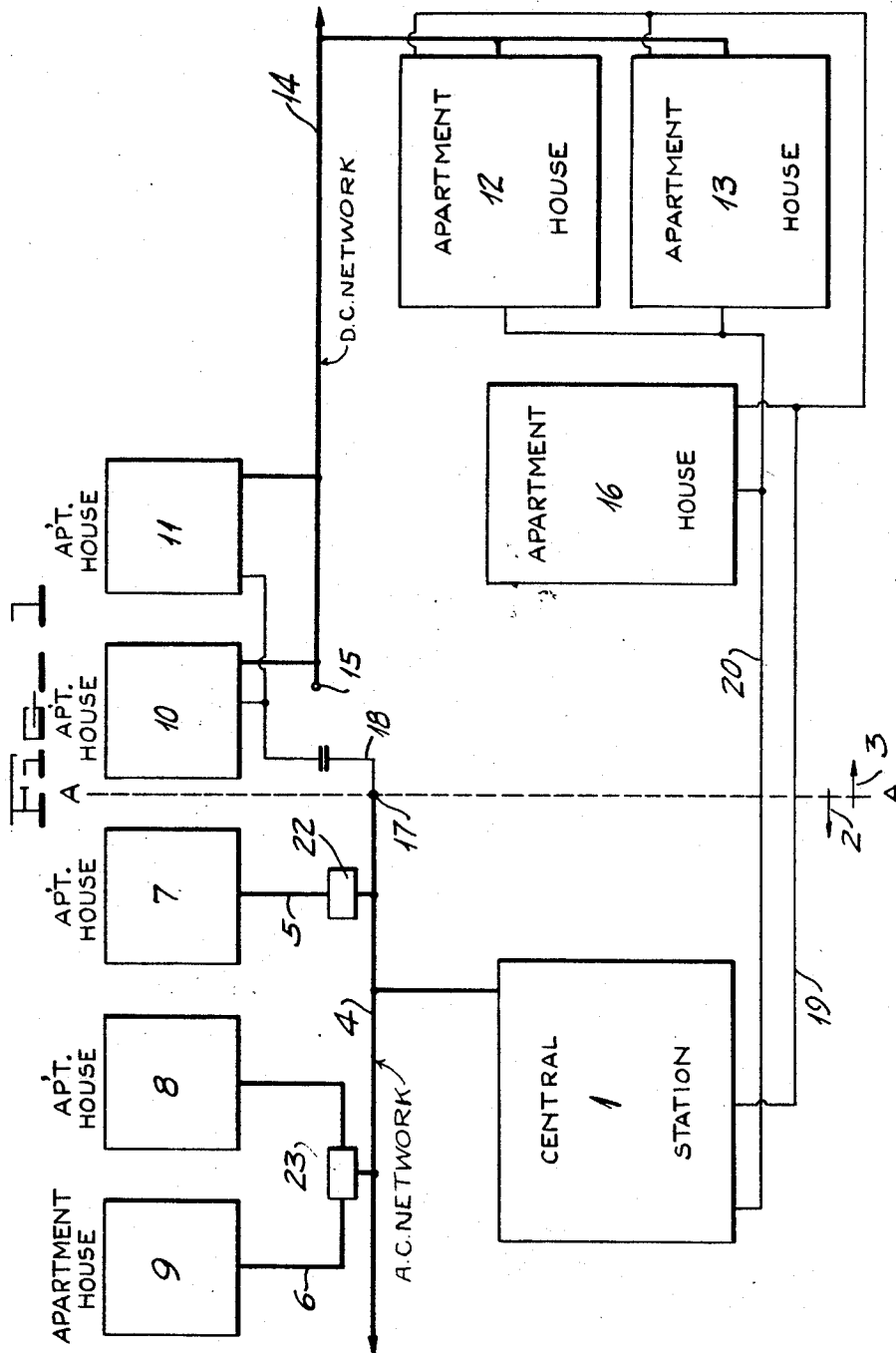
R. D. DUNCAN, JR

✓ 1,945,629

WIRED RADIO BROADCASTING SYSTEM

Filed June 3, 1931

3 Sheets-Sheet 1



