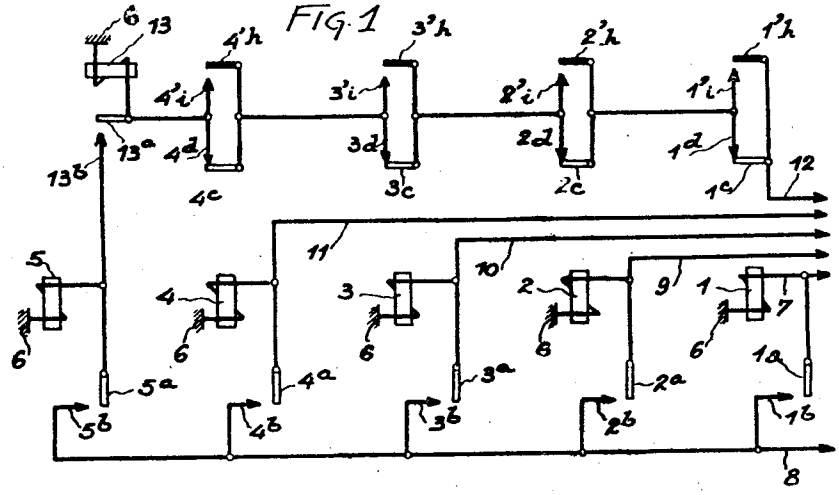
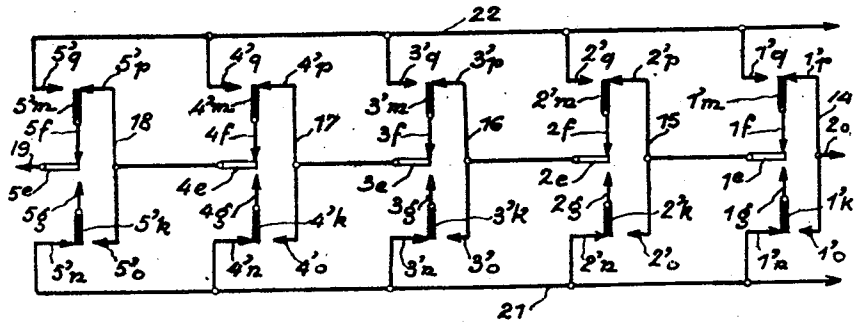
Jan. 23, 1951 J. E. P. VERNEAUX 2,539,043

