

May 26, 1942.

H. E. GOLDSTINE

2,284,415

RELAY SYSTEM

Filed Nov. 29, 1939

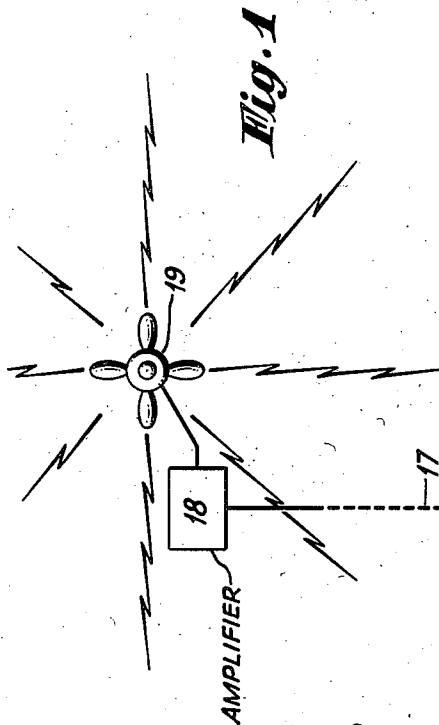
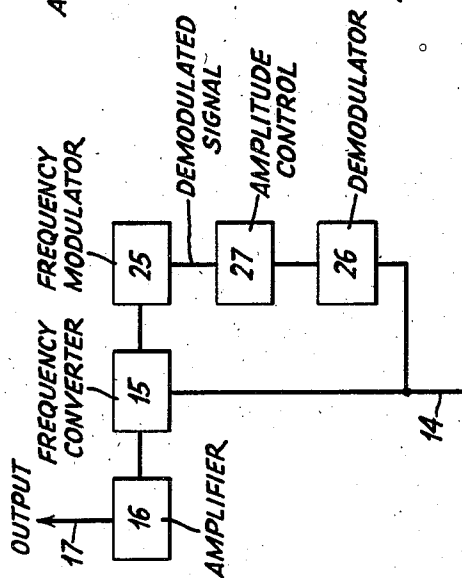


Fig. 2



BY

INVENTOR.
HALLAN E. GOLDSTINE
H. S. Swiner
ATTORNEY.

UNITED STATES PATENT OFFICE

2,284,415

RELAY SYSTEM

Hallan E. Goldstine, Rocky Point, N. Y., assignor
to Radio Corporation of America, a corporation
of Delaware

Application November 29, 1939, Serial No. 306,608

3 Claims. (Cl. 250-15)

The present invention relates to the art of signal relaying by ultra short wave radio and, more particularly, to a system for supplying a television signal to receivers which are near the relay system but not within the field of the transmitters of the system. One method of utilizing a network of television relay stations to connect important cities involves the transmission of the television signals on an ultra high frequency of the order of hundreds of megacycles from one city and at intervals of fifty miles, or thereabouts, picking up the received signals, amplifying and retransmitting the signals through the medium of highly directive antennae and thus covering the entire distance between the cities. Due to the quasi-optical characteristics of the ultra high frequencies used the signals are transmitted only along line of sight paths and due to the extreme directivity of the transmitting and receiving antenna of the relay station, as well as due to the high frequencies involved, being beyond the tuning range of television broadcast receivers, such receivers are unable to receive the programs.

An object of the present invention, therefore, is the provision of a television relay system which will supply a relayed television signal to a comparatively large area near the path of the television relay chain. In accordance with this object it is proposed that the television signal be transmitted by means of frequency modulation. At the desired locations where low frequency broadcast transmitters are to be located a pick-up antenna within the field of a high frequency relay transmitter is established, or the signals are tapped off from an adjacent relay station amplifier. The picked up high frequency signals are heterodyned by means of a fixed frequency oscillator to the television broadcast band and then amplified in a number of stages at that frequency until the power is sufficient for proper coverage of the area involved. This amplified lower frequency signal is then applied to a broadcast antenna in the conventional manner and radiated over the area to be covered. As a further feature of the invention means may be provided to alter the modulation index of this broadcast signal.

Further objects and features of the invention will be more clearly understood from the following detailed description which is accompanied by a drawing in which Figure 1 shows the layout of a television relay chain and a broadcast transmitter utilizing the principles of my invention with the amplifiers and converters shown in con-

ventional block form, and Figure 2 illustrates a modification of a portion of Figure 1.