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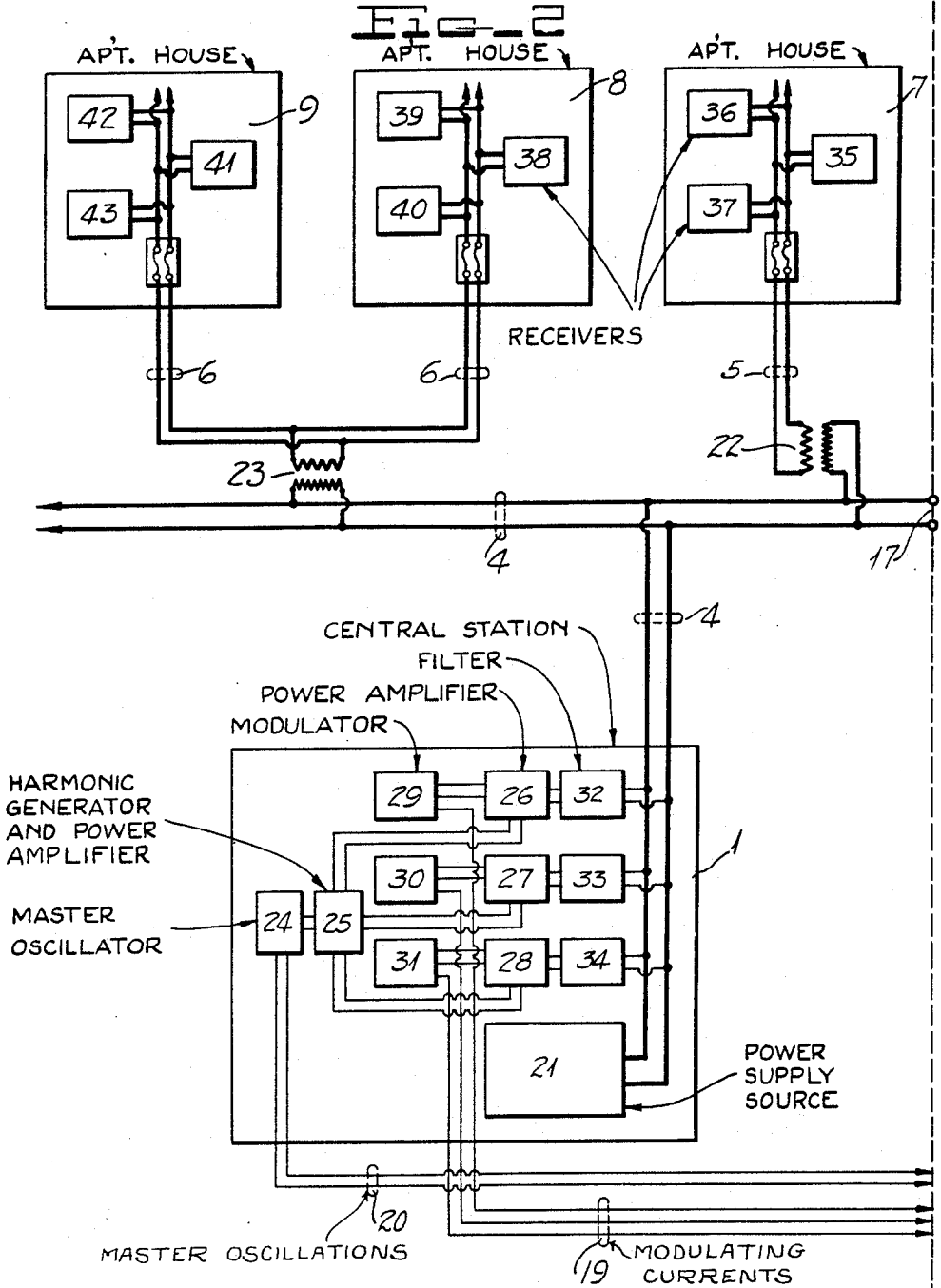
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3 Sheets-Sheet 2A