NUMBER COMPARING DEVICE

Filed May 2, 1946 2 Sheets-Sheet 1

FIG. 1





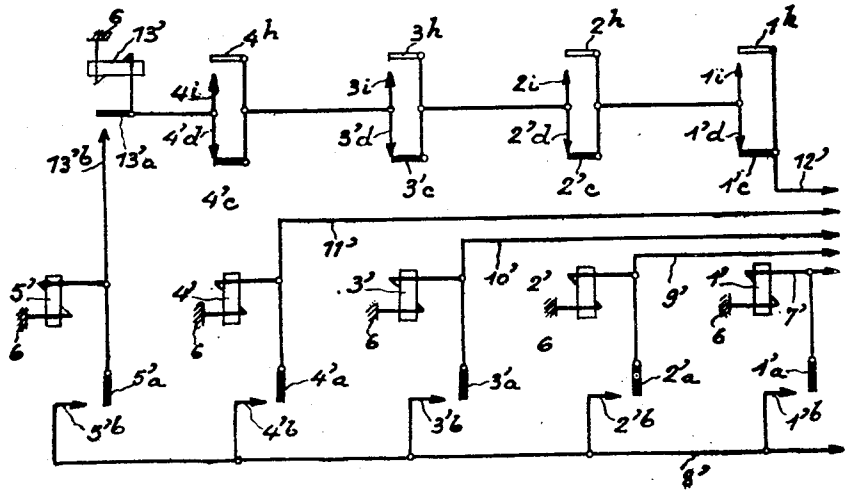


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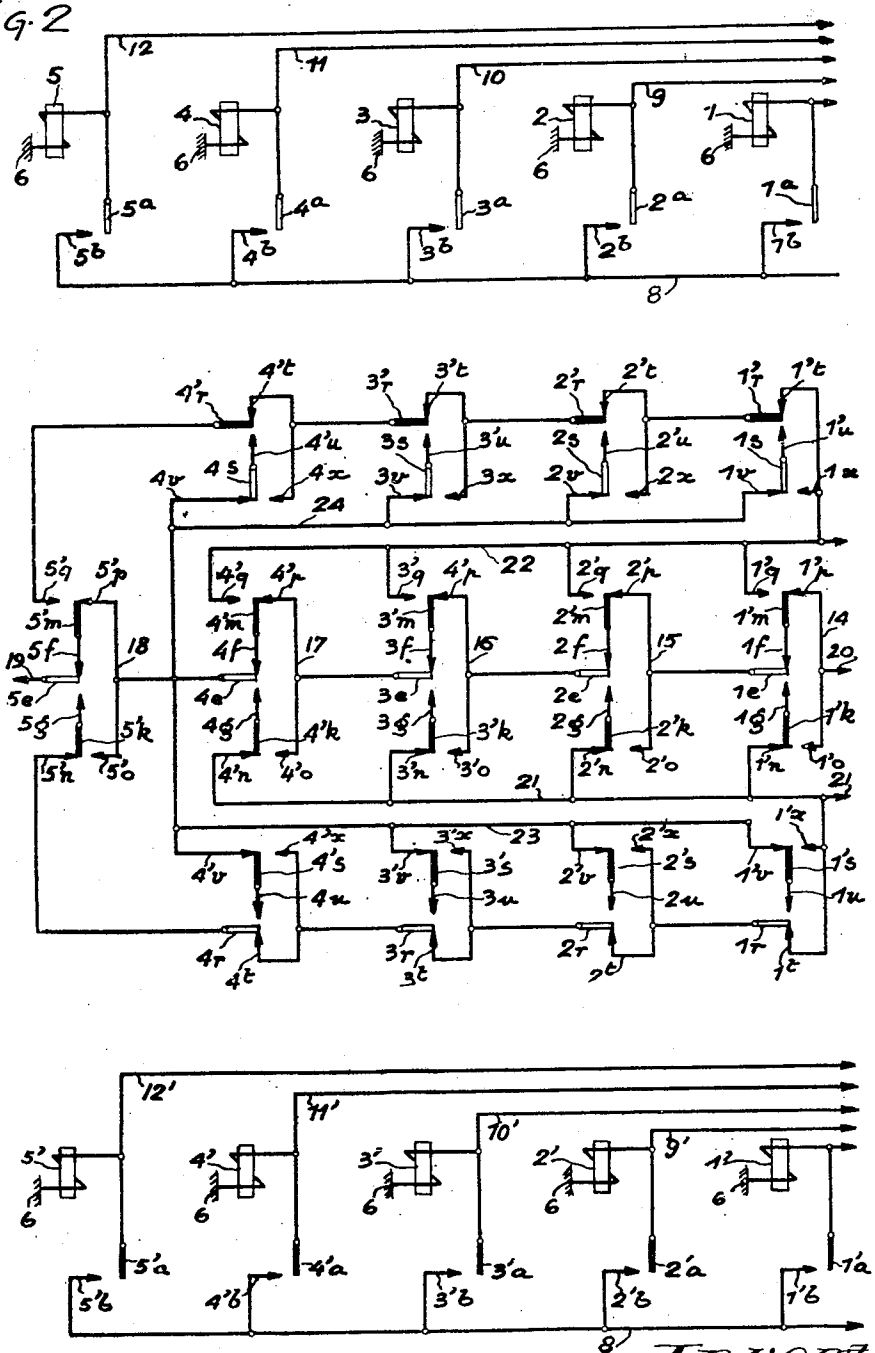
FIG. 2



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UNITED STATES PATENT OFFICE

2,539,043

NUMBER COMPARING DEVICE

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Patent expires February 22, 1963

1 Claim. (Cl. 235—61)

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This invention has for its main object to provide an automatical commutation system for interclassifying devices in statistical machines i. e. for devices, the aim of which is to compare two numbers respectively termed primary and secondary numbers with respect to each other, and to render operative a different function according to whether the primary number is inferior, equal or superior to the secondary number.

This invention is chiefly characterized in that each numeral of both said primary and said secondary number is entered into a registering device with relays which corresponds to the order of units to which belongs the numeral considered (single units, tens and so on) the relays of each registering device on one hand and the registering devices themselves on the other hand being arranged in decreasing order so as to form successive stages of two relays homologous of each registering device, each relay ensuring either immediate diversion of one signal impulse towards one of the unequality circuits and the isolation of the following stages when one only of said relays is energized or transmission of said impulse towards the following stage when both relays are simultaneously energized or at rest, the equality circuit being disposed after the last stage of relays.

Such general arrangement is applicable whatever the method of entering the numerals in the registering devices; but it is capable of a particular application in the event where the odd numerals (1, 3, 5, 7 and 9) are expressed by the energizing of a predetermined relay in the five relay registering device while the even numbers (2, 4, 6 and 8) are expressed by the energizing of the relay which corresponds to the odd numeral immediately below said even numeral and the simultaneous energizing of the relay corresponding to the numeral 9.

