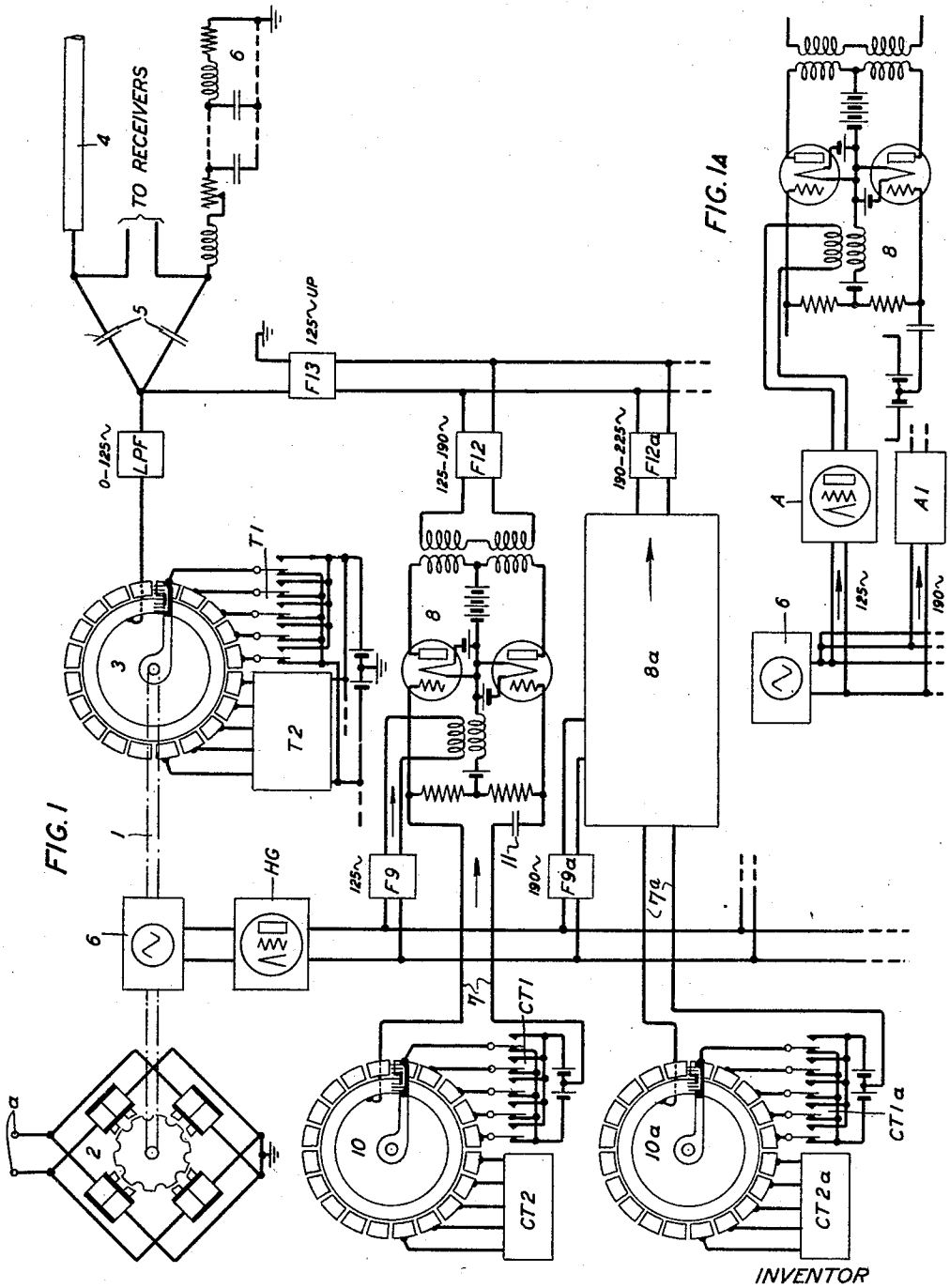
April 26, 1932. W. S. GORTON 1,855,601

IMPULSE AND WAVE TRANSMISSION SYSTEM

Filed Aug. 26, 1930 2 Sheets-Sheet 1



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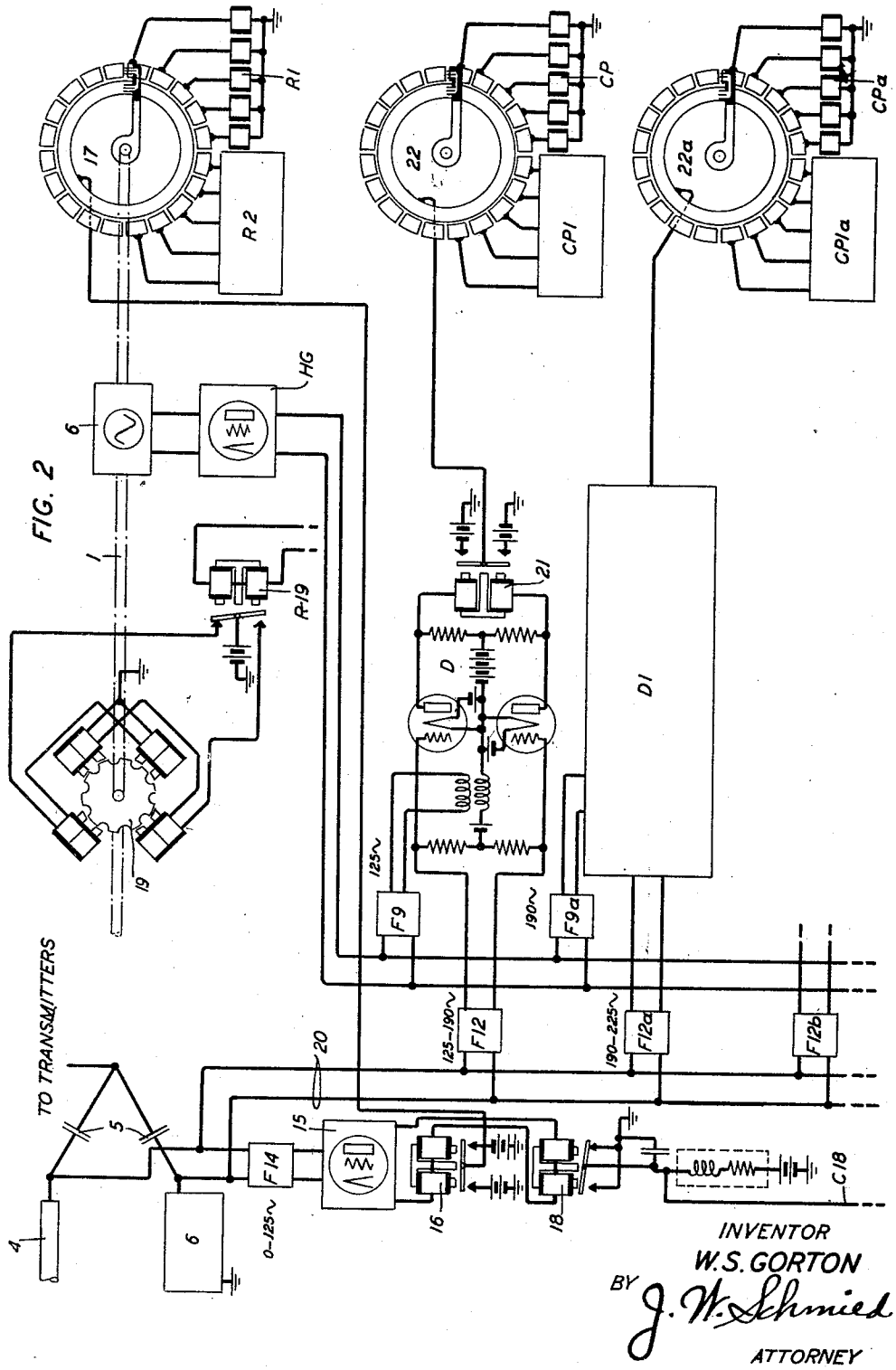

FIG. 2

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UNITED STATES PATENT OFFICE

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IMPULSE AND WAVE TRANSMISSION SYSTEM

Application filed August 26, 1930. Serial No. 477,880.

