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A. C. SCHROEDER
COMMUNICATION SYSTEM

2,406,165

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Fig. 1.

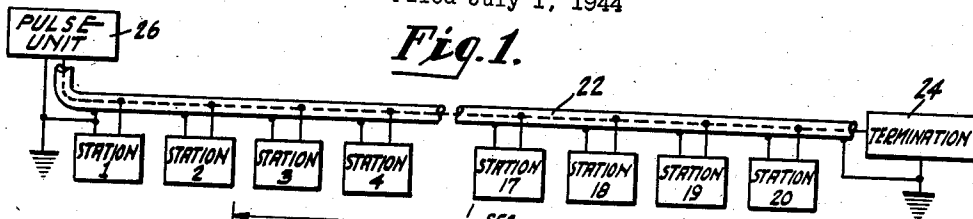


Fig. 2.

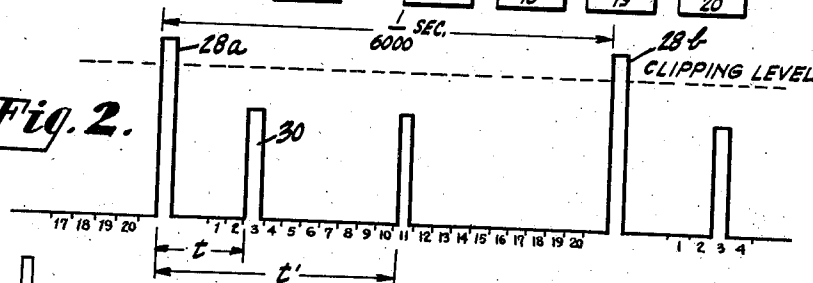


Fig. 3.

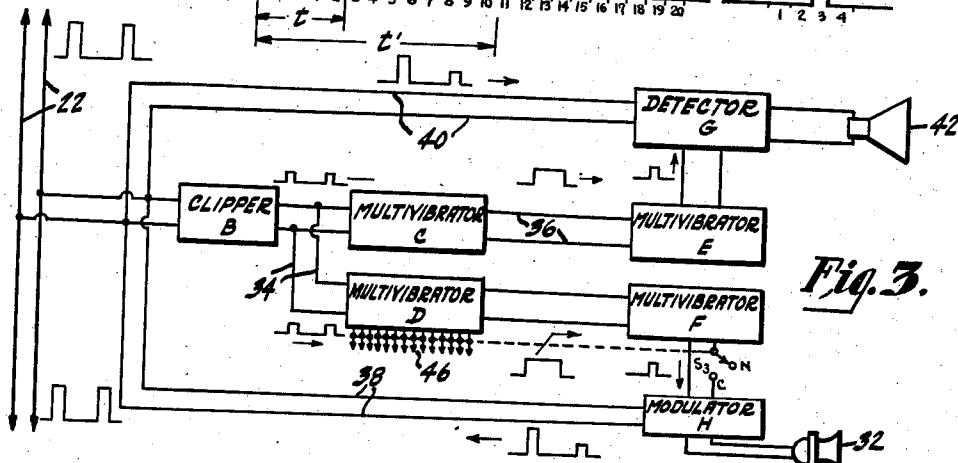
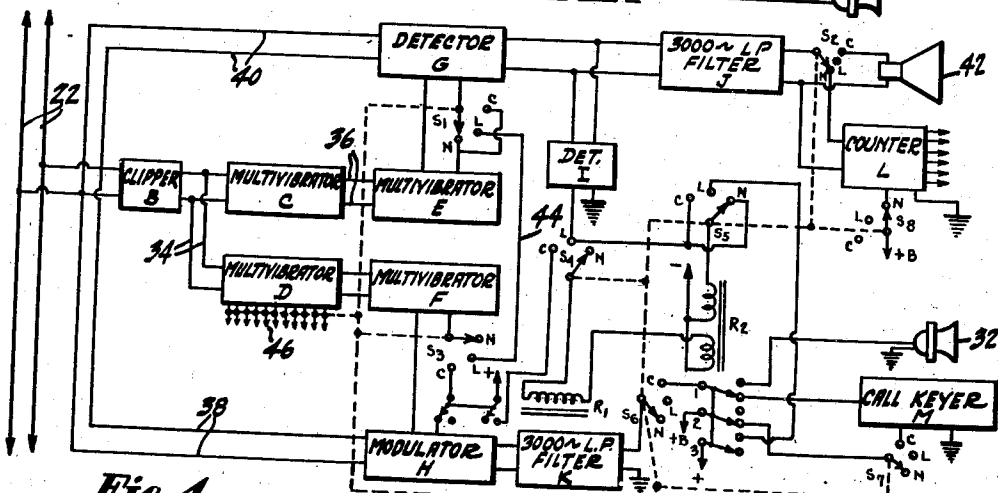