In Figure 1, I have shown a plurality of the ultra high frequency relay stations 10, each of which are placed at the top of a comparatively tall tower. These towers are spaced about 20 miles apart, depending upon the characteristics of the terrain covered, and a balancing of the cost per foot of the towers against the cost of the relay equipment. Each of the relay stations 10 comprises a receiving antenna 12 within a highly directive reflector 13 and a similar transmitting antenna likewise within a highly directive transmitting reflector 13. The receiving and transmitting antennas are connected by an amplifier which takes the signal as picked up by the receiving antenna, amplifies it without frequency conversion and retransmits it to the next relay station. The frequency employed may be of the order of several hundred megacycles. As shown in the figure, it is considered that the television relay chain passes near a neighborhood which it is desired to supply with television programs at the usual television broadcast frequency which may be on the order of 50 megacycles. A transmission line 14 is connected to the amplifier within the relay station 10 nearest the area to be covered by the broadcast signal and applies the signal taken therefrom to a frequency converter 15. If desired, the relay frequency signal may be picked up by a simple antenna between adjacent relay stations. Since the relay transmission is a frequency modulated signal the relay transmission may have its frequency changed to the conventional television broadcast band by means of a fixed frequency oscillator such as a crystal oscillator or a frequency controlled oscillator of any other convenient type at 15 and amplified at 16 for transmission by means of transmission line 17 to the power amplifiers 18. The amplified signal, of sufficient power to cover the desired area, is then applied to the broadcast antenna 19 in the usual manner. Since a frequency modulated signal is used the amplifiers 16 and 18 need not be operated as linear amplifiers but need only respond linearly with frequency, thus decreasing the cost of the system considerably.

The frequency control device 15a may be either a crystal oscillator or automatic frequency control may be applied from the output of amplifier 16, as indicated by line F+C, to maintain the average frequency of the signal in transmission line 17 and radiated from the antenna 19 essentially constant. In some cases it may be desirable to reduce the frequency swing or modula-

tion index of the broadcast signal from that existing in the relay signal. One method of doing this is shown in Figure 2 wherein a demodulator 26 takes a portion of the signal from transmission line 14, before it is applied to the frequency converter 15. The demodulated signal, of an adjustable amplitude controlled by amplitude control 27 is applied to a frequency modulator stage 25. The frequency modulator 25 applies the signal to the heterodyne oscillator in a manner to oppose the original frequency swing thereby degenerating the frequency modulated signal output from converter 15 to any desired extent.

While I have particularly shown and described a few embodiments of the present invention, it is to be clearly understood that my invention is not limited thereto but that modifications may be made within the scope of this invention.

I claim:

1. In combination, a chain of relay stations adapted to relay frequency modulated signals from one location to another on ultra high frequencies, said chain passing near an intermediate area over which signals are to be broadcast, pick-up means adapted to receive said ultra high frequency signals connected to one of said relay stations adjacent said area, an oscillator, means for applying signals picked up by said pick-up means to said oscillator so that said signals are heterodyned to a lower frequency, means for frequency modulating said oscillator in a predetermined sense with respect to the modulation of said frequency modulated signals whereby the

modulation index of said lower frequency signals may be adjusted, and means for broadcasting said lower frequency signals over said area.

2. In a signal transmission system, a source of frequency modulated high frequency waves, a frequency converter including an oscillator, means for applying said waves to said frequency converter oscillator so that they are heterodyned to a different frequency, means independent of said frequency converter means for demodulating said first mentioned high frequency waves and means for modulating said oscillator in accordance with said demodulated waves in such sense with respect to the modulation of said frequency modulated signals that the modulation index of said resultant frequency modulated signals may be adjusted.

3. In a signal transmission system wherein frequency modulated waves in one frequency band are transformed to frequency modulated waves in another frequency modulated band by heterodyning in one path the first mentioned waves with wave energy of a predetermined frequency, the method of reducing the modulation index of the second mentioned of said frequency modulated waves which comprises diverting a portion of said first mentioned waves into a second path, demodulating in said second path said diverted portion of said first mentioned waves and frequency modulating said wave of predetermined frequency by said demodulated first wave.

HALLAN E. GOLDSTINE.