This invention relates to communication systems in which signals are transmitted by means of multiplex equipment and the multiplex equipment is employed to synchronize the oscillators of modulated carrier wave transmission equipment.

An object of the invention is to make more economical use of an available frequency range than can be done where the transmission is carried on exclusively by means of rotary distributor apparatus.

Another object is to provide for the synchronization of carrier frequency circuits without the transmission of any carrier frequency current over the line.

From a generic aspect the modulating waves of the carrier portion of the system may have any wave form and may represent signals by any desired signalling code. However, in the system herein described carrier waves are modulated by telegraph impulses from printing telegraph senders which impulses are transmitted over rotary distributors.

Further objects and features of the invention will appear from a perusal of the following detailed description read in connection with the accompanying drawings.

In the drawings,

Fig. 1 represents a schematic circuit diagram of a transmitting station;

Fig. 1—A a modification thereof; and

Fig. 2, a similar diagram of a receiving station.

The circuit of Fig. 1 is represented as transmitting to the station of Fig. 2 over a duplex line, but the essential principles of the invention may be practiced in one-way systems as well as duplex systems.

In Fig. 1 the rotating shaft 1 is driven by a La Cour motor 2 having its terminal a, a' connected to any suitable source of constant frequency current such as is known in the art. The shaft 1 drives the brush arm of the synchronous distributor 3. The contacts of a group of printing telegraph senders T1, T2, etc., are connected to the segments of the distributor. The ring associated with the segments is connected to the line through a suitable low-pass filter LPF adapted to transmit a range of frequencies appropriate to the telegraph signals transmitted from the transmitters T1, T2, etc. The line in this case is indicated as a submarine cable 4. The ratio arms 5 and the balancing network 6 are of the usual type. They may be omitted in a system wherein transmission takes place in only one direction at a time. The apparatus so far described is of a more or less conventional type. Let it now be supposed that the signals transmitted from the transmitters T1, T2, do not occupy the total frequency range available on the cable 4. For example, let it be assumed that they occupy a range of frequencies extending from 0 to 125 cycles and that a range of a few hundred cycles, more or less, above this range is available for telegraph transmission. (All frequencies given herein are in complete cycles per second.) The apparatus about to be described is intended to make use of the rest of the available frequency range.

The shaft 1 carries an alternating current generator 6 which supplies the input circuit of a harmonic generator HG. The generator 6 and the harmonic generator HG typify any suitable apparatus driven by the shaft 1 to supply suitable carrier frequencies as will be described in what follows. A frequency of 125 cycles is supplied through the circuit 7 to the carrier suppression vacuum tube modulator circuit 8. A suitable filter F9 selects the frequency of 125 cycles from the output of the harmonic generator HG. A suitable other selective circuit F9a selects another suitable carrier frequency, for example, 190 cycles, transmitted through the circuit 7a to a carrier suppression modulating circuit 8a. Circuits 8 and 8a may be supplied with modulating impulses or signals from any desired signaling source. In the present system impulses from a suitable plurality of transmitters CT1 and CT2 are transmitted over a rotary distributor 10 to the input circuit of the modulating circuit 8. A condenser 11 is preferably included in the circuit connecting the rotary distributor 10 to the circuit 8. In the output circuit of the circuit 8 is a filter designed to transmit a range of frequencies from 125 cycles to 190 cycles. This range is

the upper side-band which results from modulation of a 125 cycle wave with impulses proceeding from the transmitter CT1 and CT2. The lower side-band is assumed to be suppressed by the filter F12.

