Feb. 28, 1939. R. TRECHCINSKI. 2,148,915

TELEPHONE SYSTEM

Filed April 24, 1935 4 Sheets-Sheet 1

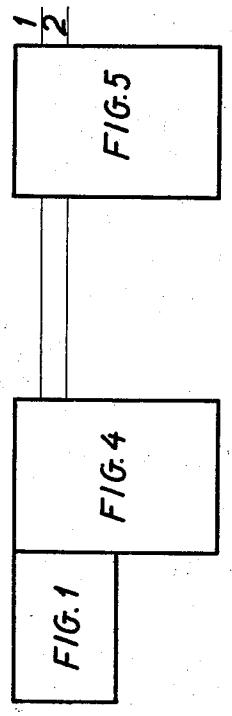

FIG. 2

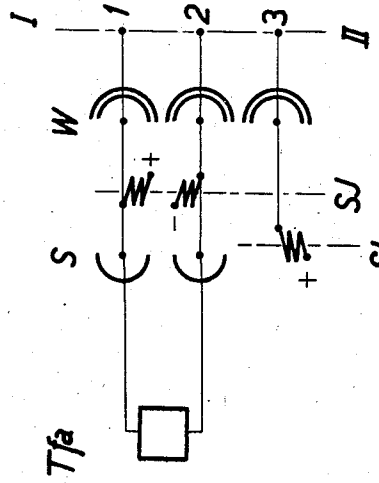

FIG. 1.

