March 21, 1939. H. WHITTLE 2,151,173

CARRIER AND SPEECH TRANSMISSION SYSTEM

Filed Oct. 6, 1936

FIG. 1

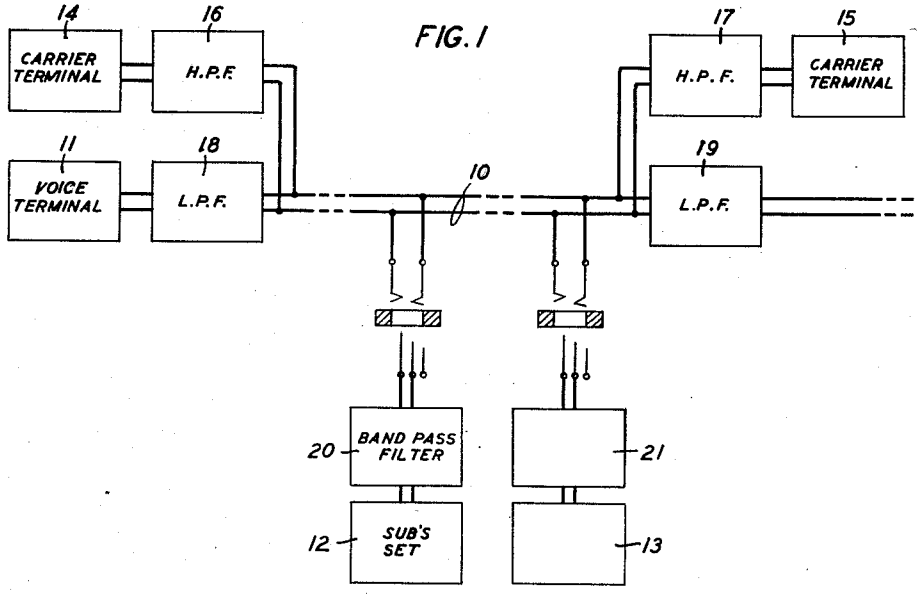
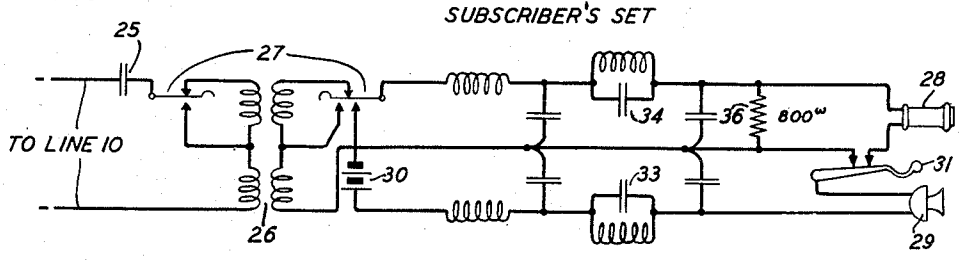


FIG. 2



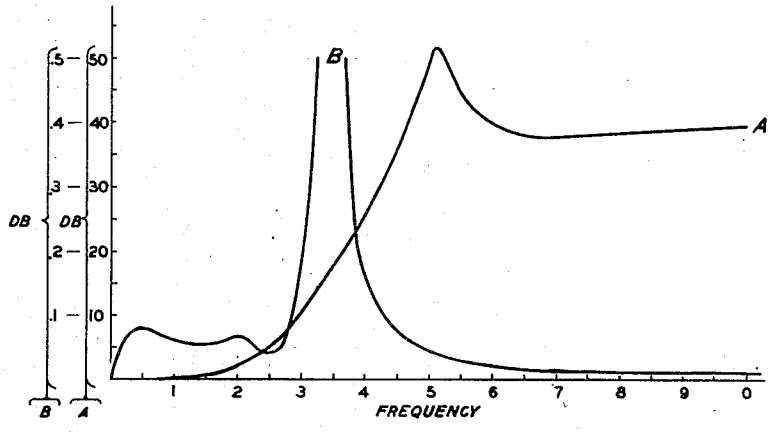


FIG. 3

INVENTOR
H. WHITTLE
BY K. A. Burgess
ATTORNEY

Patented Mar. 21, 1939 2,151,173

UNITED STATES PATENT OFFICE

2,151,173

CARRIER AND SPEECH TRANSMISSION SYSTEM

Horace Whittle, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 6, 1936, Serial No. 104,183

2 Claims. (Cl. 179—15)

The present invention relates to carrier telephone systems on lines that are also used for ordinary telephony and in particular to the provision of filters in the subscribers' lines for preventing the carrier frequency currents from entering the voice frequency apparatus.