Other filters F12*a* etc. serve to pass the waves proceeding from other modulators 8*a*, etc. which are supplied with modulating impulses from other series of transmitters CT1*a*, CT2*a*, etc. over rotary distributors 10*a* etc. A filter F13 is connected between the filter F12, F12*a*, etc. and the line. Filter F13 serves to transmit all frequencies essential to the system above 125 cycles. Filter F13 is not essential and may be omitted.

In the modified form of circuit illustrated in Fig. 1A the generator 6 is a multi-frequency generator of a type well known in the art. It supplies currents of the frequencies of 125 cycles, 190 cycles etc. to a plurality of amplifiers A, A1 which in turn apply them to the carrier suppression modulators 8, 8*a* etc. The rest of the system is the same as that of Fig. 1.

At the receiving end of the system shown in Fig. 2 waves of frequencies between 0 and 125 cycles are selected by the filter F14 and transmitted to a shaping and amplifying circuit 15. The output circuit of the circuit 15 is connected to a polar relay 16 whose contacts control the application of positive and negative battery to the ring and associated segments of a distributor 17. To the segments of distributor 17 are connected the printer magnets of the series of receivers R1, R2, P1, P2, etc.

The polar relay 18 is a synchronizing relay corresponding in function to the relay 13 of Knoop Patent 1,747,248 February 18, 1930. The La Cour motor 19 drives the shaft 1. It is assumed that the relay 18 is connected to synchronizing apparatus for driving and synchronizing the La Cour motor 19 in the same manner as the relay 13 in Patent 1,747,248 is connected to the motor 5 in that patent. Conductor C18 corresponds to conductor 56 of the patent and relay R19 corresponds to relay 43 of the patent.

The elements 18 and R19 typify any suitable sort of driving and synchronizing mechanism. If the means for maintaining synchronism consists of a corrector working on a differential gear arrangement it is considered essential for the purpose of the invention that the differential gear be not located between the generator 6 and the rotary distributor 17. It should be connected between the La Cour motor 19 and the apparatus driven thereby. With this limitation in mind practically any sort of correcting or synchronizing arrangement keeping the rotary distributor 17 of the receiving station in synchronism with the rotary distributor 3 of the transmitting station may be employed.

The shaft 1 drives the generator 6. The generator 6 supplies a harmonic generator HG in the same manner as the corresponding generator at the transmitting station to produce waves of 125 cycles, 190 cycles, etc. These waves are selected by suitable selecting circuits F9, and F9*a* and supplied to demodulating circuits D, D1, etc. which are of a well known character.

Waves of frequencies above 125 cycles arriving over the cable 4 are conveyed by the circuit 20 to a series of selective filters F12, F12*a*, F12*b*, etc. Filter F12 selects a range of frequencies of from 125 to 190 cycles, filter F12*a* selects a range of frequencies of from 190 to 265 cycles, other filters select other suitable ranges of frequencies for application to their respective demodulating circuits D1, D2, etc.

Each demodulating circuit has its output connected to receiving apparatus suitable for receiving demodulated waves. Thus, the circuit D has in its output a polar relay 21 which controls the application of positive and negative impulses over a rotary distributor 22 to printer magnets of a series of printers CP, CP1, etc. Another suitable series of printers CP*a* and CP1*a* is connected over distributor 22*a* to the output circuit of the demodulator D1, and still other series to the output circuits of other demodulating demodulators if other demodulators are provided in the system.

Generator 6 in the arrangement illustrated is driven at the same number of revolutions per unit of time as the brush arm of its associated distributor 3 or 17, as the case may be. However, if the generator 6 does not revolve sufficiently rapidly a gear may be introduced between the generator and the distributor brush to increase the relative speed of revolution of the generator to any desired amount. The La Cour motor, the generator 6, and the distributor may be located in any desired order along the shaft so that the gear will not be interposed between the La Cour motor and the distributor. The power produced by the generator 6 may be quite small because this power can be increased to any desired amount in the output circuit of the harmonic generator HG.

