Oct. 28, 1947. G. T. BAKER 2,429,911

MULTIEXCHANGE IMPULSE REPEATING SYSTEM

Filed March 6, 1943 2 Sheets-Sheet 1

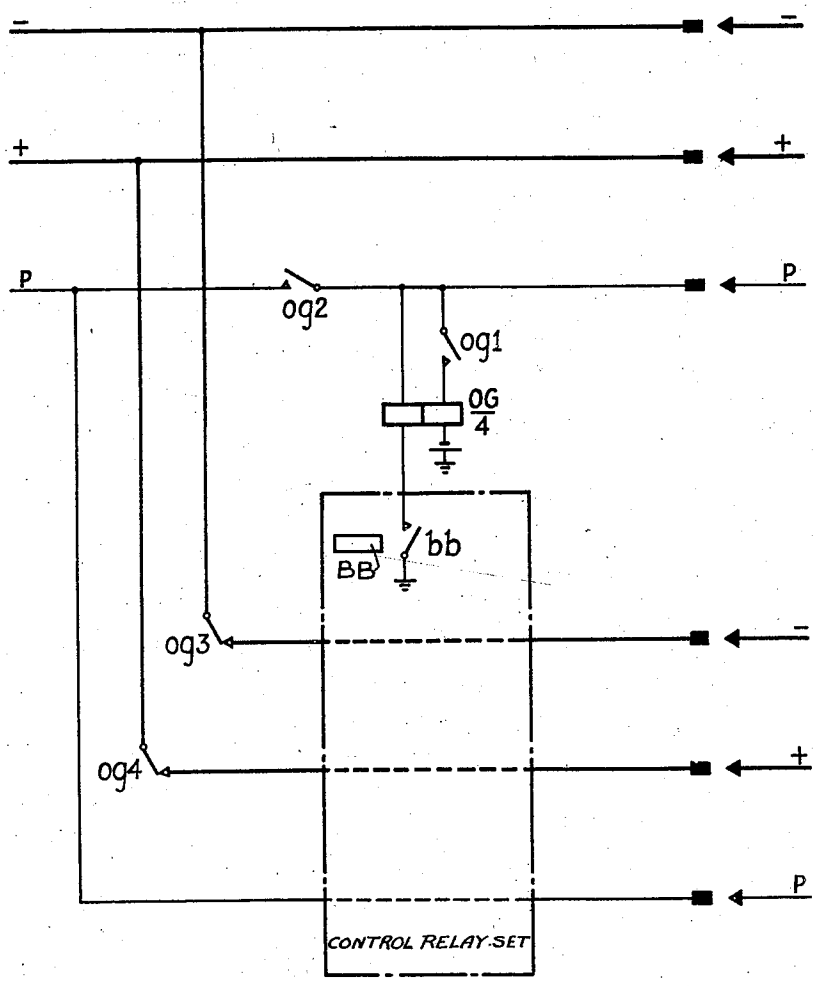


Fig. 1.

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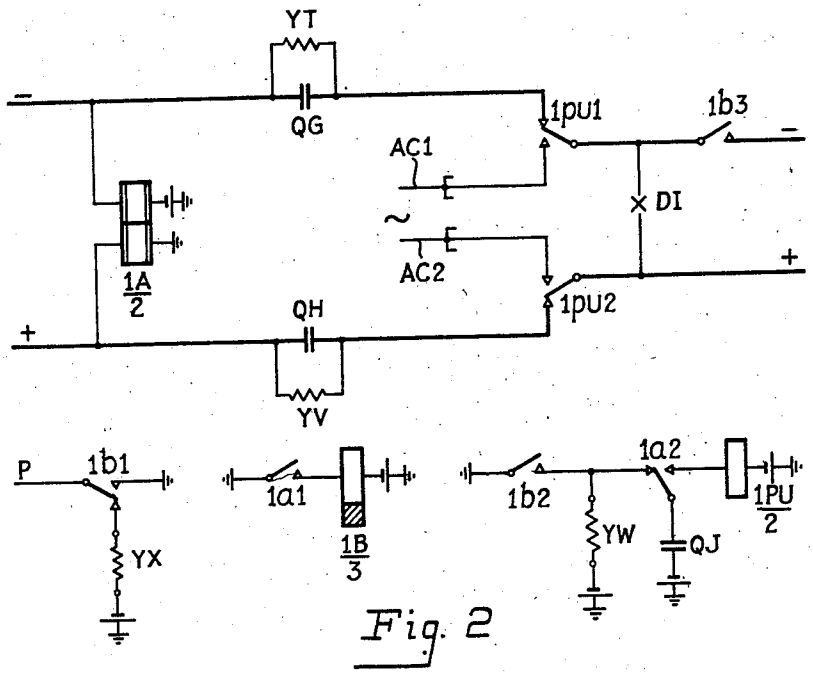