Fig. 4.



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COMMUNICATION SYSTEM

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11 Claims. (Cl. 179—15)

1

This invention relates to a communication system, and particularly to a system of the type known as an interoffice communication system.

In prior art systems of this type which include a plurality of stations, each station is ordinarily connected to at least as many circuits as there are stations with which communication is to be effected. Installation and maintenance of such a system is, accordingly, complicated and expensive.

One of the objects of this invention is to provide an improved communication system using one interconnector between all the stations.

A further object of the invention is to provide an improved communication system in which each station is connected by a single cable to the preceding station and by one other cable to the succeeding station.

Another object of the invention is to provide an improved communication system which is comparatively easy and inexpensive to install and maintain.

Another object of the invention is to provide an improved communication system wherein communication may be effected with a plurality of stations over a common interconnector.

Another object of the invention is to provide an improved communication system including a number of stations wherein communication may be effected between any two stations of the system by means of an interconnector common to all such stations, and wherein a signal will be detected by the station for which it is intended and by no other.

These objects are achieved in accordance with the invention by connecting stations of the systems by means of a single pulse-transmitting interconnector and by generating synchronizing pulses in the interconnector; each station includes means for applying to the interconnector amplitude modulated signal pulses occurring during periods in the intervals between the synchronizing pulses. These pulses differ for each station to which communication is to be effected, each station having assigned thereto a portion of the time interval between recurring synchronizing pulses. Each station is adapted to detect modulated signal pulses which occur during the period assigned to it and during no other period. This is effected by providing each station with a detector which is able to detect modulated signal pulses applied to the interconnector, but which is so biased as to give zero output except when energized by a pulse from a multivibrator, also provided at each station. This multivibrator is

2

adapted to generate pulses only during the period assigned to the station in which it is included, and the detector, therefore, detects signal pulses occurring during that period and no other.

The invention may be better understood from the following more detailed description thereof, when read in conjunction with the accompanying drawing in which:

Figure 1 is a block diagram of the system of the invention,

Figure 2 is a diagram illustrating the relation to each other in time and amplitude of the synchronizing and signal pulses before mentioned,

Figure 3 is a block diagram illustrating the relation to each other of the essential elements of each station in a system according to the invention, and

Figure 4 is a block diagram of each station in a preferred embodiment of the invention.

The system comprises a number of stations, and by following the teachings of this specification, it is possible to include at least 20 stations in any one system. In order not to crowd the drawing unduly, only 8 of these stations are shown in Fig. 1, and they are numbered 1-4 and 17-20.

All the stations are connected to a single concentric line, coaxial cable or other pulse-transmitting circuit 22, having its outer conductor grounded. The system may be thought of as a chain, with sections of the line connecting "adjacent" stations. Each station will, therefore, have only two cables connected to it (apart from connections to sources of power), one going to the preceding and the other to the succeeding station. The line is terminated at one end by its characteristic impedance 24, and connected to its other end in a pulse unit 26 which may include a multivibrator, amplifier and a clipper, or other appropriate means for applying to the line, and therefore to each station, regularly-recurring synchronizing pulses. Where the communication to be effected by the system is in the form of speech having a frequency not in excess of 3,000 cycles per second, the pulses may recur at a frequency of 6,000 cycles per second; but if greater fidelity is desired, the repetition rate should be increased.