In the operation of the system the brush of distributor 17 is kept in synchronism with the brush of distributor 3 except for small phase variations. By the use of modern correction systems this phase variation may be reduced to quite infinitesimal proportion. A correcting system suitable for doing this is illustrated, for example, in Patent 1,747,248 referred to above. Consequently, the generator 6 at the transmitting and receiving stations respectively are kept in synchronism. This results in the various sources of carrier oscillation being likewise kept in synchronism with the corresponding sources at the opposite end of the system. Thus, for example, the 125

cycle carrier wave supplied to the demodulating circuit D is in synchronism with the 125 cycle carrier wave supplied to the modulating circuit 8 at the transmitter. The distributor 22 is synchronized with the distributor 10, and the distributor 22*a* with distributor 10*a* by the signal impulses passing between the corresponding distributors in a known manner by known apparatus; these distributors are independent of distributors 3 and 17 in angular velocity and may be driven by any suitable known types of apparatus.

It is not essential to the invention that a plurality of transmitters T1, T2 be employed, although in practice this may be the most convenient way of utilizing the available frequency range. Likewise, it is not essential that the input circuit, or any particular modulating circuit such as the circuit 8, be supplied by a plurality of printing telegraph transmitters TT1, TT2, etc. Single synchronized or unsynchronized transmitters of any suitable known kind may take the place of each of the series of transmitters.

What is claimed is:

1. In a system for the communication of intelligence, an impulse transmitter at a transmitting station, an impulse receiver at a receiving station, each of said stations being provided with a rotary distributor for distributing the impulses to be transmitted or received respectively, and synchronizing means whereby the distributor at the receiving station is kept in synchronism with the distributor at the transmitting station, in combination with a carrier wave transmission system, said system comprising a source of carrier frequency oscillations at each terminal, one of said sources at one terminal being controlled in frequency and phase by one of said distributors located at the station whereat the source is located, and the other of said sources being controlled by the distributor located at the other end of the system whereat the other distributor is located.

2. In a multiplex telegraph system, distributors at remote points in the system, driving means and synchronizing means for said distributors, carrier current generators one located at each distributor, a signaling source associated with one of said generators, signal receiving means associated with the other of said generators, and mechanical coupling means for maintaining a definite periodic relation between the waves produced by each of said generators and the driving means of the distributor located thereat.

3. A communication system comprising synchronized rotary distributors at opposite terminii of the system, sources of carrier waves at opposite terminii of the system, each controlled in phase and frequency by associated synchronous distributors, and modulating means for modulating the carrier waves with waves or impulses representing signals to be transmitted at the transmitting end and demodulating apparatus for demodulating the modulated waves at the receiving end.

4. A submarine cable system comprising a synchronous distributor communication channel consisting of elements for transmitting over a line direct current impulses representing messages and elements for receiving the impulses, a carrier wave communication channel, said carrier wave communication channel including devices for producing one or more carrier waves, one or more separate sets of apparatus for producing signaling impulses, devices for modulating the one or more carrier waves with the signaling impulses and transmitting them over said signaling line, and elements whereby a distributor of said synchronous distributor communication channel and said devices for producing carrier waves are maintained in a fixed phase relation.

5. In a communication system a device for generating carrier waves driven by a shaft upon which is mounted a rotating element of a synchronous distributor, mechanism for transmitting signaling impulses to said synchronous distributor, and separate means uncontrolled by said mechanism for transmitting over a path other than said distributor, other signaling waves or impulses to said carrier waves, and devices for modulating said carrier waves by said other signaling waves or impulses.

In witness whereof, I hereunto subscribe my name this 25 day of August, 1930.

WILLIAM S. GORTON.