Fig. 2

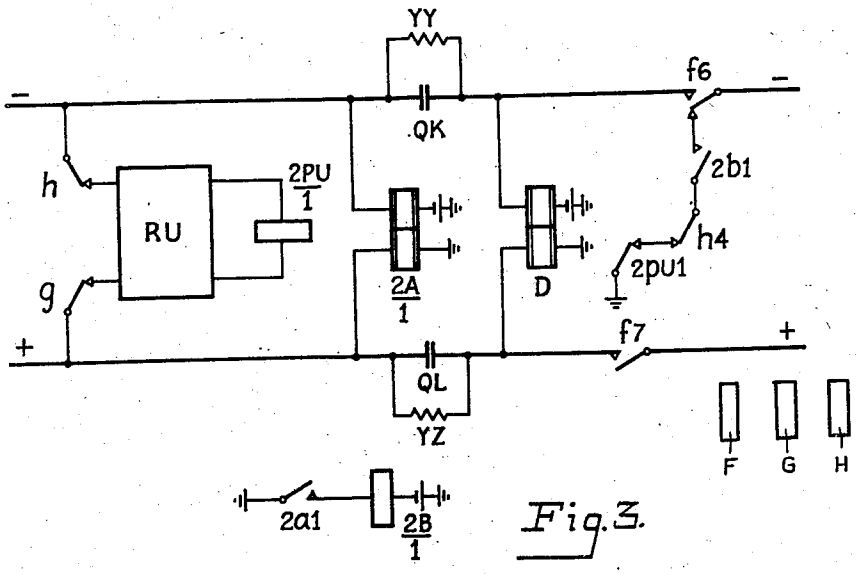


Fig. 3.

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2,429,911

MULTIEXCHANGE IMPULSE REPEATING SYSTEM

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Application March 6, 1943, Serial No. 478,244
In Great Britain April 20, 1942

10 Claims. (Cl. 179—16)

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The present invention concerns impulse repeating arrangements for use in automatic telephone or like systems and in particular in systems such as described and claimed in my copending applications Nos. 478,243 and 478,245, both filed March 6, 1943, the latter now being Pat. No. 2,402,232, dated June 18, 1946, although it is to be understood that it is not exclusively limited to such applications.

The object of the present invention is to provide a highly efficient arrangement for impulsing between exchanges over an extended area beyond the range to which the usual impulsing methods can operate reliably.

According to one feature of the present invention an impulse repeater is provided for use in telephone or like systems in which a change of current in a predetermined sense in each impulse of direct current is adapted to cause the transmission of a momentary alternating current over a junction line whereby impulses are transmitted over the junction line having no relation to the duration of an impulse and separated by intervals corresponding to the interval between corresponding parts of successive impulses.

According to another feature of the present invention an impulse repeater is provided for use in telephone or like systems for responding to momentary alternating currents in which each momentary alternating current is adapted to pass through a rectifier unit to operate a relay which in turn causes a momentary direct current impulse to be transmitted to a selector switch adapted to respond thereto.

The invention will be better understood by referring to the accompanying drawings which correspond to Figs. 23, 24 and 25 in my co-pending application No. 478,245, mentioned above, now Patent No. 2,402,232.

Fig. 1 shows circuits of the switching arrangements for outgoing selector levels.

Fig. 2 shows basic circuits of a D. C./A. C. outgoing impulse repeater for inter-exchange working, while

Fig. 3 shows similar circuits of a relay set for terminating the incoming end of inter-exchange junctions.

The invention is described in connection with a battery feeding control relay set taken into use at the originating exchange to operate the switches thereat, such relay group being switched out when the call is to be routed over an outgoing junction. In the following method now to be described in connection with Fig. 1 relay contacts in the through speaking leads to the outgoing junction repeater (Fig. 2) relay sets are entirely avoided.

