J. R. CARSON.

DUPLEX TRANSLATING CIRCUITS.

APPLICATION FILED MAR. 26, 1917. RENEWED MAY 27, 1919.

1,343,308. **Patented June 15, 1920.**

Fig. 1

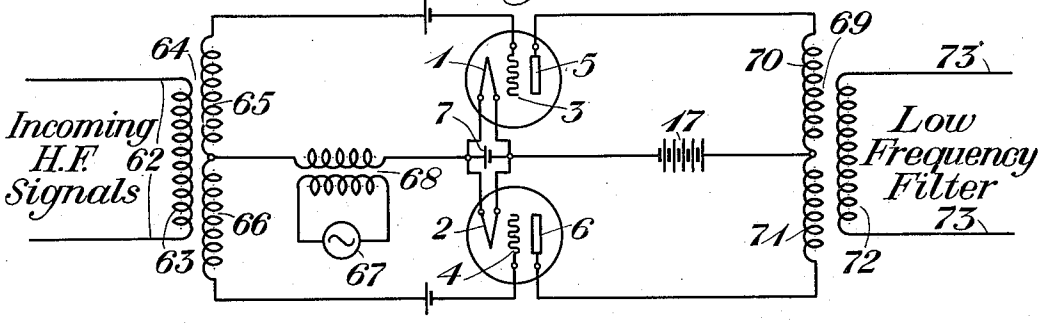


Fig. 2

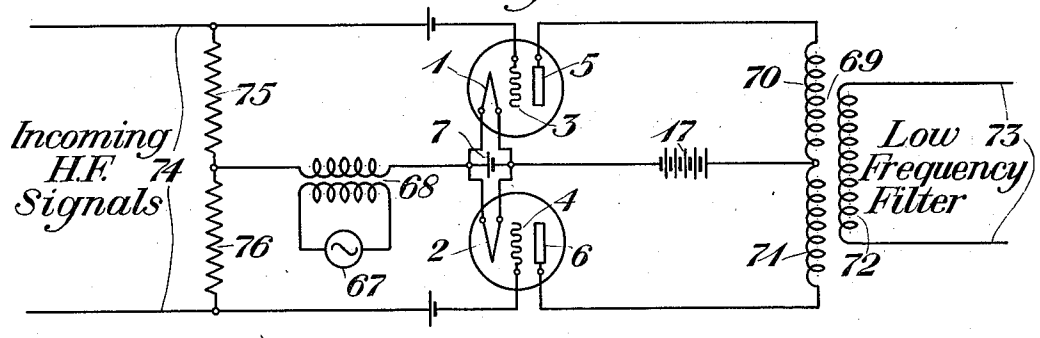


Fig. 3

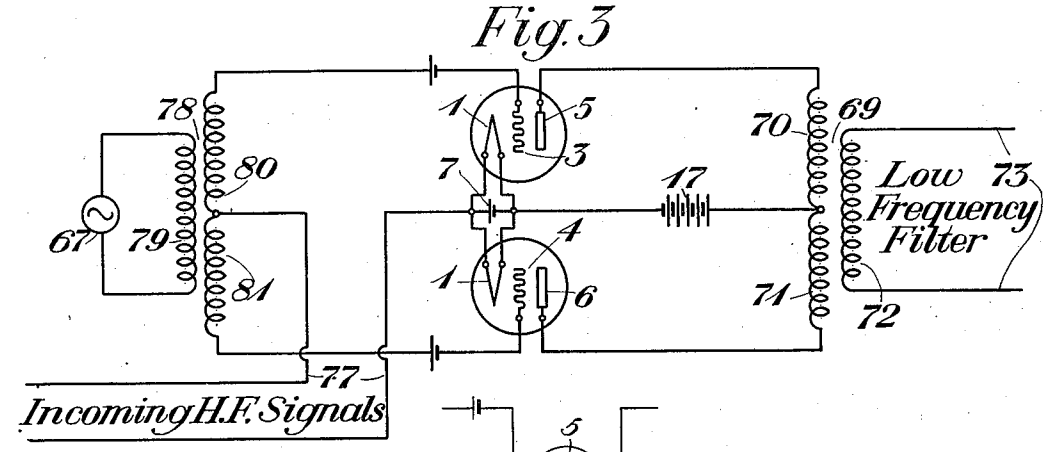
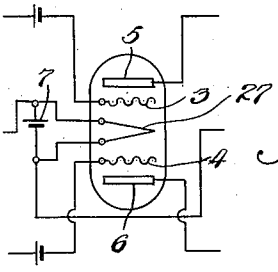


Fig. 4.