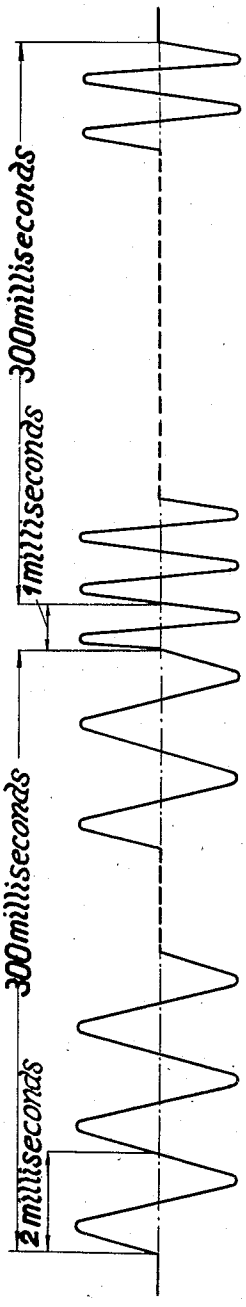

FIG.3

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TELEPHONE SYSTEM

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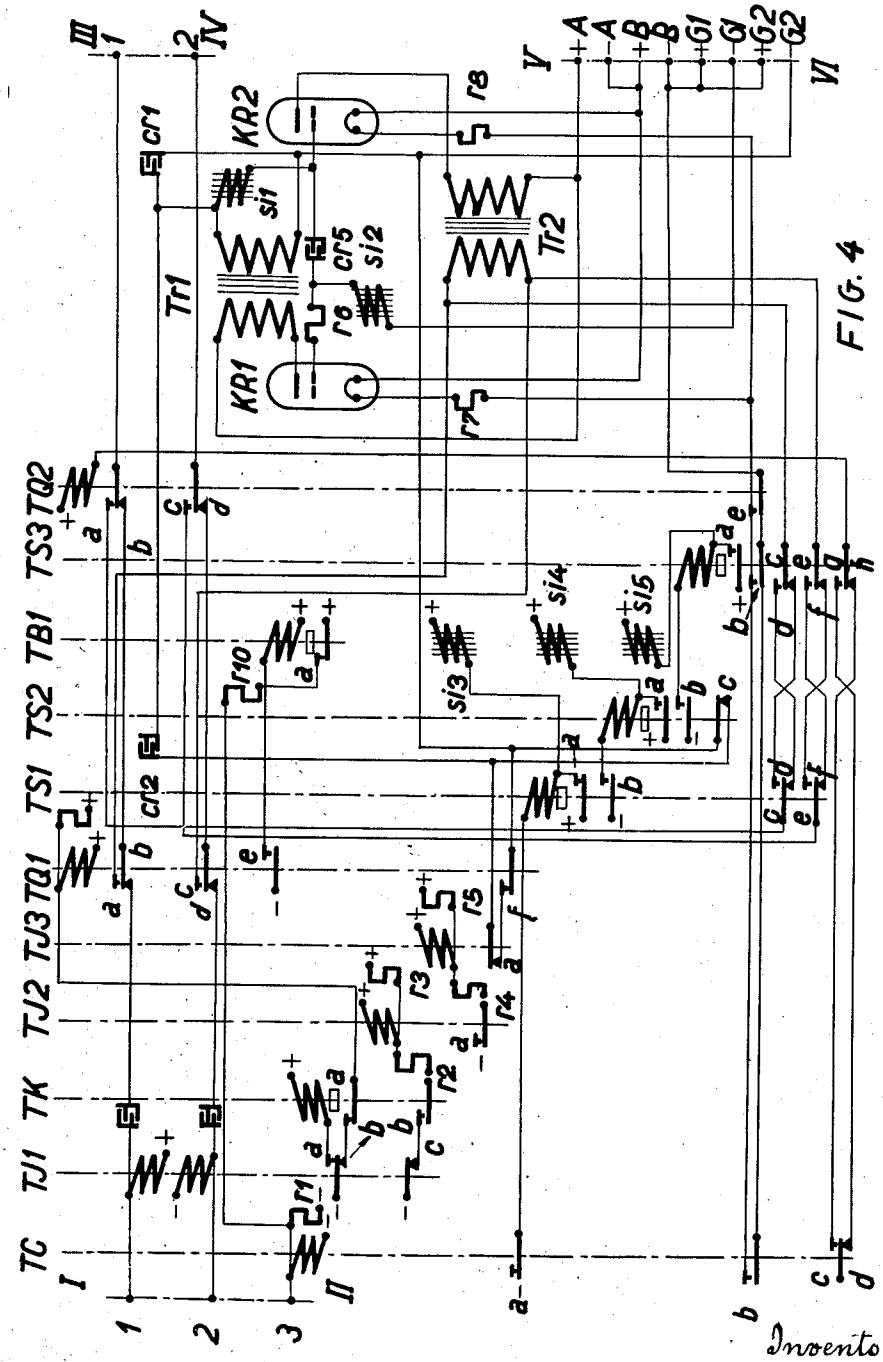

FIG. 4

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Feb. 28, 1939. R. TRECHCINSKI 2,148,915

