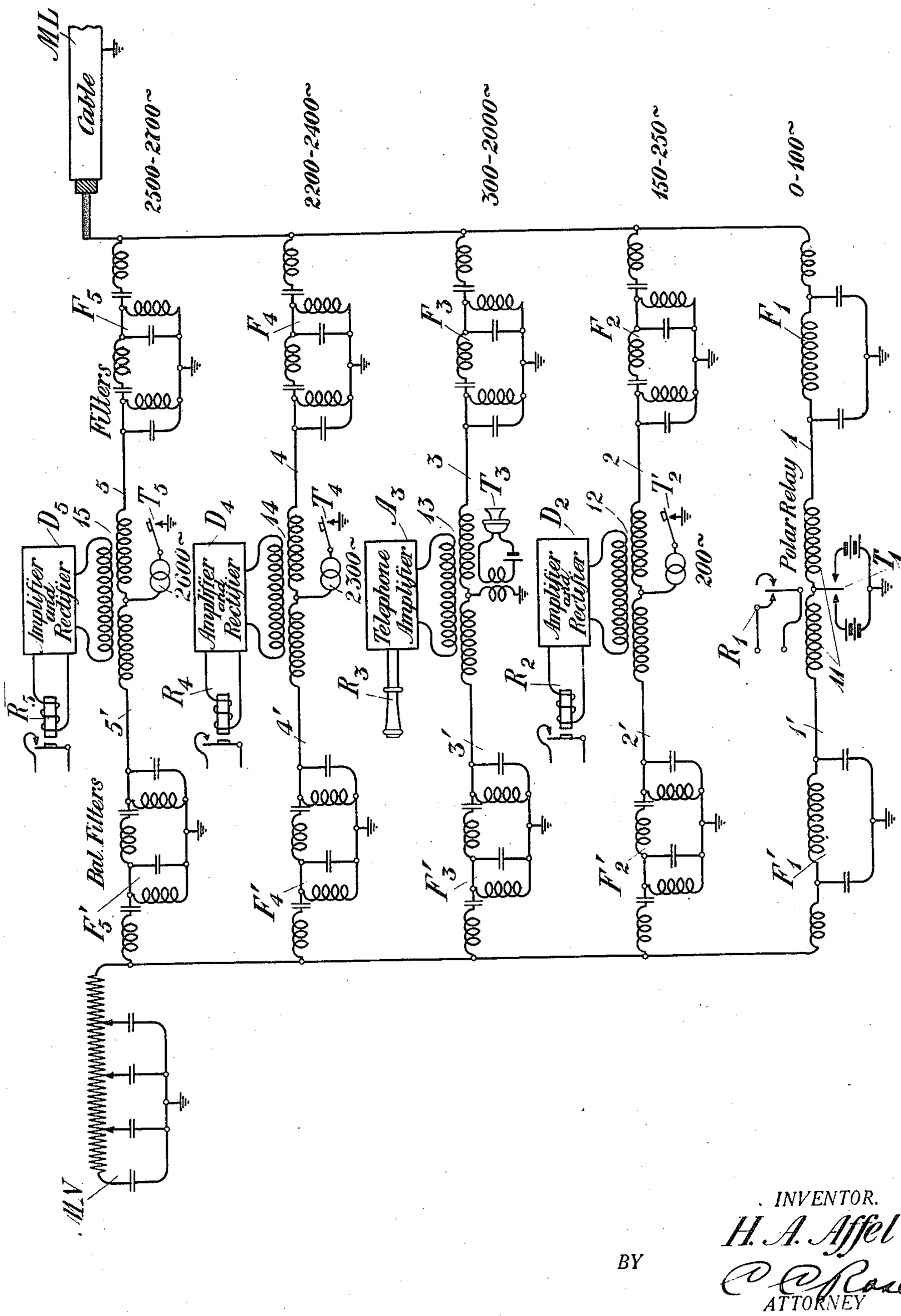
May 22, 1923. 1,455,827

H. A. AFFEL

SELECTIVE CIRCUIT FOR MULTIPLEX TRANSMISSION

Filed Sept. 24, 1919



INVENTOR.
H. A. Affel

BY

ATTORNEY

Patented May 22, 1923. 1,455,827

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SELECTIVE CIRCUIT FOR MULTIPLEX TRANSMISSION.

Application filed September 24, 1919. Serial No. 325,841.