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DUPLEX TRANSLATING-CIRCUITS.

1,343,308. Specification of Letters Patent. Patented June 15, 1920.

Original application filed September 5, 1916, Serial No. 118,573. Divided and this application filed March 26, 1917, Serial No. 157,414. Renewed May 27, 1919. Serial No. 300,180.

To all whom it may concern:

Be it known that I, JOHN R. CARSON, residing at Montclair, in the county of Essex and State of New Jersey, have invented certain Improvements in Duplex Translating-Circuits, of which the following is a specification.

The invention of this application, which is a division of application Serial No. 118,573, filed September 5th, 1916, relates to signaling circuits and has for its general object the provision of a duplex translating system which is capable of a wide range of utility, and which shall exhibit a high degree of efficiency in the various applications of which it is capable.

In its general embodiment the invention comprises a duplex translating structure having a pair of input and a pair of output circuits, the pair of input circuits being symmetrically associated with one source of current variation, and oppositely associated with a second source, the output circuits being differential with respect to one outgoing or receiving circuit and cumulative with respect to another outgoing circuit. Thus the first mentioned source produces by virtue of its symmetrical connections potential fluctuations of the same phase in the two input circuits, while the second mentioned source, by virtue of the fact that the input circuits are oppositely associated therewith, produces potential fluctuations of opposing phase in said input circuits. This statement is made to define the significance attached to symmetrical and opposite connections in this specification.

Thus in general there may be four main elements comprising two sources and two receiving circuits which may be variously related to the translating device proper. Additional results may be produced by the omission of one or more of the four main elements, with corresponding changes in the connections of the remaining elements. The form of translating device used may preferably be of the thermionic vacuum tube type, though this invention is not limited to any particular type of translating device. It will be understood that the term translating device embraces broadly an apparatus or relay capable of amplification, detection or modulation of signal waves.

In its more specific aspects the invention has for one of its objects the provision of a selective receiving apparatus for multiplex carrier wave signaling in which the necessity for high frequency tuning and selectivity is eliminated.

The invention will be more fully understood by reference to the drawing in which Figures 1, 2, 3 and 4 illustrate four modifications of a selective receiving system for multiplex carrier currents.

Referring now to Fig. 1, a pair of three element thermionic tubes, having filaments 1, 2, grids 3, 4, and plates 5, 6, are provided, the filaments being heated by a battery 7. The tubes are preferably similar and equal in their structure and characteristic, and are equivalent to and may be replaced as illustrated in Fig. 4 by a single duplex tube such as is shown in the patent of E. H. Colpitts, 1,128,292, February 16th, 1915. The input circuits of the tubes are arranged in parallel with respect to the secondary of a transformer 68 in the common conductor of the two input circuits. The output circuits are also connected in parallel with respect to a battery 17.

In accordance with this arrangement the plurality of carrier currents are led in over a circuit 62 which terminates in the primary 63 of a transformer 64, having two secondary windings 65 and 66, one included in each of the input circuits of the repeater. A local source of high frequency is supplied by a "homodyne" or "heterodyne" generator 67 which is coupled through transformer 68 to the common conductor of the two input circuits. It will be understood that a heterodyne generator is a source of alternating current energy of a frequency differing from that of the incoming carrier wave by a pre-assigned frequency preferably within the limits of audition, while a homodyne generator is a source of energy of a frequency identical with that of the incoming carrier wave. The former is employed when unmodulated carrier waves are transmitted, while the latter is preferably employed when the carrier wave is modu-

lated as in carrier wave telephony. In each output circuit is inserted a primary winding of a transformer 69, the winding in circuit with plate 5 being designated 70 and that in circuit with plate 6 being designated 71. The secondary 72 of the transformer is connected to a circuit 73 leading through a low frequency filter (not shown) to a receiving instrument. The filter to be used is of a well known type of broad band filter which will suppress all frequencies above a certain limit, but permit the passage without attenuation of all frequencies below this limit, which for telephonic purposes might be fixed at 2,500 cycles. This type of filter is disclosed and fully described in U. S. Patent of G. A. Campbell, No. 1,227,113, issued May 22, 1917.