Fig. 2 illustrates graphically two of these synchronizing pulses, designated 28a-28b, between which there is a time interval of $1/6000$ of a second. This interval is divided into portions, each station of the system being assigned to one of these portions. With 20 stations in a system, there will be at least 20 portions in the interval

between recurring synchronizing pulses. Thus, station 3 is assigned to a portion of the interval which may be, but is not necessarily, portion 3. This portion commences at time t after synchronizing pulse 28a and lasts for period 3. Similarly, station 11 may be assigned to portion 11, which commences at time t' after synchronizing pulse 28a and lasts for period 11. If a message is to be sent from any station of the system to station 3, for example, there are generated at the sending station (in manner hereinafter explained) signal pulses 30, which occur during period 3 only. These signal pulses are amplitude-modulated at the sending station, in accordance with the message to be sent, and applied to the line 22. They are, therefore, received at every station of the line but, as explained, station 3 is the only station of the system which can detect these pulses. Similar considerations with appropriate modifications apply to every other station of the system.

Referring now to Fig. 3, it will be seen that at each station the line 22 is connected to a clipper B, from the output of which there are two pulse channels 34 and 36 in parallel. One channel 34 includes two multivibrators D and F, the output of the latter multivibrator F being applied through a switch S_3 to a modulator H. A microphone 32, or other modulating means, is also connected to this modulator, the output of the modulator being applied by a conductor 38 or other pulse-transmitting channel back to the line 22. The other channel 36 includes multivibrators C and E, in series, the output of the latter being applied to a grid electrode of a blocked detector G. Another grid electrode of the detector G is connected by a similar conductor 40 to the line 22. The output of the detector is applied to a speaker 42. The multivibrator D is provided with a number of keys 46. With 20 stations on a line, each station will have 19 keys numbered to correspond with the numbers of each of the other stations. These keys are mechanically interconnected with the switch S_3 .

The tubes constituting the before-mentioned multivibrators, clipper, modulator and detector at each station are all of well-known types and it is not thought necessary to describe them or their associated circuits here in any detail. The only special requirement for the blocked detector G and the modulator H is that they shall each have at least two grid electrodes. The clipper B may be of the type described in U. S. Patent No. 2,132,655 to John P. Smith. The multivibrators may be of any appropriate type and in particular the multivibrator D may be of the type described in British Patent No. 456,840 to E. L. C. White.

The operation of the system is as follows: Synchronizing pulses from the line 22 are applied to the clipper B, which is so biased as to reject all pulses whose amplitude is below the clipping level shown in Fig. 2. This may be any convenient level. The synchronizing pulses being in excess of that level are cut off by the clipper and the clipped top portion of the pulses is employed to trigger multivibrator D, which sends out pulses commencing with the synchronizing pulses. The duration of these pulses depends on which key is pressed. If a message is to be sent to station 3, key 3 will be pressed. This will cause multivibrator D to give pulses lasting time t . These pulses, in turn, trigger multivibrator F, which sends out pulses beginning at the conclusion of time t and occurring during period 3. These are the signal pulses before referred to, and it will be

seen that they occur at the same frequency as the synchronizing pulses. Their amplitude is such that when fully modulated they do not reach the clipping level shown in Fig. 2.

Pressing the key of multivibrator D at any station causes the mechanically interconnected switch S_3 at that station to go from the normal (N) or open position to the call (C) or closed position. The signal pulses for multivibrator F are thus applied through switch S_3 to the modulator H, where the pulses are modulated in accordance with the message from the microphone 32, and the modulated signal pulses are then applied through conductor 38 to the line 22.

At this point, it will be observed that every station in the system will receive both the synchronizing pulses and the signal pulses from the sending station. Since the signal pulses are of smaller amplitude than the clipping level, they will be rejected by clipper B and will pass through conductor 40 to the detector G which is, however, so biased as to have zero output except when energized by a pulse from the multivibrator E. On the other hand, synchronizing pulses from the line 22 are applied to and clipped by the clipper B. This, in turn, triggers multivibrator C which gives pulses lasting for a definite time, different for each station. In the case of station 3, the pulses will last for time t , and in the case of station 11 they will last for time t' . The multivibrator E is triggered by the multivibrator C in the same way as the multivibrator F is triggered by the multivibrator D; that is to say, it sends out a narrow pulse commencing at the conclusion of the pulse from the multivibrator C and lasting for the period assigned to the station in which it is included. This pulse is used to energize the detector G so that in the example given, the signal pulses applied to the detector G from the line 22 and the energized pulses from the multivibrator E will coincide in time at station 3 only. The detector G then detects the signal and its output is applied to speaker 42.