In that case, in the absence of an arrangement which would take into account said particular previously known method of expressing or entering the numerals, the above outlined system would always indicate the superiority of any even number over an odd number smaller than 9 since the even number causes energizing of the relay corresponding to 9 at the same time as that of another relay and the equality between any odd number and 9. For this purpose of adapting the previously defined invention to this particular case, means are provided by said invention by which the circuit of the relay corresponding to 9 in a registering device is always broken by the energizing of any other relay of the same registering device, except in the event where the corresponding relay of the homologous registering device i. e. that of the same stage, is also energized. To this end, the circuit of the relay corresponding to 9 in each primary (or secondary) registering device comprises contacts connected in series and normally closed pertaining respectively to the other relays of the registering device, said contacts being shunted by other contacts normally open and belonging to the homologous relays of the corresponding secondary (or primary) registering device.

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In a disposition of such type, the circuit of the relay corresponding to 9 is normally closed, so that said relay may be energized before the circuit thereof is opened due to the energizing of another relay of the same registering device. To avoid this disadvantage, said relay, the energizing of which is preferably retarded, instead of directly actuating the contacts corresponding to 9, controls the circuit of another relay relating to said contacts, shunted across its own circuit by an operative contact. The time lag which it is thus necessary to introduce into the operation of the device constitutes a drawback. A further drawback resides in the fact that, due to the fact that the relay corresponding to 9 is not energized in certain cases, in spite of the impulse transmitted to the circuit thereof, the registering devices do not then form a correct image of the number which had been transmitted thereto. It then becomes impossible to utilize such registering devices for other functions as for example for the checking of sequences.

For eliminating these drawbacks, in a form of embodiment of the invention, all the relays, even those which correspond to 9, directly receive their energizing impulse and in that the inequality impulses are transmitted, by the group of contacts which corresponds to 9 through chain contact controlled by the other relays of the same registering device in such a way that the energizing of one thereof determines the deflection of the impulse towards a shunt circuit which comprises a movable contact controlled by the corresponding relay of the other registering device so that said deflected impulse returns either towards the group corresponding to 7 if said last relay is not energized or, in the opposite case, towards the preceding inequality circuit.

As a result of the above arrangement:

1. If the relay corresponding to 9 is energized in one of said two registering devices only:

(a) Either no other relay is energized in the same registering device and, in that case, the

comparative impulse is at once transmitted towards the corresponding inequality circuit;

(*b*) Or, another relay is energized in the same registering device and moreover:

The homologous relay of the other registering device is also energized; in that case, the comparative impulse is sent back towards the previous inequality circuit.

The second registering device contains no energized relay or a relay other than the relay homologous, to that of the first registering device and, in that case, the comparative impulse is sent back towards the group of contacts corresponding to the numeral 7 so that the comparison proceeds normally.

2. If both relays corresponding to 9 are at rest or both are energized, the comparative impulse is sent back towards the group of contacts corresponding to 7 so that the comparison is normally effected.

The accompanying drawings represent by way of example only, two embodiments of the invention.

Fig. 1 is a diagram for a first embodiment and, Fig. 2 relates to a second embodiment.

The embodiment of Figure 1 relates to the case where the figures of the primary and secondary numbers are entered in the registering devices by means of the above indicated code, that is that the odd numerals are expressed by the energizing of a relay while the even numerals are expressed by the energizing of the relay corresponding to the odd numeral immediately below it and by the energizing of the relay corresponding to 9. Each registering device is therefore made up at least of five relays and there are as many registering devices (primary and secondary) as there may be numerals comprised in the numbers to be compared together; if, for instance, said numbers may include four numerals, the apparatus will comprise four primary and secondary registering devices.

In Fig. 1, there has been only illustrated one primary registering device and one secondary registering device and the commutation device characterizing the invention for the portion which corresponds to said two registering devices. It will be assumed that those registering devices are those which correspond to the figures of the highest order of units in the primary and secondary numbers i. e. the figures standing at the left end thereof; and it will thereof be understood that the complete system is made up of other groups of two registering devices (primary and secondary) arranged at the right of those shown and constituted in the same manner. Of course, the expression "arranged at the right" should not be interpreted as indication of any geometrical and rectilinear disposition, as will easily be understood, but this phrase is convenient because of the analogy which it brings to mind with respect to the natural disposition of the numerals making up the numbers to be compared.

The primary registering device is composed of five principal relays: **1**, **2**, **3**, **4** and **5**; the relay **1** corresponds to the numerals 1 and 2, the relay **2** to **3** and **4**, the relay **3** to **5** and **6**, the relay **4** to **7** and **8** and the relay **5** to **9** alone.