TELEPHONE SYSTEM

Filed April 24, 1935 4 Sheets-Sheet 3

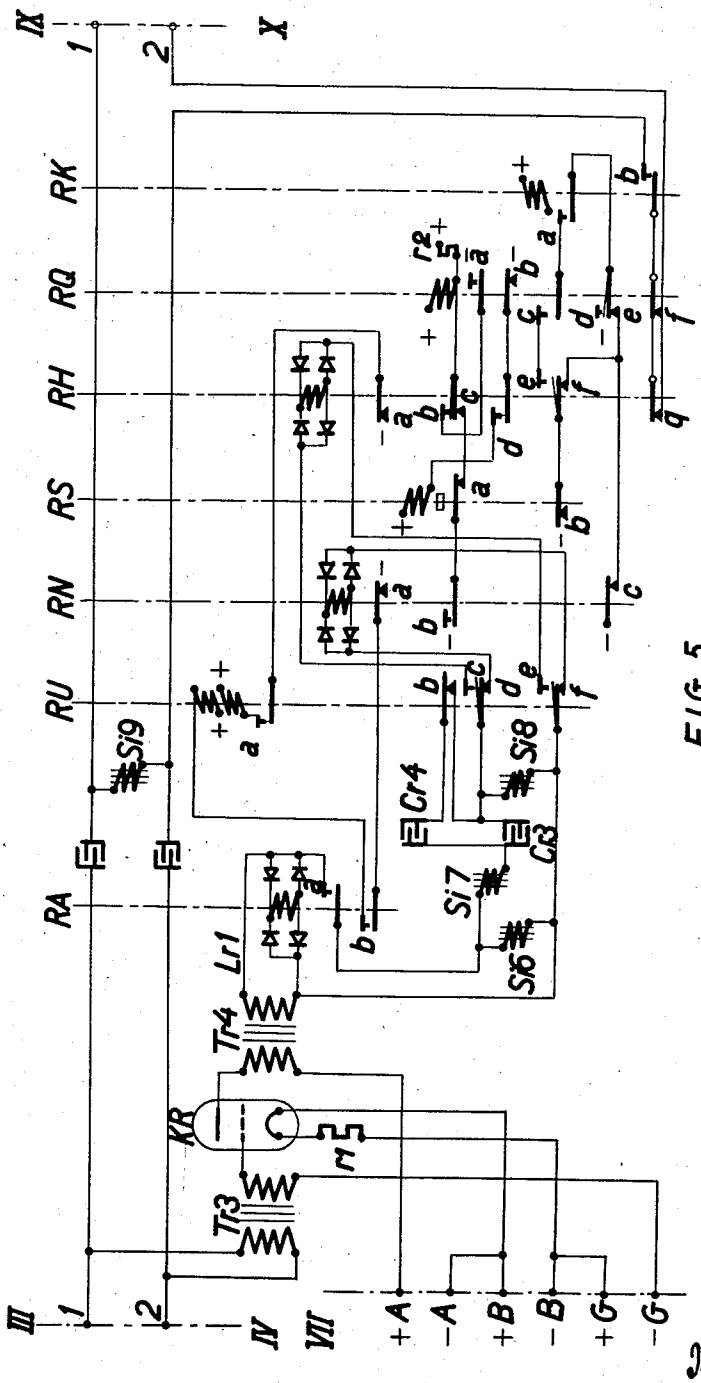

FIG. 5

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TELEPHONE SYSTEM

Filed April 24, 1935 4 Sheets-Sheet 4

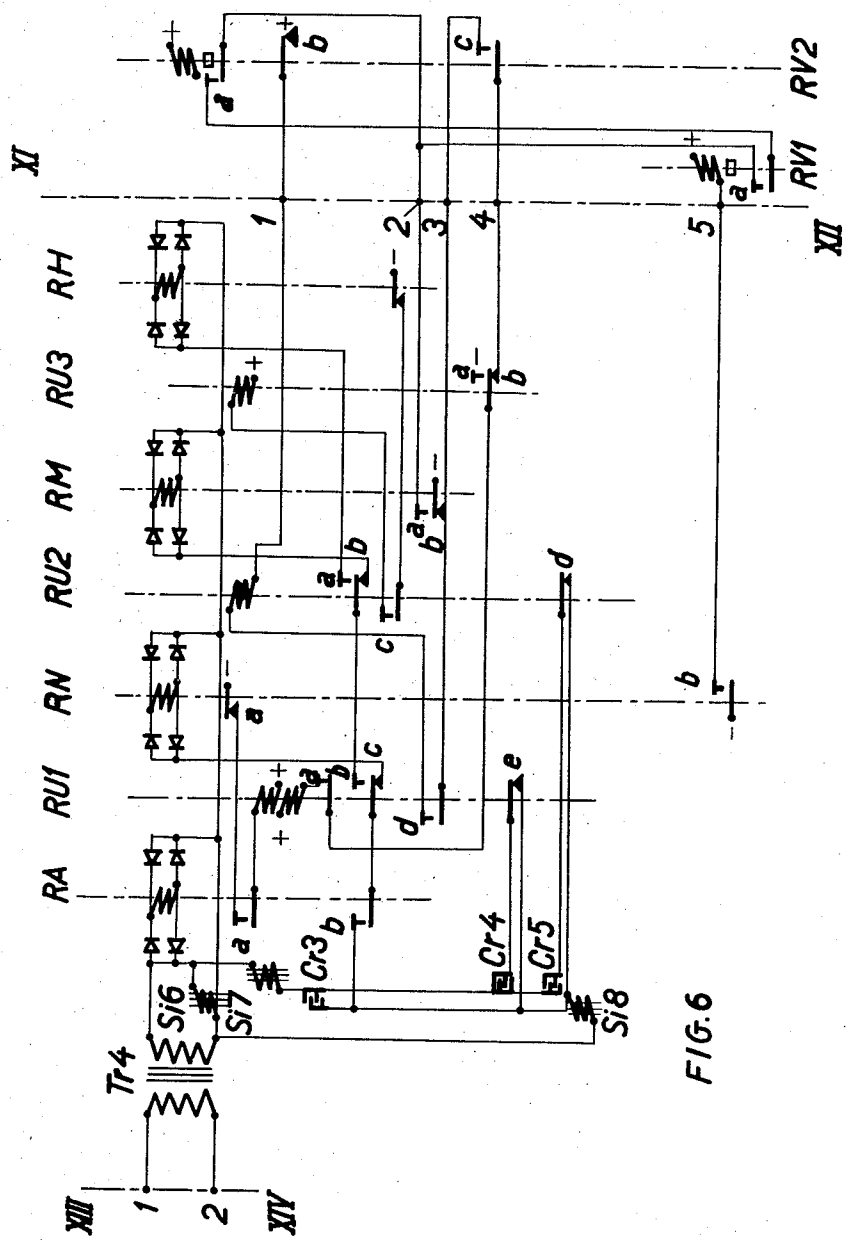

FIG. 6

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Patented Feb. 28, 1939

2,148,915

UNITED STATES PATENT OFFICE

2,148,915

TELEPHONE SYSTEM

Roman Trechcinski, Warsaw, Poland

Application April 24, 1935, Serial No. 17,962
In Poland April 28, 1934

1 Claim. (Cl. 179—16)

I have filed an application in Poland on the 28th of April, 1934.