In the form thus far described, the operator at station 3 (the receiving station) will hear the message transmitted, but will not know from what station he is being called until the sender tells him; and in order to reply, he will press the key of the station from which the signal came.

Fig. 4 is a block diagram of each station in the system in a preferred embodiment of the invention. Each station will include all the elements described in connection with Fig. 3, and, in addition thereto, a number of modifications now described. A low-pass filter K, inserted between the microphone and the modulator H prevents modulation of the signal pulses by frequencies higher than half the pulse frequency, that is, 3,000 cycles per second, since such higher frequencies will cause undesired signals. Similarly, a low-pass filter J, connected between the detector G and the speaker 42 prevents undesired frequencies higher than half the pulse frequency from reaching the speaker.

In the embodiment of Fig. 4, there are seven switches in addition to the switch S_3 . All of these switches are mechanically interconnected with the keys 46. A switch S_1 connects the multivibrator E to the detector G; S_2 connects the filter J to the speaker 42; and S_6 connects the microphone 32 to the filter K. The other switches will be described in connection with other elements of this embodiment. In addition to the normal

N and call C contacts, all switches are provided

with an intermediate listen contact (L) to which the switches go automatically when any key of the multivibrator D is pressed halfway down.

A conductor 44 connects the listen contacts of switch S₁ and S₃, so that if the key corresponding to a responsive station is pressed halfway down, the pulse from the multivibrator F will energize the detector G, and the message being delivered may be heard on speaker 42 of the station desiring to transmit a message. For this purpose, a jumper may be provided between the listen and call terminals of the switch S₂. In addition, a detector I is connected at its input terminals to a point between the detector G and the filter J. The output of the detector I is connected through a switch S₄ to relays R₁ and R₂. Therefore, pressure at any station on the key of the station already being called will energize the relays R₁ and R₂ at the station which wishes to make a call. The first of these two relays disconnects the multi-vibrator F from the modulator H, and the other supplies hold-in current for the first, so that no message can be transmitted.

It makes no difference whether the key is pressed halfway down or fully down, because as the key goes through the halfway position, the switches go to the listen contacts and the output of the detector I keeps both relays energized. If secrecy is desired, the jumper between the C and L contacts of switch S₂ may be omitted.

Another refinement lies in the provision of a call keyer M, which is connected to a source of power, indicated on the drawing by the designation B+, through the terminal 2 of the relay R₂ and a switch S₇. When a key of the multivibrator D is pressed down fully, the call keyer is energized through the switch S₇ unless R₂ has been energized by an incoming call and applies to the modulator H, through the call terminal of switch S₆, a number of low frequency pulses which turn off the comparatively high frequency signal pulses applied to that modulator by the multivibrator F. The number of these low frequency pulses depends on the station at which it is located. Thus, if a message is being set from station 3, the high frequency pulses will be turned off three times by three low frequency pulses from the call keyer M. Each station is also provided with a counter L connected to a source of power through the normal contact of a switch S₈ and to the detector G through the normal contact of the switch S₂. The counter is provided with a number of lights corresponding to the number of the other stations in the system. It counts the number of times the signal pulses from the sending station are turned off by the call keyer M and switches on the light which corresponds to the sending station. It may also be adapted to ring a bell or to give such other indication as may be desired. By the addition of further relays, it may also be made to operate automatically the appropriate key 46 of the multivibrator D, so that everything is in readiness to speak back to the sending station.

At the receiving station, also, the relay R₂ is closed by the incoming call through a switch S₅, connected between it and the detector I, and this disconnects the call keyer M. Closing the relay R₂ also immediately connects the microphone 32 to the modulator H through the filter K, so that to speak back to the sending station it is necessary only for the operator at the receiving station to press the key of multivibrator D corresponding

to the sending station, if this has not been done automatically as previously indicated.