The operation of the apparatus will be understood from the following considerations:

It has been pointed out in a U. S. patent issued to Maurice LeBlanc, No. 857,079 of June 18, 1907, that when a plurality of carrier currents of different frequencies, each modulated by voice currents are sent out on a line, and at a receiving station a frequency equal to that of one of the carriers is provided, this frequency will interact with the modulated carrier current having the same period, with the result that a suitable receiving instrument will respond to the low frequency voice currents by which that particular carrier is modulated, while carriers having a different frequency will be without effect. A full theoretical discussion of the principles involved is given in the above patent and need not here be repeated, it being sufficient to point out that if a plurality of carrier waves having frequencies $f_1, f_2 \ldots f_n$ be sent out on the line, each modulated at audio frequency p, and further if at the receiving station a "homodyne" frequency f_k equal to the frequency of one of the carrier waves be allowed to interact therewith, a plurality of frequencies will result in the output circuits of the repeater structure of Fig. 6 as follows:

$$\begin{matrix}(f_1+f_k+p), (f_1+f_k-p), (f_1-f_k+p), (f_1-f_k-p)\\ (f_2+f_k+p), (f_2+f_k-p), (f_2-f_k+p), (f_2-f_k-p)\\ (f_n+f_k+p), (f_n+f_k-p), (f_n-f_k+p), (f_n-f_k-p)\end{matrix}$$

Assuming that the "homodyne" frequency f_k is equal to frequency f_n, the last four frequencies reduce to $(2f_k+p)$, $(2f_k-p)$, p and $-p$. If the carrier frequencies differ from each other by an amount greater than $2p$ it will be clear that all of the frequencies above set forth except p and $-p$ will be greater than p. Hence a filter in the outgoing circuit which suppresses all frequencies above p will suppress everything except the audio frequency by which carrier frequency f_n was modulated. The signals by which other carriers were modulated will not be received because the resultant frequencies due to their interaction with the carrier frequency and the "homodyne" frequency will be greater than p. It will now be apparent that by applying the "homodyne" frequency to the common conductor of the input circuits of Fig. 1 through transformer 68, so that this frequency interacts with the several incoming carrier frequencies modulated by low frequency signals, the various resultant frequencies above set forth will appear in the output circuits of the repeater and be impressed on outgoing circuit 73 through transformer 69, the filter acting to suppress everything except the voice currents which modulated the carrier current having the same frequency as the "homodyne" generator. The same effect will be produced if the incoming carrier currents are impressed upon the translating circuits through transformer 68, and the homodyne frequency be impressed through transformer 64. An additional advantage to be obtained by this arrangement is that, owing to the neutral connection of the "homodyne" generator with respect to the incoming line, the energy from the generator does not react upon the line and cause a tone in other receiving devices upon the same line. A further advantage attaching to the use of duplex translating arrangements resides in the fact that distortion of the incoming signal which is always and inherently caused by ordinary detectors is substantially eliminated by the combination of the duplex detector with a local homodyne generator. Consequently the utility of the duplex detector is not limited to its use in combination with a filter nor is it limited to use in a multiplex system.

A slight modification is shown in Fig. 2 in which the incoming carrier currents are impressed upon the input circuits of the duplex detector by a conductive connection instead of by an inductive connection such as shown in Fig. 1. The two sides of the incoming line 74 are directly connected to the grids 3 and 4, and are bridged by substantially equal resistances 75 and 76, to the mid-point of which the common conductor of the input circuits of the detector is connected, the "homodyne" currents being applied just as in Fig. 1. The operation is similar to that already described in connection with Fig. 1.