The well known methods of transferring signals and impulses over the long distance lines with amplifiers are based on:

(1) Application of by-path repeaters,
(2) Application of transit repeaters,
(3) Transmitting of alternating current impulses,
(4) Transmitting of inducting vibrations.

When applying the methods at Nos. 3 and 4, it is necessary to note that the phonic currents may cause also some vibrations which may influence the receiving apparatus and cause an undesirable (faulty) signal. Likewise, temporary disturbances in the amplifiers—whistles—may be the cause of wrong signals.

To eliminate the above mentioned harmful influences, it is possible to apply a transmitting apparatus generating current of a fixed frequency, and a receiving station provided with an electric filter, permitting exclusively the reception of only one fixed frequency. The probability that the disturbing current will have just the same frequency is a very small one, and, therefore, in certain cases of technical application this system provides a sufficient security.

The primary object of the present invention is to provide a device which considerably decreases the probability of the occurrence of faults of the aforesaid kind, and which is based on the application of successive transmitting of several fixed frequencies. According to the invention, therefore, my improved system of transferring impulses and signals through lines comprises in combination: a transmitting apparatus having one generator only; means associated with this generator for enabling it to supply and forward through the line signals each formed by a succession of several, i. e. at least two, currents of different definite fixed frequencies—the order of succession of these currents, the time of duration of each of them, and the number of currents of different and equal time of duration respectively of different and the same frequencies respectively in one signal, being characteristic for the above mentioned different signals, means associated with said generator for controlling the intervals between two successive signals, said intervals being characteristic by the definite time of interruption of the signalling currents, and by the definite time of duration of a definite frequency respectively, said time of interruption as well as that of duration of a definite frequency having a definite lower limit, the above mentioned means being adapted to be controlled both by the telephone subscriber and by the personnel at the telephone exchange; means for receiving said signals from the line; and means for controlling the succession, the number and the time of duration of the said frequencies in each signal, as well as the said intervals between two successive signals. The receiving apparatus will not react on one vibration of some fixed frequency only, and will act only when after a previous transmitting of this vibration of the current having some fixed frequency, there is created another current of a different but again strictly fixed frequency. The succession in which the separate frequencies are created, as well as the length of time of the duration of the separate vibrations are applied in order to receive various signals and impulses.

As an example, I describe below the duotone method of impulsing and signaling.

Fig. 1 shows a simplified scheme of cord connecting circuit.

Figs. 4 and 5 give the scheme of an equipment according to the invention, Fig. 4 showing the transmitting side and Fig. 5 the receiving side of the equipment.

Fig. 2 shows the connections by means of which equipments shown in Figs. 1, 4 and 5 co-operate with one another.

Fig. 3 shows the diagram of the transmitted current.

Fig. 6 illustrates a scheme of a device adjusting the receiving repeater filter successively to the reception of separate frequencies.

By means of manipulations which are very well known in the telephony, and, therefore, need not be minutely described here, the calling subscriber reaches the out-going repeater, the scheme of which is shown on Fig. 4.

Circuit 1 is closed then:

01: Fig. 1: +, relay SL, wipers W, terminal 3, strips I—II.
Fig. 2: terminal 3 of the strip I—II, relay TC,—; relay TS operates closing circuit 2.
02: Fig. 4: +, self-inductance Si, relay TS1, contact TC^a, —.

At the same time the cathode valves KR1 and KR2 are lit as per circuit 3:

03: Fig. 4: + B of the strip V—VI from the cathode feeding storage battery, KR1, r7, TC^b, —B strips V—VI cathode feeding battery; (analogous for KR2) and circuit 4 is closed.
04: Fig. 4: TQ2, $TS3^h$, TC^c, —: in consequence of which relay TQ2 operates.