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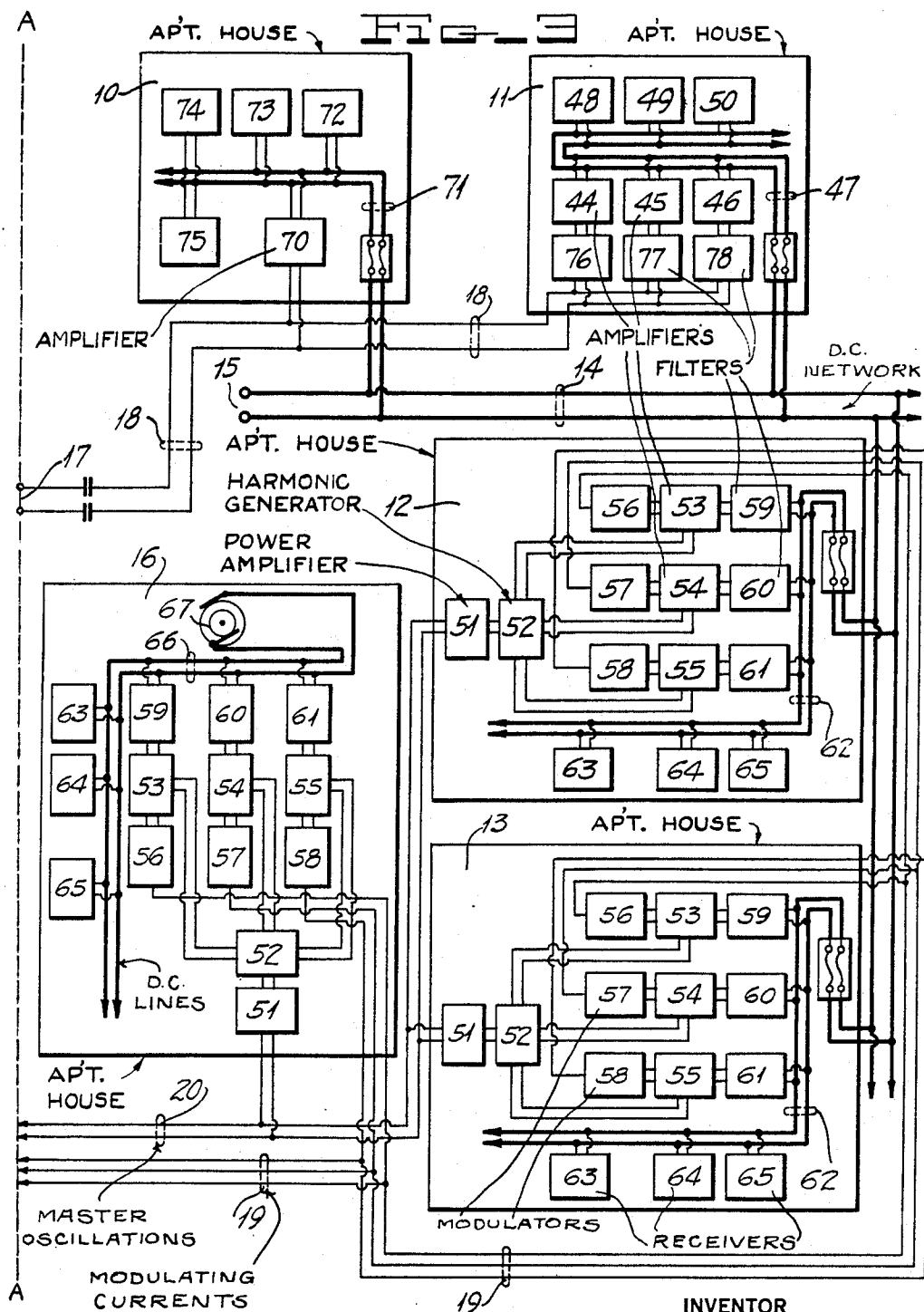
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WIRED RADIO BROADCASTING SYSTEM

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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WIRED RADIO BROADCASTING SYSTEM

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Application June 3, 1931. Serial No. 541,769

4 Claims. (Cl. 179—2.5)

My invention pertains in general to wired radio broadcasting systems and specifically relates to a wired radio broadcasting system adapted for use in metropolitan or other localized areas.