While in the system described each station can call only one other station at a time, one of the stations may be adapted to modulate the synchronizing pulses. This is equivalent to modulating all the other pulses at once, and the message from this station will be heard by all the other stations.

The line 22 has been described as a concentric cable or any other circuit capable of transmitting pulses. It will be appreciated that by the addition of appropriate tuned circuits at each station, the circuits connecting each station may even be a radio link. It will also be seen that messages may be transmitted simultaneously between any number of pairs of stations of the system.

There has thus been described a communication system in which all the stations are connected by a single circuit, along which synchronizing pulses and amplitude-modulated signal pulses occurring in fixed time relation with the synchronizing pulses are transmitted. Each station of the system is adapted to detect signal pulses which occur in different timed relation to the synchronizing pulses.

I claim as my invention:

1. A communication system including a single pulse-transmitting circuit, a plurality of stations effectively connected at points on said circuit, means for applying to said circuit regularly-recurring synchronizing pulses, each of said stations having assigned thereto a predetermined period in the intervals between said pulses, said period having a predetermined time relation to said pulses, and said relation being different for each of said stations, and means at each station for applying to said circuit modulated signal pulses and for selecting a period for the occurrence of said signal pulses corresponding to the period assigned to the station to which said signal pulses are to be transmitted, each station being adapted to detect said signal pulses during the period assigned thereto only.

2. A system according to claim 1, characterized by the addition of means at each station controlled by said selection for indicating the station at which said selection has been made.

3. A communication system including a plurality of stations, a single pulse-transmitting circuit connecting said stations, means for applying regularly-recurring synchronizing pulses to said circuit, each of said stations being adapted to detect modulated signal pulses applied to said circuit and occurring during a predetermined period only, said period having a predetermined time relation to said synchronizing pulses and said relation being different for each of said stations, and means at each station for applying to said circuit modulated signal pulses capable of being detected by another of said stations as aforesaid, and for selecting the period during which said signal pulses occur.

4. A communication system including a plurality of stations, cables connected to each of said stations and connecting said station to the preceding and succeeding stations respectively, means for applying regularly recurring synchronizing pulses to the circuit constituted by said stations and said cables, each of said stations being adapted to detect modulated signal pulses applied to said circuit and occurring during a predetermined period only, said period having a predetermined time relation to said synchronizing pulses and said relation being different for each of said stations, and means at each station

for applying to said circuit modulated signal pulses capable of being detected by another of said stations as aforesaid, and for selecting the period during which said signal pulses occur.

5. A communication system including a plurality of stations, a single coaxial cable connecting said stations and terminated at one end thereof by its characteristic impedance, a pulse unit connected to said cable at its other end for applying regularly recurring synchronizing pulses to said cable, each of said stations being adapted to detect modulated signal pulses applied to said cable and occurring during a predetermined period only, said period having a predetermined time relation to said synchronizing pulses and said relation being different for each of said stations, and means at each station for applying to said cable modulated signal pulses capable of being detected by another of said stations as aforesaid, and for selecting the period during which said signal pulses occur.

6. A communication system including a plurality of stations, a single pulse-transmitting circuit connecting said stations, means for applying regularly-recurring synchronizing pulses to said circuit, each of said stations including a multivibrator and a detector, said multivibrator being adapted to apply to said detector energizing pulses occurring during a predetermined period only, said period having a predetermined time relation to said synchronizing pulses, and said relation being different for each of said stations, and said detector being adapted to detect modulated signal pulses applied thereto through said circuit on being energized by said multivibrator as aforesaid, and means at each station for applying to said circuit modulated signal pulses capable of being detected by another of said stations as aforesaid, and for selecting the period during which said signal pulses occur.

7. A communication system including a plurality of stations, a pulse-transmitting circuit connecting said stations, means for applying regularly-recurring synchronizing pulses to said circuit, each of said stations being adapted to detect modulated signal pulses applied to said circuit and occurring during a predetermined period only, said period having a predetermined time relation to said synchronizing pulses and said relation being different for each of said stations, means at each station including a key-controlled multivibrator activated by said synchronizing pulses for applying to said circuit modulated signal pulses capable of being detected by another of said stations as aforesaid, and means for selecting the period during which said signal pulses occur.