As the result of the forming of the circuit 2, relay TS1, forming together with the self-inductance Si3 the time factor at about 300 milliseconds provided for warming up of the valves and the stabilization of the work of the valve generator, will operate and connect the valve generator to the line as per circuit 5:

05: Fig. 4: the top transformer terminal Tr2, TS3[d], TS1[c], TQ2[a], term. 1, strips III—IV, line, terminal 2, strips III—IV. TQ2[c], TS1[e], TS3[f], bottom terminal Tr2.

The valve generator consisting of the above 2 cathode valves KR1 and KR2, transformers Tr1 and Tr2, inductances and condensers, generates two different but fixed frequencies; if to the vibrating circuit only one condenser Cr1 is connected, then a higher frequency current is generated, e. g., 1000 cycles per second; if, however, the condenser Cr2 is connected parallelly to Cr1, then a lower frequency current is generated, e. g. 500 cycles per second. At the just discussed moment, i. e. when the valve generator is connected with the line, there will be connected the condenser Cr2 over the contact TS2[c], consequently the line is fed by the current of 500 cycles per second.

Circuit 6 is closed as the result of the operation of the relay TS1.

06: Fig. 4: +, Si4, TS2, TS1[b], —: in consequence of which after about 300 milliseconds relay TS2 operates disconnecting contact TS2[c], separating Cr2, causing an immediate break in transmitting of the 500 cycles per second current instead of which the current of a 1000 cycles per second frequency will be transmitted.

After the operation of TS2 circuit 7 is closed.

07: Fig. 4: +, Si5, TS3, TS2[b], —: at about 300 milliseconds relay TS3 operates and will cut the circuit 5 and 5 thus causing a break in the transmitting of the current to the line.

On the Fig. 3 the proper diagram of the transmitted currents is shown.

The above described currents reach the receiving repeater over the line the scheme of which is shown on Fig. 5 as per circuit: out-going repeater, terminal 1, strips III—IV, coiling of the transformer Tr3, terminal 2, strips III—IV and back to the out-going repeater.

An aperiodic amplifier consisting of the valve KR will forward the above current to the relay RA which by means of the rectifying device Lr1 will accept the same regardless of their frequency, in consequence of which the relay RA will operate. The circuit 8 will be closed then.

08: Fig. 5 the top terminal Tr4, RA[a], filter for 500 cycles per second RU[d], RN, RU[f], bottom terminal Tr4.

The filter of the in-coming repeater consists of self-inductions Si6, Si7, Si8 and condensers Cr3 and Cr4; at the two parallelly connected condensers Cr3 and Cr4 this filter lets the 500 cycles per second current through, but in case of a disconnected Cr4—the 1000 cycles per second current. At the described moment both condensers are parallelly connected, consequently the filter accepts then 500 cycles per second. The relay RN is quickly acting (about 3 milliseconds) and disconnects sooner the contact RN[a], before the relay RU has time to operate on circuit 9.

09: Fig. 5: +, RU, RA[b], RN[a], —.

As the operating time of the latter is longer (about 10 milliseconds) at the moment of the acting of RN circuit 9 is immediately disconnected, RU remains inactive.

By operating of the relay RN circuit 10 is closed:

010: Fig. 5: +, RQ, RH[c], RS[a], RN[b], — : in consequence RQ operates.

After about 300 milliseconds the out-going repeater disconnects the 500 cycles per second current transmitting in its stead the 1000 cycles per second current which is not let through by the filter and therefore the relay RN becomes inactive. Circuit 9 is then closed again and (after about 10 milliseconds) RU operates disconnecting Cr4 by opening the contact RU; the altered filter will let through the current of the 1000 cycles per second frequency which sets in motion the relay RH as per circuit 11:

011: Fig, 5: top terminal Tr4, RA[a], filter RU[c], RH, RU[e], bottom terminal TR4.

The relay HR is quickly acting (about 3 milliseconds) and before RU has time to be de-magnetized (from the additional circuit 12:

012: Fig. 5: +, bottom coiling of the opposite winding relay RU, RU[a], RH[a], —.),

will disconnect the contact RH[a], in consequence of which RU will be attracted. As RH is provided with many springs it may be possible that for the technical purposes it will be more convenient to apply a supplementary relay, relieving RH.

When RN releases, circuit 10 is cut, but as the relay RQ is slightly delayed (about 30 milliseconds) it has no time to release and RH operates closing circuit 13:

013: Fig. 5: +, RQ, RH[b], RQ[a], —, which supplies further the current to the relay RQ.

After operation of RH circuit 14 is closed:

014: Fig. 5: +, RK, RQ[c], RH[e], RS[b], —: relay RK operates.