Wired radio broadcasting systems usually comprise means for distributing radio frequency signals to a large number of consumers by impressing such signals upon lines normally serving a large number of subscribers, such as power and light distribution systems. Due mainly to the line characteristics, it has been found largely impractical to serve a great number of consumers located in geographical areas served by direct current for electric light and power by impressing radio frequency signals on the direct current lines. In direct current distribution systems the power is directly transmitted to the consumer at the voltage used by the consumer, while in alternating current distribution systems the power is transmitted from a central station to substations at 11,000 volts for distribution at 2300 volts to the consumer's step-down transformers which supply the consumer's voltages of the order of 110-220 volts.

Direct current transmission systems, to reduce voltage drop, invariably use wire lines employing conductors of large cross-sectional area which because of the relatively low voltages used are spaced relatively close together. On the other hand, alternating current distribution systems effecting transmission at high voltages use conductors which are comparatively small in cross-sectional area and which are spaced a considerable distance from each other for insulation purposes. It will therefore be evident that the wire lines in direct current systems present much greater linear capacitance than will be found in alternating current distribution lines and accordingly cause greater dissipation of carrier frequency energy due to the shunting effect of this relatively large distributed capacity. The use of wired radio broadcasting over light and power lines has, therefore, been generally restricted to lines carrying alternating current. However, in many metropolitan areas, both alternating current and direct current light and power distribution systems are to be found.

The principal object of my invention consists in producing a wired radio broadcasting system for use in metropolitan areas where both alternating current and direct current supply systems are employed.

Another object comprises producing a system in which carrier frequency currents, impressed

on alternating current distribution lines, are extended on auxiliary lines to areas served by direct current light and power distribution systems.

A further object consists in providing a system in which a central station impresses modulated carrier frequency signals upon the lines of an alternating current distribution system, while an unmodulated base frequency oscillating current and the audio frequency modulating current are independently transmitted over auxiliary lines to points located in areas served by direct current distribution systems, at which points the oscillating current and modulating current are combined for local wired radio broadcasting over a limited area of the direct current distribution system.

I accomplish these and other objects in a novel system for wired radio broadcasting in metropolitan areas and the like where dissimilar types of power and light supply systems are encountered.

In the drawings accompanying and forming a part of the specification, and in which like reference numerals designate corresponding parts throughout:

Fig. 1 is a schematic representation of the broadcasting system of my invention for use in a typical portion of a metropolitan area where several types of light and power supply systems are employed.

Fig. 2 is a schematic representation in more detail of part of a system shown in Fig. 1.

Fig. 3 is a schematic representation in more detail of that part of Fig. 1 not shown in Fig. 2. In the drawings, I have shown rectangular blocks as representative of apartment houses and of certain apparatus such as alternating current generators, carrier frequency oscillators, band pass filters, et cetera, the construction of which are well known to those skilled in the art, and are therefore not described in detail.

Referring to the drawings in detail, I have shown in Fig. 1, a schematic representation of a portion of a metropolitan area, where several dissimilar types of electric light and power distribution systems are to be encountered. Although in many large areas, only one type of current distribution systems, such as an alternating current distribution system, is to be found, there are many sections, especially in some of the larger cities, where both alternating and direct current distribution systems are to be encountered. The different sections of a city served, respectively, by alternating current and direct current distribution systems, are not definitely delineated by any

arbitrary line of demarkation. However, for the purpose of the present description, I have indicated a dotted line A—A as dividing the area of Fig. 1 into two distinct portions served by dissimilar types of current distribution. That portion on the side of the dotted line A—A indicated by the arrow 2 represents the portion of the area which is served by alternating current, while the portion indicated by the arrow 3 represents the area served by direct current distribution systems. A central station 1 generates and supplies alternating current through the high tension line 4, step-down transformers 22 and 23, and intermediate low voltage lines 5 and 6, to several different groups of consumers which, for descriptive purposes, will be considered as apartment houses 7, 8, and 9. Other apartment houses 10, 11, 12, and 13, located in the direct current section of the metropolitan area, are supplied with direct current through the distributing line 14 which originates at a direct current central supply station. This line 14 is arbitrarily indicated as ending within the direct current section of the metropolitan area at the termination 15.