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Fig. 1 illustrates diagrammatically two sets of contacts in the contact bank of a selector switch of the kind shown in my copending application Serial No. 478,242, filed March 6, 1943. The bank contacts of this switch are arranged in levels or rows, usually ten levels with ten sets of pairs of contacts in a level. One contact of each pair consists of a tooth of a comb plate so that corresponding contacts of each pair in a level are multiplied together by a comb plate. The other contact of each pair is connected to an outgoing multiple and as shown there are three pairs to a set, one corresponding to each speaking lead and one to the private. The fourth pair of contacts allocated to a set is not used in the present invention. Normally on a selector bank the comb plates relevant to each of the various leads, say, negative, positive and private are all strapped together, but where, say, levels 1—9 of a first selector are to give access to the local switching train, and where level 0 is to give access to outgoing junctions the comb plate wiring may be split so that the incoming speaking leads will connect via contacts *og*3 and *og*4 of a relay OG and the control relay set described more particularly with reference to Fig. 6 of the above mentioned application No. 478,243, with the comb plates 1—9, and will connect directly with the comb plates of level 0.

The control relay set of the said Fig. 6 is taken into use in usual manner and if any of the digits 1–9 are dialled, the selector train will be set up in normal manner as described in my copending application No. 478,243, but if digit 0 is dialled for the purpose of an outgoing junction call, then the directly connected 0 level comb plates will come into operation as follows. When a free outgoing repeater is found (for instance the one shown in Fig. 2), relay OG will be operated over its left-hand low resistance winding from earthed contacts *bb* of the control set relay BB to the idle resistance marking battery which will be connected to the incoming P lead at the outgoing repeater, the low resistance winding of relay OG serving as a guarding potential and also to operate relay OG which thereupon at contact *og*3 and *og*4 disconnects the circuit to the control group. During the release of the control group, which will take place at approximately 150 milli-seconds after the opening of the loop thereto, the subscriber's loop will be extended forward to operate the impulse accepting relay 1A and in turn the guard relay 1B in the out-

going relay set (Fig. 2) and a guarding and holding earth will be extended back to hold relay OG on its other winding, before relay BB in the control group which has previously been holding it, releases. The subscriber will now be directly connected through to the outgoing repeater which will receive the remainder of the trains of impulses to be dialled and which will provide the battery feed to the calling subscriber. The selector will of course remain held over the P lead from earth at the outgoing relay set which will extend via contacts *og*2 and through the control group to the selector primary control relay.

The above arrangement can also apply to the case where the group selector has only one level giving access to the local switches in the exchange and the other levels all have access to outgoing repeaters leading to other exchanges the only difference being that instead of the control relay set leading to the first nine levels it will only be connected to the level leading to local switches while the other levels will be connected direct to the incoming leads. The circuit arrangements of Fig. 1 will equally apply to this arrangement. Similarly it is possible to arrange for more than one level to be used for the local switch train and more than one level to be used for connections to other exchanges again employing the circuit arrangements of Fig. 1.

This facility, whereby levels may be split to allow for differing circuit operations according to the different level or levels involved, may have other applications.

Consideration will now be given to the question of inter-exchange working.

The impulsing improvements proposed in application No. 478,243, such as self-correcting switch magnets and speed timing impulse-responding arrangements provide a highly efficient arrangement for the receipt of impulses, but it is possible that when several impulse repetitions are concerned, no impulses at all will be received at the distant end.

So far a single exchange has been envisaged, and this exchange has been made such as to interwork into an existing area. In new areas a greater flexibility is possible, and it seems desirable to provide an impulsing scheme in which the present impulse repetition method is obviated.

For this purpose it is proposed that all inter-exchange impulsing should be of the alternating current type; holding and supervisory signals will still be on a direct current basis as at present, but alternating current pulses, preferably of voice frequency, will be superimposed on these to perform the actual movement of the selectors. In the case of tandem exchanges the received alternating current impulses will be converted to direct current impulses for the purpose of setting up the selector train in the tandem exchange and thereafter the necessary conversion unit will be cut out and the remainder of the alternating current impulse train will pass straight through to the terminating exchange in the same manner as for speech currents, the direct current supervision arrangements being retained.

Referring now to the basic D. C./A. C. outgoing repeater circuit shown in Fig. 2, when this is taken into use via a switching arrangement such as that shown in Fig. 1 relay 1A operates and is followed by relay 1B which at contacts *1b1* replaces the idle marking battery via resistance YX by a guarding and holding earth and at contacts *1b3* extends a D and I relay loop, either of normal type described in Saville Patent No. 2,218,659, issued Oct. 22, 1940, or of the thermionic valve type described in Taylor and Baker application Ser. No. 446,900, filed June 13, 1942, now Patent No. 2,350,652, dated June 6, 1944, over the right-hand outgoing junction conductors to the distant office.