In some types of lines, such, for example, as train despatching lines, it is customary to have a number of subscriber stations adapted for connection in bridge of the line. If a carrier telephone system is to be superimposed on the same line it is necessary to provide selective circuits in the sub-set branches to prevent undue shunting of the high frequency currents used for carrier communication. If sufficiently high frequencies were used for the carrier communication, these selective circuits could be of quite simple construction and might reduce to a simple inductance or resonant circuit. It is desirable, however, to keep the frequencies used for carrier transmission to as low a frequency range as practicable because of such factors as cross-talk, attenuation and variations in transmission characteristics with weather conditions on open-wire lines, since all of these effects increase as the frequency increases.

Where the frequencies used for carrier transmission are brought down so low that a rather carefully designed band filter is required for the bridged sub-sets, a difficult problem is encountered because of the fact that the usual bridging sub-set is designed to have widely different impedances for the transmitting and receiving conditions.

This problem is solved according to the invention by providing in the preferred form of embodiment, two filters for the talking and listening conditions so designed as to provide optimum conditions of transmission for the voice currents with adequate discrimination against the frequencies used for carrier transmission.

The objects of the invention and its mode of application in practice will be made clear in the following description with the aid of the accompanying drawing, in which

Fig. 1 is a block schematic circuit diagram of a system to which the invention is particularly applicable;

Fig. 2 is a schematic diagram of a substation circuit equipped with filters in accordance with the invention; and

Fig. 3 shows insertion and bridging loss characteristic curves for a system incorporating the invention.

In Fig. 1 the telephone line or train despatching line 10 has a voice terminal at 11 which may be a despatcher's telephone set of standard type for communicating over the line with bridged substations, two of which are shown at 12 and 13. There may be a large number of these bridged stations, in accordance with usual practice. Carrier terminals are provided at 14 and 15 for communicating over line 10. A high-pass filter 16 or 17 is connected between the respective carrier terminal and line and a low-pass filter 18 or 19 is placed in the voice current branch of the line as in usual practice.

A bridging filter 20 or 21 is shown for connection between line 10 and respective substation set 12 or 13, these filters being for the purpose of preventing the shunting off by the bridged circuits of the currents used in carrier communication on line 10. In Fig. 1 the filters 20 and 21 are merely indicated as included in the circuits in bridge of the line. In case of sufficiently great frequency separation between currents used for the carrier and voice communication channels, a simple frequency selective circuit such as a tuned circuit or possibly a series inductance might suffice at the position indicated by 20 or 21.

In one system to which the invention has been applied, however, the carrier frequency was 7150 cycles and the lower side-band (used in west to east transmission) extended downward in frequency to about 4150 cycles whereas the speech channel utilized frequencies up to about 2750 cycles. These values of frequency in relation to the other factors that were involved required a special system of filters for the substation circuit branches, as will now be described in connection with Fig. 2.

The substation circuits used on line 10 comprised, before the inclusion of the carrier discriminating filters, a condenser 25, a repeating coil 26 equipped with a talk-listen key 27 arranged to include the whole coil in circuit in the listening condition and a small part of the coil in the talking condition; a receiver 28 and a transmitter 29. The resistance of the receiver was of the order of ten times that of the transmitter. A talking current battery 30 was arranged to be connected into and out of the circuit by a contact on the key 27. The switchhook is shown at 31.

With the entire coil 26 in circuit (key 27 released) the substation set presented a high impedance across the line. (The line to drop impedance ratio of this coil may, for example, be 50 to 1.) A large number of sets could, therefore, be bridged on the line in the listening condi-

tion without producing too great a bridging loss to speech currents transmitted over the line from station 11 or from any bridged substation. It was necessary in talking to depress key 27 to remove all but a small part of the impedance of coil 26 from the circuit in order to give the proper mutual impedance and low direct current resistance to the battery current to secure efficient transmission from the transmitter 29 out on to the line. Battery 30 in the talking position of key 27 is connected through only the lower part of coil 26 which has a low direct current resistance.