Another apartment house 16, located in the direct current section of the metropolitan area is provided with means for generating its own supply of direct current.

It is obvious that the apartment houses herein described are merely representative of groups of electric light and power consumers, and could be equally well considered to be any other localized group of electric current consumers, such as a city block or blocks of dwellings.

In my wired radio broadcasting system I provide a source of carrier frequency signals at the central or substation 1, from which signals are impressed on the alternating current distribution system, represented in part by the lines 4, 5, and 6. Such a source of carrier frequency signals could be located at any other point, but as a matter of convenience is situated at the power and light central station 1. The distribution of radio frequency signals over alternating current distributing lines to a large number of consumers, as indicated, presents no unusual difficulties, and is a matter of general practice. It is obvious that it is equally desirable to make wired radio programs available to consumers located in areas served by direct current lines such as the apartments 10, 11, 12, 13, and 16. The apartments 10 and 11 are situated not far removed from the termination 17 of the alternating current distribution systems. In my invention, I make wired radio broadcasting available to the consumers situated near the alternating current network, by extending an auxiliary line 18 which carries carrier energy only, from the termination 17, to the consumers located in the apartments 10 and 11, at which points the carrier frequency signals may be amplified as hereinafter provided.

To provide wired radio programs to the consumers in the apartment houses 12 and 13, as well as apartment house 16, I provide a suitable telephone cable 19 from the audio source at the central station 1 to the said apartment houses, and which conveys audio frequency modulating currents from the source to the apartment houses. I also provide another cable 20 for conveying unmodulated carrier frequency oscillating currents from the source at the central station 1 to the apartments 12, 13, and 16, to serve as carrier currents for impressing the before mentioned

modulating currents on the direct current distribution systems at radio frequencies. It is an important feature of my invention that a common source of master oscillating current is so provided to a plurality of localized distributing areas, inasmuch as any attempt to provide independent oscillators for these areas would result in disturbing heterodyne interference.

The limiting line characteristics and capacitance of the direct current distribution systems tend to quickly dissipate impressed carrier frequency energy if impressed thereon at the power house. My system, therefore, provides means for impressing these carrier frequency signals on the direct current network in the immediate vicinity of a localized area in which a certain group of subscribers to be served is located. It is intended that the carrier frequency signals shall be properly amplified, as hereinafter provided, in the vicinity of local distribution, so as to insure sufficient strength of signals to reach all of the intended subscribers.

In Fig. 2, I show in more detail the alternating current section of the metropolitan area generally indicated in Fig. 1. It will be seen that the high tension line 4 originates at a source of alternating current 21. In one instance this line 4 ends at the termination 17. Stepdown transformers 22 and 23 are connected to the line 4, as shown, and provide operating voltages to the apartment houses 7, 8, and 9, respectively, through the intermediate lines 5 and 6.

A master carrier frequency oscillator 24 is provided as a common source of master oscillations for the wired radio broadcasting system of my invention. A harmonic generator and power amplifier 25 is provided, in electrical association with the master oscillator 24, as means for producing three amplified harmonics of the master oscillating frequency. These harmonics are delivered, respectively, to three power amplifiers 26, 27, and 28. The master harmonic frequencies delivered to the power amplifiers 26, 27, and 28 are in turn modulated by audiofrequency modulating currents derived from the modulators 29, 30, and 31, respectively. The modulators 29, 30, and 31 are connected to different studios, not shown, for deriving independent program modulation. Modulated carrier frequency currents are delivered from the power amplifiers 26, 27, and 28 to suitable filters 32, 33, and 34 and thence impressed upon the alternating current supply line 4.

A cable or line 20 is connected to the master oscillator 24 for the purpose of transmitting master oscillating currents to other localities. Another cable 19 is provided to the outputs of the modulators 29, 30, and 31 so as to independently transmit the audiofrequency modulating currents from the modulators to other localities. These cables 19 and 20 can be of any type suitable for the purpose intended, such as ordinary telephone cables.