To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Selective Circuits for Multiplex Transmission, of which the following is a specification.

This invention relates to signaling systems and more particularly to systems in which a plurality of signals are simultaneously transmitted over the same conductor.

One of the principal features of the invention resides in the provision of an arrangement whereby a plurality of signals may be transmitted over a grounded conductor such as a submarine cable.

Still another feature of the invention relates to the provision of arrangements whereby a channel for the transmission of ordinary voice currents and a number of channels for the transmission of telegraph signals or additional telephone channels by the use of carrier currents may be simultaneously superposed upon a grounded conductor such as a submarine cable.

The above features, together with other features of the invention more fully hereinafter appearing, are realized by superposing upon the ordinary voice currents transmitted over a submarine cable, a plurality of carrier currents having frequencies in some instances above and in some instances below the voice range, together with ordinary Morse currents, the several channels being separated by means of frequency selectivity.

The invention may now be more fully understood by reference to the following description when read in connection with the accompanying drawing. Referring to the drawing, ML designates a transmission circuit such as a submarine cable, which forms one conductor of a transmission circuit employing a grounded return. An artificial line or net work MN is provided for balancing the cable MN and a plurality of parallel signaling paths, 1—1′, 2—2′, 3—3′, 4—4′ and 5—5′ are provided for interconnecting the cable and artificial line. Morse transmitting apparatus T_1 and Morse receiving apparatus R_1 is associated with the junction points of the paths 1 and 1′, the polar receiving relay having its windings so arranged that one-half is included in each of the paths 1 and 1′, while transmitted currents from the transmitter T_1 are applied to the midpoints of the windings 11. An alternating current telegraphic transmitting apparatus T_2 is applied to the midpoints of the windings of a balanced transformer 12, connected in the path 2—2′, while an amplifying and detecting arrangement D_2 and a receiver R_2 is inductively associated with the path through said transformer. A telephone transmitter T_3 is arranged to apply telephonic currents to the midpoint of the windings of a transformer 13 in the path 3—3′, while a telephone amplifier A_3 and telephone receiver R_3 are inductively associated with said path through said transformer 13. In a similar manner carrier transmitting arrangements T_4 and T_5 are connected to the midpoints of the windings of transformers 14 and 15 included in the paths 4—4′ and 5—5′. Detecting and amplifying arrangements D_4 and D_5 having receiving devices R_4 and R_5 associated therewith are inductively coupled to said paths through the transformers 14 and 15 respectively.

It will be observed that the arrangement above described is such that all of the transmitting devices are conjugate with respect to all of the receiving devices and vice-versa, so that there will be substantially no interference between oppositely directed transmissions, regardless of the frequencies. In order to provide for frequency separation between transmission in the same direction, filters or selecting circuits F_1, F_2, F_3, F_4 and F_5 are provided in the paths 1, 2, 3, 4 and 5, respectively. These filters may be of any well-known character, but are preferably band filters of the type disclosed in the U. S. Patents to George A. Campbell, Nos. 1,227,113 and 1,227,114, dated May 22, 1917.

The filter F_1 may be a low filter and, as illustrated, is designed to transmit a range of frequencies extending from zero to 100 cycles, this range being sufficient to take care of ordinary Morse transmission. The filter F_2 is a band filter whose frequency limits are illustrated as 150 and 250 cycles. This filter permits of telegraph signaling on a carrier wave whose frequency is 200 cycles per second. The filter F_3 is a band filter whose limits are illustrated as being 300 and 2000 cycles, this range corresponding

substantially to the range of frequencies employed in ordinary telephonic transmission. The filter F_4 is illustrated as a band filter whose range extends from 2200 cycles to 2400 cycles, thus permitting of transmitting telegraphic signals upon a carrier current of 2300 cycles. The filter F_5 is shown as a band filter possessing a range of frequencies between 2000 and 2700 cycles, thus permitting the transmission of telegraph signals by means of carrier currents of 2600 cycles.

In order to balance the filters F_1 to F_5 inclusive, balancing networks should be provided in the corresponding halves of the signaling paths designated 1′ to 5′ inclusive. These balancing arrangements may comprise any suitable form of network whose electrical characteristics simulate those of the filter to be balanced. As illustrated, however, duplicate filters F_1', F_2', F_3', F_4' and F_5' are provided for balancing the selective filters F_1 F_5 inclusive. The filters F_1' to F_5' should each transmit the same band of frequencies as the filter which it is intended to balance. It will be understood, of course, that the various frequencies above referred to are given merely for purposes of illustration and that in actual practice other frequencies than those indicated may be used.