The initial energization of relay 1A switches over contact *1a2*, and the subsequent energization of relay 1B prepares a charging circuit for condenser QJ by closing contact *1b2*. When relay 1A releases responsive to the first received impulse condenser QJ is charged via contacts *1a2* and *1b2* to earth while on the reenergization of relay 1A at the end of the impulse relay 1PU is energised for the discharge time of condenser QJ. Similarly, upon each subsequent impulse in the received train condenser QJ is recharged and at the end of each impulse it causes relay 1PU to reoperate for the discharge time of the condenser. As a result of these momentary operations of relay 1PU flick impulses of alternating current are extended from leads AC1 and AC2 and then over contacts *1pu1*, *1pu2* and *1b3* to the outgoing junction, the D and I loop either remaining intact, or in the case of the sensitive D and I relay arrangement described in the aforementioned application, Ser. No. 446,900, now Patent No. 2,350,652, being rendered insensitive during the application of each pulse to line. As regards resistance YW this serves slowly to drain away any residual charge on condenser QJ when the outgoing repeater is subsequently released at the end of the call.

At the distant end of the trunk line is an incoming relay set, shown in Fig. 3, which preferably forms a part of a control relay set like that disclosed in Fig. 6 of my aforementioned application Serial No. 478,243. The said control relay set includes a ring cut-off relay F, a busy relay G and an idle relay H, which for convenience are shown schematically in Fig. 3. Referring more particularly to the latter figure, relay 2A operates on seizure of the relay set by the forward extension of the direct current loop and this at contact *2a1* operates relay 2B which in turn closes contact *2b1*; relay 2B need not be slow-to-release since relay 2A is only adapted to respond to the direct current supervisory and holding signals and does not do so to the subsequently received alternating current impulses. The latter are adapted to be received on a rectifying unit RU which might consist of a dry plate rectifier bridge followed by a small gas discharge tube in the anode circuit of which relay 2PU would be situated. As more fully described in the aforementioned application, Ser. No. 446,900, this gas discharge tube would be caused to flash on the incremental front or on the decremental termination of each signal wave and would remain locked in until relay 2PU had at contacts *2pu1* repeated a suitable "flick" direct current pulse out over the negative wire to the subsequent switch train.

As soon as the call has been extended to the wanted subscriber the H relay in the control relay set will be operated if this subscriber is found to be free, while the G relay will be operated if he is engaged as described in connection with Fig. 6 of my copending application, Ser. No. 478,243. In either case the rectifying unit is disconnected by additional contacts *h* or *g* of these relays from across the lines in readiness for speech or tone transmission.

In the case of a tandem exchange an incoming selector will conveniently be similar to that shown in Fig. 1 except that the dotted rectangle

will in this case represent a control relay set combining the A. C. receiving arrangement RU of Fig. 3 and the normal functions of the control group of Fig. 6 of application No. 478,243.

The received alternating current impulses will be converted to direct current "flick" impulses to actuate the tandem selector train via the control relay set, while relay OG will be operated as described in connection with Fig. 1 to disconnect the modified control relay set when a tandem outgoing repeater is taken into use. Subsequent alternating current impulses will thereupon extend through to the outgoing repeater in the tandem exchange, which it will be understood is identical to the outgoing repeater in the originating exchange, shown in Fig. 2, and will pass through the Stone bridge therein comprising relay IA, the D and I relay and condensers QG and QH with their respective contact setting resistances YT and YV to the distant incoming relay set at the required exchange or at another tandem exchange in the same manner as for speech.

Several points should be noted about this arrangement.

1. No attempt has been made to preserve any impulse ratio. The pulse is merely a kick which triggers the later operations of the selector, and no regard is paid to the impulse break and make ratio determined by the subscriber dial. The only use made of the dialled impulses is that they serve to indicate the number of impulses in a train. This arises from a combination of self-correcting magnets and speed timing.

2. No difficulty is encountered with speech condensers and moreover the impulse receiving shunt is removed before either tones or speech is required. This arises from the position of the bridge preceding the first selector.