8. A communication circuit including a plurality of stations, a plurality of sections of a coaxial cable, each of said sections connecting one of said stations to the next succeeding station, said cable being terminated at one end thereof by its characteristic impedance, a pulse unit including a multivibrator connected to the other end of said cable for applying regularly-recurring synchronizing pulses to said circuit, each of said stations including a multivibrator and a detector, said last-mentioned multivibrator being adapted to apply to said detector activating pulses occurring during a predetermined period only, said period having a predetermined time relation to said synchronizing pulses, said relation being different for each of said stations, and said detector being adapted to detect modulated signal pulses applied thereto on being activated by said last-mentioned

multivibrator as aforesaid, and means at each station including a modulator and a key-controlled multivibrator adapted to be activated by said synchronizing pulses for applying to said circuit modulated signal pulses capable of being detected by another of said stations as aforesaid, and for selecting the period during which said signal pulses occur.

9. A communication system including a single pulse-transmitting circuit, a plurality of stations effectively connected at points on said circuit, means for applying to said circuit regularly-recurring synchronizing pulses, each of said stations having assigned thereto a predetermined period in the intervals between said pulses, said period having a predetermined time relation to said pulses, and said relation being different for each station of the system, means at each station for generating signal pulses, for selecting periods for the occurrence of said pulses corresponding to the periods assigned to the other stations of the system, for modulating said signal pulses and for applying said signal pulses to said circuit, each of said stations including at least two channels, means at each station for diverting synchronizing pulses applied thereto to one of said channels and signal pulses applied thereto to another of said channels, and means in the second of said channels for detecting signal pulses diverted thereto and occurring during the period assigned to the station in which said detecting means are located.

10. A communication system including a single pulse-transmitting circuit, a plurality of stations effectively connected at points on said circuit, and means for applying to said circuit regularly-recurring synchronizing pulses having an amplitude in excess of a predetermined level, each of said stations having assigned thereto a predetermined period in the intervals between said pulses, said period having a predetermined time relation to said pulses and said relation being different for each station of the system, each of said stations including (a) a clipper for clipping said pulses at said level and adapted to be activated by pulses having an amplitude in excess of said level, (b) means including at least one multivibrator adapted to be activated by said clipped pulses for generating signal pulses having an amplitude less than said level by the amount of a predetermined amplitude of the modulation, (c) means controlled by keys associated with said multivibrator for selecting periods for the occurrence of said signal pulses corresponding to the periods assigned to the other stations of the system, (d) means for modulating said signal pulses and for applying said modulated pulses to said circuit, (e) means including at least another multi-vibrator adapted to be activated by said clipped pulses for generating activating pulses occurring only during the period assigned to the station in which such means are located, and (f) means including a detector adapted to be activated by said activating pulses only for detecting modulated signal pulses applied to said circuit and occurring during the period assigned to said station.

11. The method of effecting communication between a plurality of stations effectively connected to points on a single pulse-transmitting circuit, including the following steps: (1) Generating in said circuit regularly-recurring synchronizing pulses, (2) Adjusting each station of the system to a predetermined period in the intervals between said pulses, said period bearing

9

a predetermined time relation to said pulses and said relation being different for each of said stations, (3) Generating signal pulses at one station, (4) Selecting a period for the occurrence of said signal pulses corresponding to the period assigned to a responding station, (5) Modulating said signal pulses in amplitude in accordance with the communication to be effected, (6) Ap-

10

plying said modulated pulses to said circuit, (7) Diverting synchronizing and signal pulses applied to said responding station into separate channels, (8) Detecting signal pulses diverted to one of said channels and occurring during the period assigned to the responding station.

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Disclaimer

2,406,165.—*Alfred C. Schroeder*, Feasterville, Pa. COMMUNICATION SYSTEM. Patent dated Aug. 20, 1946. Disclaimer filed Oct. 29, 1948, by the assignee, *Radio Corporation of America*.

Hereby enters this disclaimer to claims 1, 3, 4, and 9 of said patent.

[Official Gazette Dec. 7, 1948.]