It will be seen that by means of the arrangements above disclosed it is possible to utilize the full frequency capacity of an expensive conductor such as a submarine cable, so that in addition to the ordinary Morse signals ordinarily transmitted a telephone channel as well as a number of additional carrier telephone or telegraph channels are provided.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a multiplex system, a transmission circuit, balancing means therefor, a plurality of signaling paths connected in multiple between said transmission circuit and balancing means, said balancing means simulating the impedance of the transmission circuit at the frequencies transmitted over each of said paths, means whereby telephone currents of voice frequencies may be transmitted from one of said paths over said transmission circuit, means whereby signaling currents having frequencies below the lower voice limit may be transmitted over certain other of said paths, means whereby signaling or carrier currents having frequencies above the upper voice limit may be transmitted over said transmission circuit through still other of said paths, and means to substantially prevent in each of said paths the transmission of frequencies from the other paths.

2. In a multiplex signaling system, a transmission circuit, balancing means therefor, a plurality of signaling paths connected in multiple between said transmission circuit and said balancing means, said balancing means simulating the impedance of the transmission circuit at the frequencies transmitted over each of said paths, means associated with one of said paths for transmitting and receiving Morse currents, means associated with another of said paths for transmitting and receiving alternating carrier currents whose frequency is less than that of the lowest frequency employed in ordinary telephonic transmission, means associated with a third of said paths for transmitting and receiving ordinary telephone currents, means associated with still other of said paths for transmitting and receiving alternating carrier currents having frequencies above the upper limit of frequencies employed in ordinary voice transmission, and means to substantially prevent in each of said paths the transmission of frequencies from the other paths.

3. In a multiplex signaling system, a transmission circuit, balancing means therefor, a plurality of signaling paths connected in multiple between said transmission circuit and balancing means, said balancing means simulating the impedance of the transmission circuit at the frequencies transmitted over each of said paths, telephonic transmitting and receiving apparatus associated with one of said paths and telegraphic transmitting and receiving apparatus associated with the remaining paths, certain of said apparatus being arranged to transmit and receive frequencies above the upper voice limit, other of said apparatus being arranged to transmit and receive frequencies below the lower voice limit, and means to substantially prevent in each of said paths the transmission of frequencies from the other paths.

4. In a multiplex signaling system, a transmission circuit, comprising a grounded cable conductor, an artificial line or network, a plurality of signaling paths connected in multiple between said transmission circuit and artificial line, said artificial line simulating the impedance of the transmission circuit at the frequencies transmitted over each of said paths, and selective means in said paths for providing frequency discrimination between alternating currents transmitted over the paths.

5. In a multiplex signaling system, a transmission circuit comprising a grounded cable conductor, an artificial line or network, a plurality of signaling paths connected in multiple between said transmis-

sion circuit and artificial line, said artificial line simulating the impedance of the transmission circuit at the frequencies transmitted over each of said paths, selective means in said paths for providing frequency discrimination between the paths, the selective means associated with one of the paths permitting the transmission of ordinary voice currents, the selective means associated with other of said paths permitting the transmission only of signaling frequencies below the lower limit of voice transmission and the selective means associated with still other of said paths permitting the transmission only of signaling or carrier frequencies above the upper limiting voice frequency.

6. In a multiplex transmission system, a transmission circuit comprising a grounded cable conductor, an artificial line or network, a plurality of signaling paths connected in multiple between said transmission circuit and artificial line, said artificial line simulating the impedance of the transmission circuit at the frequencies transmitted over each of said paths, Morse transmitting and receiving apparatus associated with one of said paths, alternating current telegraphic transmitting and receiving apparatus associated with another of said paths, said apparatus employing frequencies below the lower voice limit, telephonic transmitting and receiving apparatus associated with another of said paths, and carrier current transmitting and receiving apparatus associated with still other of said paths, said carrier current apparatus employing frequencies above the upper limiting telephonic frequency, and means to substantially prevent in each of said paths the transmission of frequencies from the other paths.

In testimony whereof, I have signed my name to this specification this 23rd day of September 1919.

HERMAN A. AFFEL.