When after further 300 milliseconds the 1000 cycles per second current disappears, relay RA releases, in consequence of which circuits 9 and 11 are disconnected; RH and RU release; RK operates still, at first per circuit 15:

015: Fig. 5: +, RK, RK[a], RQ[d], —,

and after further 30 milliseconds when RQ releases, per circuit 16:

016: Fig. 5: +, RK, RK[a], RQ[e], RH[f], RS[b], —.

When RH releases the desired telephone exchange is alarmed in the known customary manner by closing of the loop per circuit 17:

017: Fig. 5: terminal 1, strips IX—X, Si9, RK[b], RH[g], terminal 2, strips IX—X.

The alarmed telephone exchange or central station puts up then an alarming call signal, e. g. in the form of a current of 200 cycles per second frequency. This current is to signal the calling subscriber the possibility of starting the impulses; besides this the current sets in motion RA. The relay RU begins to vibrate with a cycle of 10 milliseconds (100 cycles per second) however, the filter will not let the 200 cycles through and relays RN and RH remain inactive.

The calling subscriber begins the impulsing, and the relay TJ1 (Fig. 4) which operated through the

loop of the subscriber parallelly to the feeding relay SJ (Fig. 1) will receive the subscriber's impulses.

When TJ1 operated, circuit 18 is closed:

018: Fig. 4: +, TK, TJ1[a], —: relay TK operated,

but as the same is a relay with a delayed activity (it releases after about 200 milliseconds) it is on operation also during the impulsing by the subscriber.

When TJ1 releases, the circuit 19 is closed:

019: Fig. 4: +, TQ1, TK[a], TJ1[b], —: relay TQ1 operates;

it is a quickly operating relay (about 5 milliseconds) and it releases slowly (about 200 milliseconds) owing to which it operates during the whole series of impulses.

After the operation of the relay TQ1, the 500 cycle current is closed to the line as per circuit 20:

020: Fig. 4: top terminal Tr2, TQ1[a], RQ2[b], terminal 1, strips III—IV, line, and back, terminal 2, strips III—IV, TQ2[d], TQ1[c], and bottom terminal Tr2.

The condenser Cr2 is connected to the circuit 21:

021: Fig. 4: Cr2, TJ3[a], TQ1[f], parallelly to Cr1.

When TJ1 releases, then the circuit 22 is closed:

022: Fig. 4: +, TJ2, r2, TK[b], TJ1[c], —: in consequence TJ2 will operate after some delay (about 30 milliseconds) and close the circuit 23:

023: Fig. 4: +, TJ3, r4, TJ2[a], —: in consequence of which TJ3 operates after some delay (about 30 milliseconds).

and disconnects Cr2, cancelling the circuit 21, so that the generator begins to produce the 1000 cycle current instead of the 500 cycle current.

As TJ3 and TJ2 are pulsating in accordance with TJ1 (but with some delay), this line will be then successively fed by the current vibrations of 500 or 1000 cycles per second and the number of the 1000 cycle vibrations will be equal to the number of impulses in the subscriber's series.

After the last impulse still another vibration of 500 cycles per second will be forwarded, viz.: when TJ1 operates the circuits 22 and 23 will be cut, in consequence of which after about 60 milliseconds TJ3 will release closing circuit 21 and as TQ1 is still active the 500 cycles per second pulsation will go through the line, but, later on, because of disconnecting of the contact TJ1[b], TQ1 will release (after about 200 milliseconds) as from the moment of disconnecting) and the transfer is terminated.

When the first 500 cycle vibration was taken over by the receiving repeater, causing as the result—in accordance with the above elucidated course of operation of the relays RA, RN, RQ (Fig. 5), then after some time there will arrive the first 1000 cycle vibration, corresponding to the break of the first impulse. In consequence of the disconnection of the circuit 8, the relay RN releases: circuits 9 and 11 are closed, causing that RN and RU operate, and RH will break the central loop by means of the contact RH[g]. (RQ operates during all this time.) After some time the 1000 cycles per second vibration alters into one of 500 cycles per second corresponding to the closing of the first impulse. In consequence the circuit 11 will be cancelled and the relay RH releases; then through RH[a] the bottom coiling of the opposite winding relay RU will get the current and RU releases, and by closing the circuit 8, RN will operate. When, after some time, the 500 cycle current will fade, RN and RQ will release.

In the described manner one series consisting of one impulse is received; in an analogous manner a series of any number of impulses will be accepted causing a corresponding number of operations of the relay RH.