In the apartment houses 7, 8, and 9, wired radio receivers 35, 36, 37, 38, 39, 40, 41, 42, and 43 are connected to the local alternating current distribution systems. These receivers are substantially means for receiving, at selected frequencies, any one of the programs impressed on the electric light and power distribution system for rendering the same audible.

In Fig. 3, I show in more detail the direct current section of the metropolitan area represented in Fig. 1. An auxiliary line 18 is provided from the termination 17 of the alternating cur-

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rent network, to the apartment houses 10 and 11. This line 18 may be capacitively coupled to the said termination, the purpose of the said line being to extend the radio frequency signals to the said apartment houses 10 and 11. In the apartment house 10, I provide an amplifier 70 which amplifies the modulated radio frequency currents carried on the line 18 and impresses them, by suitable means, on the local distribution line 71 which is connected to the main line 14 of the direct current distribution system which originates at a suitable direct current supply central station. Wired radio receivers 72, 73, 74, and 75, situated within the apartment house, are connected to the said direct current distribution line 71 of the apartment house 10 so as to properly receive the wired radio signals.

In the apartment house 11 the line 18 terminates in parallel connections to three filters 76, 77, and 78, which pass, at selected frequency bands, three different programs, respectively, corresponding to those originating in the modulators 29, 30, and 31 in Fig. 2. These selected frequency bands are delivered to three amplifiers 44, 45, and 46 and thence impressed by suitable means upon the local distribution line 47 in the apartment house 11 and which is connected to the main line 14 of the direct current distributing network. Wired radio receivers 48, 49 and 50 are connected to the direct current line 47 in a manner hereinbefore described.

Although but one method is used to deliver the radio-frequency signals to the apartment houses 10 and 11, I have shown two different methods of amplifying such signals for local distribution, the two amplification methods varying in that all three frequency bands of the modulated radiofrequency current are simultaneously amplified by the amplifier 70 for distribution in the apartment house 10, while the modulated radiofrequency signals are separated into different frequency bands for separate amplification and combined distribution in the apartment house 11. I assume the apartment house 11 to be differently situated from the apartment house 10 and that the distribution line 47 would have electrical characteristics differing from the distributing line 71 of the apartment house 10. In other words, different distributing conditions are to be met with in the two apartment houses 10 and 11, and even though deriving radiofrequency signals from the same line 18, I have provided means to effect a different method of local amplification in each case to meet the requirements of different operating conditions.

The apartment houses 12 and 13 are relatively remotely situated from the available termination 17 of the alternating current network. To make wired radio broadcasting available to these apartment houses I extend the cable 20, carrying master oscillation currents, to an amplifier 51 in the apartment house 12. The amplifier 51 amplifies the said master oscillation currents and delivers them to a harmonic generator 52 which delivers, respectively, three amplified harmonics of the master oscillating frequency to three power amplifiers 53, 54, and 55. These frequency harmonics are in turn modulated by audiofrequency modulations derived from the modulators 56, 57, and 58. The controlling modulating currents of these three modulators are derived from the master modulators 29, 30, and 31 in the central station 3 of Fig. 2 by means of the intervening telephone cable 19. Each modulator corresponds

to one frequency band or one program channel of the wired radio broadcasting system.

The amplified modulating radiofrequency currents are delivered from the amplifiers 53, 54 and 55 to the filters 59, 60 and 61 and thence impressed upon the local distribution line 62, which is connected to the main line 14 of the direct current distributing network. Wired radio receiving devices 63, 64 and 65 are connected to the direct current distributing line 62 in a manner hereinbefore described, for the reception of the radiofrequency signals.

The apartment house 13 is similar to apartment house 12 and is equipped with an arrangement of apparatus identical to that shown in the apartment house 12. Inasmuch as a common source of master oscillating carrier currents is provided for both apartment houses 12 and 13, it is obvious that there will be no disturbing heterodyning frequency interferences.

The apartment house 16 has a direct current distributing line 66 originating at a direct current supply source 67 maintained in the immediate vicinity of the said apartment house, it being very often the case that large establishments of this kind generate their own light and power currents. I, therefore, provide in the apartment house 16 an arrangement of apparatus similar to that shown in the apartment house 12.