3. The system combines easily with the long distance voice frequency systems. When it is desired to work over a 2 V. F. or some other all A. C. system, arrangements are provided in association with lines outgoing from the area to transform the seizing and supervisory signals into the appropriate A. C. equivalents. The dialing and actuating pulses are sent out unchanged.

I claim:

1. In an impulse repeater, means for receiving direct current impulses each having a make period of a certain duration and a break period of a certain duration, and means controlled by one of said periods of each received impulse but not by the other period for transmitting a transitory impulse of alternating current, whereby a single impulse is transmitted for each received impulse and the duration of the transmitted impulse is independent of the duration of either period of the corresponding received impulse.

2. In a telephone system having three exchanges connected in series by trunk lines, means in the first of said exchanges for transmitting to the second of said exchanges impulses of alternating current, a repeater in said second exchange, a direct path through said repeater for conducting said impulses without repetition to the third of said exchanges, and means in said repeater for converting impulses generated locally in said second exchange into impulses of alternating current and transmitting said last impulses to said third exchange.

3. In a telephone system having three exchanges connected in series by trunk lines, means in the first of said exchanges for transmitting to the second of said exchanges impulses of alternating current, means in said second exchange for receiving part of said impulses and converting them into corresponding impulses of direct current, and switching apparatus in said second exchange at times controlled by the converted impulses to complete a direct path through said second exchange for conducting the remainder of said alternating current impulses without conversion to the third of said exchanges.

4. A telephone system as claimed in claim 3, wherein direct current supervisory signals are transmitted over the same interexchange trunk lines as said alternating current impulses.

5. In a telephone system having three exchanges connected in series by trunk lines, means in the first of said exchanges for transmitting to the second of said exchanges impulses of alternating current, means in said second exchange for receiving part of said impulses and converting them into corresponding impulses of direct current, a repeater in said second exchange, switching apparatus in said second exchange at times controlled by the converted impulses to complete a direct path through said repeater for conducting the remainder of said alternating current impulses without conversion to the third of said exchanges, and means in said repeater for at times converting direct current impulses generated locally in said second exchange into corresponding impulses of alternating current and transmitting said last impulses to said third exchange.

6. In a telephone system, two exchanges, a line between said exchanges over which supervisory impulses of direct current are transmitted at times, means in one of said exchanges for receiving direct current impulses each having a make period of a certain duration and a break period of a certain duration, means controlled by one of said periods of each received impulse but not by the other period for impressing upon said line a transitory impulse of alternating current, whereby a single impulse of alternating current is impressed upon said line for each of said received impulses and the duration of such alternating current impulse is independent of the duration of either period of the corresponding received direct current impulse.

7. In a telephone system, two exchanges, a direct current supervisory circuit interconnecting said exchanges, a relay in one of said exchanges connected to said circuit and controlled by direct current impulses received thereover, means at the other of said exchanges for superimposing flick impulses of alternating current upon said circuit, said relay being non-responsive to said flick impulses, and other means in said one exchange responsive to said flick impulses.

8. In a telephone system wherein calls local to an originating exchange and calls outgoing from the originating exchange to another exchange both are extended under the control of impulses transmitted to the originating exchange from the calling subscriber's station, switching apparatus in each of said exchanges, means in said originating exchange for receiving said impulses, means controlled by said receiving means on a local call for converting the received impulses into corresponding flick impulses of direct current and transmitting said flick impulses to said switching apparatus in the originating exchange to control the extension of the call, and means controlled by said receiving means on an outgoing call for converting the received impulses into corresponding flick impulses of alternating

current and transmitting said last impulses to the switching apparatus in said other exchange to control the extension of the call.

9. In a telephone system having three exchanges connected in series by trunk lines, means in the first of said exchanges for transmitting to the second of said exchanges flick impulses of alternating current, a repeater in said second exchange, a direct path through said repeater for conducting said impulses without repetition to the third of said exchanges, and means in said repeater for converting impulses generated locally in said second exchange into flick impulses of alternating current and transmitting said last impulses to said third exchange.

10. In a telephone system having three exchanges connected in series by trunk lines, means in the first of said exchanges effective whenever it is desired to extend a call to either of the other exchanges to transmit to the second of said exchanges flick impulses of alternating current, switching apparatus in said second exchange, means in said second exchange effective at times

to receive said impulses and repeat them to said apparatus to control the completion of said call in said second exchange, and means for at other times conducting said impulses directly, without repetition, through said second exchange to the third of said exchanges to control the completion of said call in said third exchange.

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