The termination signal takes place as follows: when the subscriber puts the hand-set on the forks, TJ1 releases. If the repeater has no special apparatus with a registration of impulses from the subscriber and forwarding them after cumulation, then the described simple device in the out-going repeater at the hanging up of the hand-set, will forward one superfluous impulse in the form of vibrations: the 500 cycles per second and then the 1000 cycles per second. In the meanwhile, however, one cord circuit line in the central will be released and the relay TC may release within some undefined time what would cause undesirable (faulty) signals.

To avoid this eventuality the relay TB1 is added giving a guaranty that TC will release by 200 milliseconds later than TQ1, as TB1 is set in motion by TC1, as per circuit 24:

024: Fig. 4: +, TB1, TQ1[e], —;

TB1 has a delayed activity and keeps TC as per circuit 25:

025: Fig. 4: +, TB1[a], r10, TC, —.

When TJ1 releases, the circuit 18 is cancelled, then the relay TK becomes inactive, and consequently, because of the disconnection of the contact TK[a], the relay TQ1 releases; the circuit 24 becomes cancelled and TB1 releases after 200 milliseconds taking the plus for the relay TC from TB1[a], and consequently TC releases.

When TC releases, circuit 26 is closed:

026: Fig. 4: +, TQ2, TS3[g], TC[d], —: consequently relay TQ2 operates.

At the same time circuit 2 is cut: TS1 releases and a 1000 cycle vibration is forwarded; then circuit 6 is cut and TC2 releases after about 200 milliseconds altering the 1000 cycle current into a 500 cycle current.

As the result of releasing of the relay TS2 the circuit 7 is cut and after about the expiration of further 200 milliseconds TS3 releases cutting circuit 26, then TQ2 releases, cutting the termination signal. From the above it is clear that the termination signal is forwarded in the form of 2 vibrations: at first one of 1000 cycles per second and then one of 500 cycles per second.

The incoming repeater (receiving) accepts a 1000 cycle vibration by means of a filter through the relay RH which operates and closes circuit 27:

027: Fig. 5: +, RS, RH[d], RQ[b], —: relay RS operates

receiving because of the opening of the contact RS[b] an additional minus for RK; then, if after the fading of the 1000 cycle vibration the 500 cycle vibration occurs and the relay RN becomes active by opening its contact RN[c] taking off the current from the relay RK, the latter, in consequence of the loss of the additional minus from RS[b] releases sooner than RS (with a delayed activity) will have time to release because of the inactivity of RH and gives it back its minus; the subscriber's loop is cut.

After the termination of forwarding of the 500

cycle current the relays RA and RN release and the whole receiving repeater becomes inactive.

The trio-tone system

The above described duo-tone system may have not only a theoretical, but also a practical application. However, the apparatus for the separate processes is simpler when applying a trio-tone system, which, in principle, differs only very little from the duo-tone system.

To describe in full all separate technical processes which have to be signalized, i. e. the necessary connection and disconnection, repeated ringing, the compulsory disconnection, the interception of catching connections from both sides, the control of the state of organs, further impulsing and the then following new connections and disconnections, as well as signalization of zones, would be only a useless complication of the whole system, and, therefore, I shall limit my description to some fundamental things, viz.: only to a few fragments of the whole system.

The signaling currents may be of e. g. three following frequencies: 500, 1000 and 1500 cycles per second. On Fig. 6 is shown a scheme of a device adjusting the receiving repeater filter successively to the reception of separate frequencies; in this case all terminals of the strips XI—XII with the exception of terminal 1 to which the plus pole of the storage battery is connected, should be understood as insulated; the relays RV1 and RV2 are not necessary.

After receiving by the aperiodic amplifier of the receiving repeater of the 500 cycle vibration current, the relay RA operates, consequently, because of the longer time needed by the relay RV1 for operation than RN (similarly as in the formerly described duotone system) the latter operates on circuit 28:

028: Fig. 6: from $Tr4$, RN (through the rectifying device) $RU1^c$, RA^b, to $Tr4$;

and cuts the minus pole from the relay RU1 which remains inactive and will operate only then, when after cutting of the vibration of the 500 cycle current and altering the same by the 1000 cycles per second current, the relay RN will release; the circuit 29 will be closed then:

029: Fig. 6: +, top coiling RH1, RA^a, RN^a, —: consequently the relay RU1 operates and closing its contact $RU1^b$, will switch over the filter to the relay RM and opening the contact $RU1^e$, will cut off the condenser $Cr4$ and adapt the filter for reception of the 1000 cycles per second frequency current.