As I have heretofore pointed out, the apartment houses which I have shown are merely indicative of localized areas in which are located groups of subscribers deriving electric light and power from dissimilar electric light and power distribution systems. It is not the intention of this description to represent a definite and exact arrangement of subscribers of distribution systems, inasmuch as such arrangements vary greatly in different populated areas. I do, however, clearly show how I provide means for distributing wired radio programs to an entire metropolitan area or the like in which dissimilar electrical distribution systems are to be found.

Although I have shown certain details of electrical arrangements and circuits, I do not wish to be limited thereto, except insofar as may be pointed out in the appended claims.

What I claim as new and original and desire to secure by Letters Patent of the United States is:

1. A wired radio broadcasting system comprising, an alternating current distribution network, a direct current distribution network, a common source of high frequency current, means for deriving from said high frequency current a plurality of discrete harmonically related carrier frequencies, means for producing modulating currents comprising a plurality of distinct program channels, means in the geographic vicinity of said alternating current network adapted to combine said modulating channels respectively with said harmonically related carrier frequencies and to impress the resultant modulated carrier frequencies on said network, means for conveying current from said common source and said program channels to the geographic vicinity of said direct current network, means in the geographic vicinity of said direct current network adapted to derive from said high frequency current a plurality of discrete harmonically related carrier frequencies, means to respectively modulate each of said harmonically related carrier frequencies with said program channels and to impress the resultant modulated carrier frequencies on a local area of said direct current network.

2. A wired radio broadcasting system comprising, an alternating current distribution network, a direct current distribution network, a common source of master radiofrequency oscillating currents, a source of audiofrequency modulating currents, means in the geographic vicinity of said alternating current network adapted to combine said audiofrequency modulating currents and said radiofrequency oscillating currents and adapted to impress said resultant modulated radiofrequency currents on said network, lines extending from said source of audiofrequency modulating currents to at least one point located in the geographic region of said direct current network and adapted to convey said modulating currents to said point, lines extended from said source of master oscillating currents to said point located in the geographic region of said direct current network, means in the geographic vicinity of said direct current network adapted to combine said modulating currents and said master oscillating currents and impress the resultant modulated radiofrequency current on a localized area of said direct current network.
3. A wired radio broadcasting system comprising, a plurality of dissimilar current distribution systems, a common source of master radiofrequency oscillating currents, a source of audiofrequency modulating currents, means adapted to combine said modulating currents and said radiofrequency currents and impress the resultant modulated radiofrequency currents on one of said dissimilar electric current distribution systems, lines extended from said last mentioned distribution system and adapted to convey said modulated radiofrequency currents to a second and dissimilar distribution system, means electrically coupled with said second electrical distribution system and adapted to impress said modulated radiofrequency signals thereon, lines extended from said source of master radiofrequency oscillating currents to a third dissimilar electrical distribution system and adapted to convey said oscillating currents to said third distribution system, lines extended from said audiofrequency modulating source to said third distribution system and adapted to convey said modulating currents thereto, and means in geographic association with said third distribution system adapted to combine said oscillating currents and said modulating currents and impress the resultant modulated radiofrequency current on said third electric distribution system.
4. A wired radio broadcasting system comprising, a plurality of dissimilar electric current distribution networks, a common source of master radiofrequency oscillating currents, a plurality of sources of audiofrequency modulating current, means located in the geographic vicinity of one of said dissimilar electric distribution systems and adapted to generate harmonics of the said master radiofrequency oscillating currents, means located in the geographic vicinity of said current distribution network adapted to combine said plurality of modulating currents, respectively, with said plurality of harmonic frequencies and adapted to impress said resultant modulated currents at a plurality of frequencies on said current distribution network, means located in the geographic vicinity of a second of said plurality of dissimilar networks adapted to generate harmonics of said master frequency oscillating currents, means associated in the geographic vicinity of said second distribution network and adapted to combine said plurality of modulated audiofrequency currents with said harmonics of said master oscillating frequency and impress the resultant modulated radiofrequency currents at a plurality of different frequencies on a localized area of said second dissimilar distribution network.
- ROBERT D. DUNCAN, JR.

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