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IMPULSE SELECTOR

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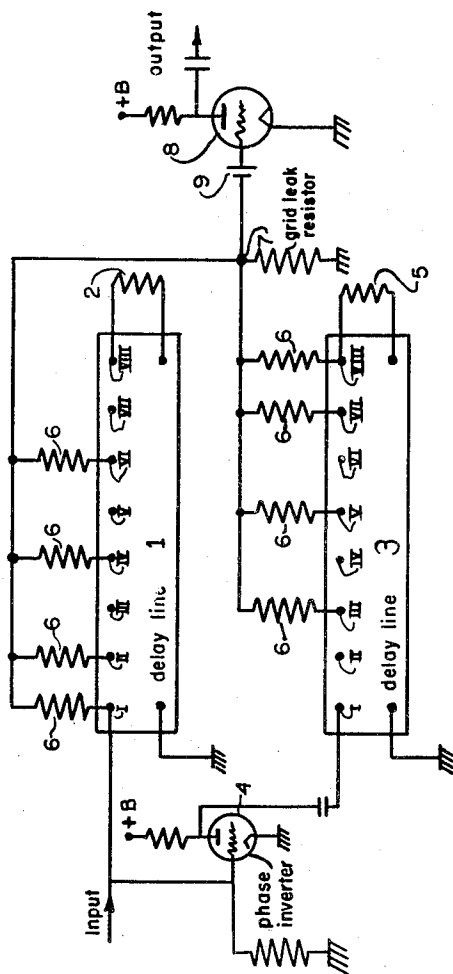


Fig 2

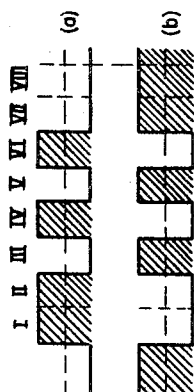


Fig 1

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IMPULSE SELECTOR

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This invention relates to apparatuses for selecting electrical impulse trains such as are commonly employed in telegraphic tele-control and similar systems and has for its object to provide improved and simple apparatus for reliably selecting a predetermined train out of different impulse trains.

Referring to accompanying drawings briefly: Fig. 1a illustrates the impulse train referred to.

Fig. 1b illustrates the complementary impulses cooperating therewith according to my invention.

Fig. 2 is a wiring diagram embodying my invention.

The type of impulse with which the invention is concerned is exemplified at *a* in the accompanying Fig. 1 which shows voltage (ordinates) plotted as a function of time (abscissae). As will be seen the train is composed of a number *n* of voltage impulses of equal duration, separated by not more than *p* interruptions of the same duration. The number of different possible trains obviously depends upon the number of combinations of *n+p*, each of which is caused to correspond to a different tele-control operation or a different telegraph signal. If, for example, *n* is four and *p* has also a maximum value of four there are 70 possible combinations of impulses and spaces

$$\frac{(5.6.7.8.)}{(1.2.3.4.)}$$

thus permitting the transmission of 70 different tele-control functions or 70 different telegraph signals. Clearly if there is no marking signal to enable distinguishing between the beginning and end of a train the number of practically utilisable trains or combinations that cannot be obtained through mere time shifting of another combination is reduced by 2 so that if *n=4* (maximum value) and *p=4* (maximum value) the number of different trains is

$$\frac{5.6.7.}{2.3} = 35 \quad \text{i. e.} \quad C_{n-1}^{n+p-1}$$

The present invention seeks to provide an improved and simple method and apparatus to enable the differentiation of such trains from one another to be effected at the receiver, so that each train may be caused selectively to operate a desired control member which in the most general case will be a relay. The method according to my invention consists essentially in applying the impulse train receiver to one delay line and simultaneously applying a symmetrical or

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complementary (mirror image) impulse train to another identical relay line. There is a pair of lines for each possible train and by suitably (and differently) tapping the pairs of lines the result is achieved that each line pair gives a potential which is of maximum value only for the particular train for which that pair is designed. The line output potentials are then fed to suitable threshold devices, preferably electronic signal measuring circuits, each of which controls a relay or the like associated with the particular train so as to produce the tele-control or signaling result desired to be brought about upon reception of that train.

The invention is illustrated in and further described in drawings Fig. 1(b) and Fig. 2 which illustrates one way of carrying the said invention into practice.