Similarly as above, the relay RU2 needs a longer time to operate than RM, and, the latter, therefore, operates on circuit 30:

030: Fig. 6: from $Tr4$, RM, $RU2^b$, $RU1^b$, RA^b, to $Tr4$ and remain active during the whole time of the duration of the 1000 cycle current.

At the moment of altering of this current to a 1500 cycles per second current, which is not let through the filter, the relay RM becomes inactive, and, therefore, circuit 31 is closed:

031: Fig. 6: +, RU2, $RU1^d$, RM^b, —; the relay RU2 operates

opening the contact $RU2^d$, cutting off $Cr5$ and by closing the contact $RU2^a$, switches over the filter to the relay RH. The filter begins to let through the 1500 cycle current which is accepted by RH (operating quicker than RU3) on circuit 32:

032: Fig. 6: from $Tr4$, RH, $RU2^a$, $RU1^b$, RA^b, to $Ta4$; relay RH operates.

After the fading of the 1500 cycle current RH releases, then RU3 will operate on the circuit 33:

033: Fig. 6: +, RU3, $RU2^a$, RH^a, —;

consequently the lower coiling of the opposite wired RU1 will receive the current from its own plus and minus through $RU3^a$, then the relay RU1 releases and circuits 31 and 33 are cancelled, in view of which RU2 and RU3 become inactive and because of the connecting back of condensers $Cr4$ and $Cr5$ the filter is adapted for the reception of the 500 cycle per second current and a collaboration with RN.

By this means this device will successively connect the line currents to the proper relays, altering the properties of the filter by the contacts $RU1^e$, $RU2^d$, separating the condensers $Cr4$ and $Cr5$.

In some cases, however, as e. g. for pulsation, the duo-tone system might be more convenient than the trio-tone system. And just to facilitate in some circumstances a passing over from a trio-tone system to a duo-tone and the necessary changing of a receiving repeater from a trio- to a duo-tone, there is foreseen a device consisting of relays RV1 and RV2 (terminals of strips XI—XII are now not insulated).

As an example the following disposition is given: the repeater is in each case transformed into a duo-tone, if after a former appearance of a 500 cycle current a 1000 cycle current is received; in all other combinations a 1500, 1000, and 500 cycle, the repeater is not transformed into a 3-tone system.

After the 500 cycle vibration will appear, RA and RN will operate, and the circuit 34 will be closed:

034: Fig. 6: +, RV1, RN^b, —: consequently RV1 operates.

When the 1000 cycle current will appear after the fading of the 1000 cycle current, RN releases, RU1 operates and RM receives the 1000 cycles per second current; circuit 35 is closed then:

035: Fig. 6: +, RV2, $RV1^a$, RM^a, —;

relay RV2 operates and opening the contact $RV2^b$, takes the plus pole from the storage battery to the relay RU2 which, after disappearing of the 1000 cycle vibration, when RM releases, cannot operate in the circuit 31, and owing to the closed $RV2^c$, circuit 36 is closed:

036: Fig. 6: +, RU1, $RU1^a$, $RU3^b$, $RV2^c$, RM^b, —:

the opposite wired RU1 releases, owing to which the receiving device becomes, immediately after the disappearance of the 1000 cycles per second current adapted for the reception of the 500 cycle current.

Instead of electromagnetic relays for the adaptation of filters and connection of the separate receiving apparatus, also other relays may be applied, e. g. valve devices; these apparatus, as quite non-essential for the above system, were not described at all.

The whole system is understood as acting on both sides.

I claim:

System of transferring impulses and signals through lines, particularly for use with ampli-

fiers for manual, half-automatic and full-automatic telephony, comprising in combination: a transmitting apparatus having one generator only; means associated with this generator for enabling it to supply and forward through the line signals each formed by a succession of several, i. e. at least two, currents of different definite fixed frequencies—the order of succession of these currents, the time of duration of each of them, and the number of currents of different and equal time of duration respectively of different and the same frequencies respectively in one signal, being characteristic for the above mentioned different signals, means associated with said generator for controlling the intervals between two successive signals, said intervals being characterized by the definite time of interruption of the signalling currents, and by the definite time of duration of a definite frequency respectively, said time of interruption as well as that of duration of a definite frequency having a definite lower limit, the above mentioned means being adapted to be controlled both by the telephone subscriber and by the personnel at the telephone exchange; means for receiving said signals from the line; and means for controlling the succession, the number and the time of duration of the said frequencies in each signal, as well as the said intervals between two successive signals, substantially as described.

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