In Fig. 3 an alternative arrangement is shown in which the incoming line 77 is directly connected in the common conductor of the two input circuits of the repeater, while the "homodyne" currents from generator 67 are applied through a transformer 78, having secondary windings 80 and 81, one in each of the input circuits. The operation of this circuit is similar to that of Figs. 1 and 2. It will be understood that the ar-

rangements of Figs. 1, 2 and 3 are essentially equivalent and that the particular connections are immaterial although preferably one of the two sources of potential variations should be applied symmetrically or cumulatively and the other oppositely to the two input circuits and the receiving circuit 73 should be differently coupled to the two output circuits. The invention is not limited to such an arrangement, however.

It will be seen that by this invention a duplex translating system has been devised which is both simple and efficient and which is capable of a large number of applications to produce widely varying results. While the invention has been illustrated as embodied in a limited number of forms it will be understood that the embodiment may be widely varied without departing from the scope of the appended claims.

What is claimed is:

1. A receiving apparatus for carrier wave signaling systems comprising a pair of translating devices having input and output circuits, a circuit for the reception of high frequency signals, a second circuit containing a local source of high frequency energy, one of said circuits being symmetrically associated with said input circuits, and the other being oppositely associated with said input circuits, and a receiving circuit differentially associated with said output circuits.

2. A receiving apparatus for carrier wave signaling systems comprising a duplex detector arrangement having divided input and divided output circuits, a circuit for the reception of high frequency signals, a second circuit containing a local source of high frequency energy, one of said circuits being symmetrically associated with said input circuits and the other being oppositely associated with said input circuits, and a receiving circuit differentially associated with said output circuits.

3. A receiving apparatus for carrier wave signaling systems comprising a pair of translating devices having input and output circuits, a circuit for the reception of high frequency signals, a second circuit containing a local source of high frequency energy, one of said circuits being symmetrically associated with said input circuits and the other being oppositely associated with said input circuits, a receiving circuit differentially associated with said output circuits, and a filter in said receiving circuit.

4. A receiving apparatus for carrier wave signaling systems comprising a duplex detector arrangement having divided input and divided output circuits, a circuit for the reception of high frequency signals, a second circuit containing a local source of high frequency energy, one of said circuits being symmetrically associated with said input circuits and the other being oppositely associated with said input circuits, a receiving circuit differentially associated with said output circuits and a filter in said receiving circuit.

5. In a multiplex carrier wave transmission system, a receiving system comprising a pair of translating devices having input and output circuits, a circuit for the reception of signal waves, a second circuit containing a source of energy of frequency substantially equal to that of one of the carrier waves, one of said circuits being symmetrically associated with said input circuits and the other being oppositely associated with said input circuits, a receiving circuit differentially associated with said output circuits and a filter in said receiving circuit.

6. In a multiplex carrier wave signaling system, a receiving system comprising a duplex translating arrangement having divided input and divided output circuits, a circuit for the reception of signal waves, a second circuit containing a source of energy of frequency substantially equal to that of one of the carrier waves, one of said circuits being symmetrically associated with said input circuits and the other of said circuits being oppositely associated with said input circuits, a receiving circuit differentially associated with said output circuits and a filter in said receiving circuit.

7. A receiving apparatus comprising a pair of translating devices, a circuit upon which carrier currents of different frequencies are impressed, said last named circuit being associated with the translating devices, a source of local oscillations of a period substantially equal to that of one of the carrier currents associated with said repeater circuits, and an outgoing circuit provided with a low frequency filter associated with said translating devices, whereby only the low frequency signals impressed upon the carrier currents of the frequency of the local source will be effective in the outgoing circuit.

8. In a receiving apparatus, a pair of repeater circuits comprising a common conductor and also individual sections, a circuit upon which carrier currents of different frequencies are impressed, said last named circuit being serially associated with the individual conductors of the repeater circuits, a source of local oscillations of a period substantially equal to that of one of the carrier currents associated with the common conductor of the repeater circuits, and an outgoing circuit provided with a low frequency filter associated with said repeater circuits, whereby only the low frequency signals impressed upon the carrier currents of the frequency of the local source will be effective in the outgoing circuit.