In the example now to be described *n* and *p* will each be assumed to be four (maximum) but it will be clear that the method of the invention is the same whatever may be the maximum value of *n* and *p*. The train of impulses as received is preferably shaped in any convenient known way so that all the pulses are of uniform voltage *V*, and is applied to a delay line 1 which is terminated at its right-hand end by a resistance 2 equal to its characteristic impedance so as to avoid all reflection of waves from the said right hand end. This line has *n+p=8* taps regularly spaced along it and is so designed that the time of travel from one tap to the next is equal to the duration of an elemental impulse (or an interruption) in the train. The input terminal of the line preferably constitutes the first tap and the last terminal the eighth. The shaped train received is also fed through a phase inverter 4 of unity amplification factor to a similar delay line 3 which accordingly receives a symmetrical complementary or mirror image impulse train. That is to say each elemental impulse of the received train is replaced by an interruption in the complementary train and vice versa. Fig. 1 shows at *a* a transmitted train and at *b* its mirror image or complementary train. The line 3 also has 8 taps disposed like those of line 1 and is similarly terminated by a resistance 5 equal to its characteristic impedance. Each of the lines 1 and 3 thus comprises *n+p-1=7* sections, the two lines being simultaneously fed, one with the impulse train and the other with its complement.

As soon as the leading edge of the first impulse of a train has passed the eighth tap on the appropriate line by a time equal to one-half duration of the time taken to travel from one tap to

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the next, the potentials at the taps of the lines will be characteristic of the train transmitted and of its complement. Thus assuming the transmitted train and its complement to be as shown in Figs. 1(a) and (b), the taps numbered I, II, IV, VI of line 1 will be positive while at the same instant the taps III, V, VII, VIII of the line 3 will also be positive. If therefore those particular taps are connected by identical resistances 6 to a conductor 7 as shown, since all these taps are carried to a positive potential with respect to ground at the same time, there will be a maximum voltage (V) on wire 7. It will be clear, however, that for any other train of impulses one at least of the resistance 6 (assuming the same connections) will be connected to a point of zero potential. Thus potential V will be attained by conductor 7 only when all the taps in question are positive i. e. only for this particular train. If the voltage at one of these taps falls away the potential also falls away to a value

$$\frac{n+p-1}{n+p} \times V$$

differing from V by the amount

$$\frac{V}{n+p}$$

The resistances 6 should be large with respect to the apparent resistance of the lines 1 and 3. The conductor 7 is connected to a relay or other threshold device 8 imposing practically no energy load on the lines and arranged to be non-responsive to voltages of values equal to or less than

$$\frac{n+p-1}{n+p} V$$

and to be responsive only to the voltage V. Accordingly the relay 8 will operate only on reception of the particular train of impulses for which the taps on the lines are selected and will be non-responsive to any other train.

It may be pointed out that the case mentioned above in which the voltage on the conductor 7 falls below V only by the value

$$\frac{V}{n+p}$$

is the least favourable case possible and in fact corresponds to the reception of a train having an added impulse due, for example, to a stray or other interference. In the case of a different, but normal train, it will be easily seen that the conductor 7 can attain at the most a voltage

$$\frac{n+p-2}{n+p} V$$

the difference from V being then

$$\frac{2V}{n+p}$$

that is twice as much as in the preceding case. It may be noted also that in the total absence of a received train of impulses, the voltage on the conductor 7 will be

$$\frac{V}{2}$$

(4 taps being at the potential V, the 4 others at the potential zero). It is thus possible to polarise

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the relay 8 by interposing in the conductor 7 a battery 9 of value

$$\frac{V}{2}$$

so that the differences

$$\frac{V}{n+p} \text{ or } \frac{2V}{n+p}$$

are compared to

$$\frac{V}{2}$$

thus giving still easier selection through a doubling of the ratio between the voltages to be compared.

A similar pair of lines, phase inverter and relay is provided for each train of impulses, only the taps to which the resistances 6 are connected being differently chosen for each pair. Assuming the number of possible trains of impulses

$$C \frac{n-1}{n+p-1}$$

to be N, there will be N systems of $n+p$ resistances 6 suitably connected to the taps on the lines, N conductors 7 and N relays 8 to complete the receiver in accordance with the invention. It will be noted that in each given arrangement the taps on the line 3 connected to resistances correspond in order number to the taps on the line 1 which are not so connected and vice versa. One may also arrange that the last tap on the line 1 is connected to a resistance (for each combination) because, as already indicated, the arrangement will not discriminate for trains of impulses that may be superimposed by simple shift in time.