Superposing the carrier communication channel on the line 10 raised the problem of providing in the substation branches sufficient discrimination against the carrier communication currents to prevent too great a bridging loss in the carrier frequency range regardless of the number of substation circuits in use at one time, and also of keeping the attenuation and impedance at such values in the voice frequency range as not to impair speech transmission over the system.

This was accomplished by providing separate filters having quite different nominal impedance but similar cut-off characteristics in the talking and receiving branches of the circuit, shown respectively at 33 and 34. These are low-pass filters with a suppression peak in the neighborhood of 5 kilocycles, a typical characteristic being given by curve A in Fig. 3.

With key 27 released, and therefore with filter 34 in circuit and filter 33 out of the circuit, filter 34 is terminated on the line side by the impedance of the line transformed by coil 26, the whole of which is in circuit. It is terminated on its opposite end in the receiver 28 and an 800-ohm resistance 36. This resistance is for the purpose of providing a terminating resistance to filter 34 when the receiver is on the switchhook 31. It performs no useful function when the receiver is in circuit but the loss due to it is not serious.

With key 27 depressed, filter 33 is brought into circuit and is terminated on one end by transmitter 29 and on the other end by the line impedance transformed through the lower portion of coil 26. In this condition of the circuit filter 34 is also in circuit, filter 34 being connected across the lower part of the drop side of coil 26 in parallel with the output terminals of filter 33.

It is to be noted that a number of the bridged sets may be listening across line 10 at the same time but that in general only one will be talking at a time. It is necessary therefore to provide high impedance as well as attenuation for the carrier frequencies in the receiving condition of the substation circuit. It is not so necessary to provide such high impedance in the talking condition.

The bridging loss curve for one substation circuit of Fig. 2 in its receiving or in its idle condition is given by curve B in Fig. 3. The peak in the loss curve which occurs unavoidably due to the presence of the filter critical or cut-off frequency, falls in between the two utilized frequency ranges, namely, the voice and carrier ranges. The loss is seen to be of the order of only .01 or .02 decibel over the carrier range, and less than 0.1 decibel in the voice range. In the transmitting condition the loss in the carrier range is of the order of .1 decibel. In other words, the filters 33 and 34 have practically no effect on the performance of the substation in the voice range and at the same time produce negligibly small bridging loss for both side-bands used in carrier communication. The upper side-band was, in the system under discussion, transmitted from east to west, while the lower side-band was, as stated, transmitted from west to east. The upper side-band extended up to 10,150 cycles.

The circuits and specific example of their use that have been given are to be regarded as illustrative rather than limiting. The scope of the invention is indicated in the claims.

What is claimed is:

1. In combination with a line carrying currents in the voice frequency range and carrier communication currents of frequencies slightly higher than the upper frequency of said currents of the voice frequency range, a substation circuit including a transmitter and a receiver of differing impedances, and a repeating coil, said circuit in listening condition including said coil, said receiver and a filter across the line, the transmitter being disconnected from the line, and in talking condition including a portion of said coil, said transmitter and a second filter across the line, said repeating coil being connected between said line and said filters and said filters freely transmitting the voice frequency currents between the line and receiver and transmitter while offering high attenuation to currents of the frequencies used for carrier communication.

2. In combination with a line carrying currents in the voice frequency range and carrier communication currents of frequencies higher than the upper frequency of said currents of the voice frequency range, the lower frequency of the carrier communication currents being close to the upper frequency of the currents in the voice range, a substation circuit including a receiver and a transmitter of differing impedances, a repeating coil having a primary winding and a secondary winding, said primary winding being connected across said line, said circuit in listening condition having the receiver, a filter and the secondary winding connected together, and in talking condition having the transmitter, a portion of said secondary winding and a second filter connected together, said filters freely transmitting voice currents between the line and receiver and transmitter while offering high attenuation to currents of the frequencies used for carrier communication.

HORACE WHITTLE.