9. In a receiving apparatus, a duplex re-

peater arrangement comprising a pair of input and a pair of output circuits, each pair having a common conductor, a circuit upon which carrier currents of different frequencies are impressed, said last named circuit being serially associated with the two input circuits, a source of local oscillations of a frequency substantially equal to that of one of the carrier currents associated with the common conductor of said input circuits, and an outgoing circuit provided with a low frequency filter, differentially associated with the output circuits, whereby only the low frequency signals impressed upon the carrier currents of the frequency of the local source will be effective in the outgoing circuit.

10. In a receiving apparatus, a pair of repeater circuits comprising a common conductor and also individual sections, means for applying received oscillations to said repeater circuits in such manner as to react serially upon the individual sections thereof, a source of local oscillations of a frequency slightly differing from that of the received oscillations, means associating the local source with the common conductor of the repeater circuits, and an outgoing circuit, provided with a filter which passes a frequency substantially equal to the difference between the received and local frequency, said outgoing circuit being associated with said repeater circuits.

11. A translating apparatus comprising a duplex translating arrangement including a common path and individual paths, a plurality of independent circuits, one of said independent circuits comprising a source of modulated high frequency oscillations, another of said independent circuits comprising a source of unmodulated high frequency oscillations and another of said independent circuits comprising a receiving circuit, one of said independent circuits being associated with said common path.

12. A translating apparatus comprising a duplex translating arrangement including a common path and individual paths, a plurality of independent circuits, one of said independent circuits comprising a source of modulated high frequency oscillations, another of said independent circuits comprising a source of unmodulated high frequency oscillations and another of said independent circuits comprising a receiving circuit, one of said independent circuits being associated with said common path, and the others of said independent circuits being associated with said individual paths.

13. A translating apparatus comprising a duplex translating arrangement, parallel circuits for said translating arrangement including a common path and individual paths, conductive evacuated gaps in said individual paths, a source of unmodulated high frequency oscillations and a source of modulated high frequency variations associated with said circuits, one of said sources being associated with said circuits through said common path.

14. A translating apparatus comprising a duplex translating arrangement, parallel circuits for said translating arrangement including a common path and individual paths, conductive evacuated gaps in said individual paths, a source of unmodulated high frequency oscillations and a source of modulated high frequency variations associated with said circuits, one of said sources being associated with said circuits through said common path, and the other of said sources being associated with said circuits through said individual paths.

15. A translating apparatus comprising a duplex translating arrangement, parallel circuits for said translating arrangement including a common path and individual paths, conductive evacuated gaps in said individual paths, a plurality of independent circuits comprising a source of unmodulated high frequency oscillations, a source of modulated high frequency oscillations and a receiving circuit, one of said independent circuits being associated with said parallel circuits through said common path.

16. A translating apparatus comprising a duplex translating arrangement, parallel circuits for said translating arrangement including a common path and individual paths, conductive evacuated gaps in said individual paths, a plurality of independent circuits comprising a source of unmodulated high frequency oscillations, a source of modulated high frequency oscillations and a receiving circuit, one of said independent circuits being associated with said parallel circuits through said common path, and the others of said independent circuits being associated with said parallel circuits through said individual paths.

17. A receiving apparatus for carrier wave signaling systems comprising a duplex translating arrangement including a common path and individual paths, a circuit for the reception of high frequency signals, a second circuit including a local source of high frequency energy, one of said circuits being associated with said common path and the other of said circuits being associated with said individual paths, an outgoing circuit associated with said translating arrangement, and a filter in said outgoing circuit.

18. A receiving apparatus for carrier wave signaling systems comprising a detecting arrangement for translating high frequency received oscillations into low frequency signaling current, a circuit to supply high frequency received oscillations to said detecting arrangement, and a circuit

for supplying local high frequency energy to said detecting arrangement, said circuits being so associated with said detecting arrangement that energy from said last mentioned circuit will not react upon said first mentioned circuit.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 15th day of March, 1917.

JOHN R. CARSON.

Witnesses:
RALPH W. WOLF,
FRED'K S. ROBINSON.