In the foregoing it has been assumed that the trains of impulses applied to the input ends of lines 1 and 3 are pulses of voltage (and interruptions) above ground voltage, the voltage origin for the curves of Fig. 1 coinciding with the time axis. In however the majority of cases, owing to the use of transmission elements which will only pass alternating current components, the trains received will correspond to elemental impulses which are alternatively positive and negative, the voltage zero being half way between the tops and bottoms of the pulse waves as indicated in broken lines in Fig. 1. An arrangement in accordance with this invention will operate equally well in this case, the operation being practically the same as already described. The tube 8 may be connected to form the first tube of a multivibrator circuit comprising two reciprocally coupled tubes and is connected to have one stable position of equilibrium, and another of suitable duration serving for the temporary actuation of an electro-magnetic relay or the like. It may be further noted that the trains of impulses utilised do not involve any specially provided definite pilot signals to indicate, for example, the beginning of a train and this fact presents advantages in the way of simplicity.

It will be clear that various details can be changed from the described arrangement, without departing from the scope of the invention. For example, in order to compensate for losses for the different sections of the lines 1 and 3 it may be of advantage to employ resistances 6 of different values according to the points to which they are connected, the value of these resistances decreasing as they get further and further away from the input end of the delay lines. Again in order to compensate for such losses it is possible to employ identical resistances 6 and utilise lines

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the sections of which are of characteristics varying exponentially in accordance with their order number. Both solutions are well known per se.

In accompanying claims mention is made of trains of different signs. This expression is intended to convey the meaning of a predetermined succession of pulses of two selected values of opposite signs, as disclosed for instance in the example illustrated hereinabove. The reversal of such zero or negative signals produces positive pulses.

What I claim is:

1. A method for actuating a relay by means of a train of predetermined pulses comprising the steps of applying the pulse train to a delay line, reversing the phase of the pulses of said pulse train and applying said phase reversed pulse train to another delay line, selecting output voltages from said delay lines at points where the voltage of the pulses of the desired pulse train is at a maximum, adding said output voltages and applying them to the relay which does not operate unless said addition provides a voltage of a predetermined value.

2. A method for actuating a relay by means of a train of predetermined pulses comprising the steps of applying the pulse train to a delay line, reversing the phase of the pulses of said pulse train and applying said phase reversed pulse train to another delay line, selecting output voltages from said delay lines at points where the voltage of the pulses of the desired pulse train is at a maximum, adding said output voltages and applying said added voltages to a voltage threshold device responsive only to voltages above a certain value and controlling an output device only in accordance with said added voltages above said value.

3. An arrangement for actuating a relay by means of a train of predetermined pulses comprising a pair of delay lines, each of said delay lines having taps at selected positions thereon, means for feeding the train of pulses to one of said delay lines, means for reversing the polarity of said pulses in said train, said last mentioned means including means for feeding said pulses of reversed polarity to the other of said delay lines, means for taking voltages from the tap on said delay lines at which the voltage of the pulses corresponding to the desired pulse train is a maximum, means for adding said voltages taken from said taps and means for controlling an output device in accordance with said added voltages.

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4. An arrangement for actuating a relay by means of a train of predetermined pulses comprising a pair of delay lines, each of said delay lines having taps at selected positions thereon, means for feeding the train of pulses to one of said delay lines, means for reversing the polarity of said pulses in said train, said last mentioned means including means for feeding said pulses of reversed polarity to the other of said delay lines, means for taking voltages from the taps on said delay lines at which the voltage of the pulses corresponding to the desired pulse train is a maximum, connections to said taps for adding the voltages taken therefrom, a voltage threshold device responsive only to the added voltages above a certain value connected to said last mentioned connections, and an output circuit connected to said threshold device to be energized in accordance with said added voltages above said certain value.

5. An arrangement for actuating a relay by means of a train of predetermined pulses comprising a pair of delay lines, each of said delay lines having taps at selected positions thereon, means for feeding the train of pulses to one of said delay lines, means for reversing the polarity of said pulses in said train, said last mentioned means including means for feeding said pulses of reversed polarity to the other of said delay lines, a plurality of resistors for taking voltages from the taps on said delay lines at which the voltage of the pulses corresponding to the desired pulse train is a maximum, connections for connecting said resistors together to add said voltages taken from said taps, a voltage threshold device responsive only to said added voltages above a certain value connected to said last mentioned connections, and an output circuit connected to said threshold device to be energized in accordance with said added voltages above said certain value.

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