The winding of relay **1** is connected on one hand to earth (or to a return conductor) at **6** and, on the other hand, to a conductor **7** which leads to the feeler device of the statistical machine. Such device which does not form part of the invention is not described herein; it will

be sufficient to state that, when the numeral scanned is 1 or 2, the feeler device connects the wire **7** to the free terminal of the source of power, thereby obviously causing energizing of the relay **1**. Becoming energized the relay **1** attracts the movable contact **1***a* and this closes a holding circuit for the relay **1**, that is so because the fixed operative contact **1***b* is connected to the wire **8** in turn connected through the medium of a switch not represented in the drawing to the free terminal of the source of power. It will here be noted that the contacts relating to a given relay are designated by the reference number of that relay followed by a letter index, as for instance the contacts **1***a* and **1***b* which have just been described and which belong to the relay **1**. The latter further comprises the movable contact **1***c* cooperating with the fixed rest contact **1***d*, the movable contact **1***e* cooperating with the fixed rest contact **1***f* and the fixed operative contact **1***g*; lastly, the movable contact **1***h* cooperating with the fixed operative contact **1***i*.

The relays **2**, **3** and **4** are identically constituted and arranged as the relay **1**, the description of this arrangement will therefore not be repeated and it will only be observed that the contacts corresponding to each of said relays have been given the same letter index as those corresponding to relay **1**. Thus, for instance, contacts **2***a*, **3***a*, **4***a* are identically related with respect to relay **2**, **3** and **4** as contact **1***a* with respect to relay **1**.

The windings of the relays **2**, **3** and **4** are like that of relay **1** connected on one hand to earth or to a return conductor which has uniformly been designated by the reference **6** and, on the other hand, to a conductor respectively designated by **9**, **10** and **11** which, like the wire **7** previously described, leads to the feeler device of the statistical machine.

Relay **5**, which has started, corresponds to the figure 9, is constituted and arranged in a manner somewhat different from the preceding relay. It comprises the same contacts with the sole exception of the contact which would have borne the latter indices *c*, *d*, *h* and *i*. On the other hand, while the winding of relay **5** is earthed at **6**, it is not directly connected to conductor **12**, which, like the wires **7**, **9**, **10** and **11** previously described leads to the feeler device of the statistical machine. Such connection occurs through contacts **1***c*—**1***d*—**2***c*—**2***d*—**3***c*—**3***d*—**4***c*—**4***d* in series and by the movable contact **13***a* and the fixed operative contact **13***b* of a relay **13**, the winding of which connected to earth at **6** is also connected in series through the contacts **1***c*—**1***d*—**2***c*—**2***d*—**3***c*—**3***d*—**4***c*—**4***d* with the wire **12**.

The secondary registering device is constituted in the same way as the primary registering device, it is therefore needless to repeat the description thereof. It will be enough to state that the relays and the contacts of the secondary registering device have been designated in the drawing by the same numbers of reference followed by the same letter indices but moreover with the index prime. Moreover, whereas the movable contacts of the primary relays are indicated by two parallel lines, the movable contacts of the secondary relays are indicated by a thick line. However, there are no homologous contact to those which bear, in the primary registering device, the letter indices *e*, *f*, and *g* but, on the contrary, the relay **1'** for instance comprises two additional movable contacts **1'***k* and **1'***m*. The movable contact **1'***k* is connected to the fixed

operative contact 1g and cooperates with a fixed rest contact 1'n and a fixed operative contact 1o. The movable contact 1'm is connected to the fixed rest contact 1f and cooperates with a fixed rest contact 1'p and with a fixed operative contact 1'q. All the relays 2'—3'—5' comprise, in the same way, contacts similarly indicated by the letter indices k, m, n, o, p, q disposed in the same way.

It will be noted that in the primary registering device the separate rest contacts such as 1'h and 1'i are arranged to shunt the contacts which are mutually engaged at rest position such as 1d and 1c. In the same way, contacts 2'h, 2'l shunt the contacts 2c—2d, the contacts 3'h—3'i shunt the contacts 3c—3d and the contacts 4'h—4'i shunt the contacts 4c—4d. In the secondary registering device, the same arrangement is repeated, but reversed. In other words the contacts 1h—1i shunt the contacts 1'c—1'd, contacts 2h—2i shunt the contacts 2'c—2'd and so on.

The commutation device proper, has already been partially described at the same time as some of the contacts of the primary and secondary registering devices; it will be sufficient to add that:

(a) The contacts bearing the letter indices o and p (such as for instance 1'p and 1'o) are connected together in each group as shown at 14—15—16—17 and 18;

(b) The inlet terminal of the signalling impulse is connected to the movable contact 5e as shown at 19, while connection 18 is connected to the movable contact 4e, connection 17 to movable contact 3e, connection 16 to movable contact 2e, connection 15 to movable contact 1e and connection 14 to wire 20 which extends the signaling circuit towards the group corresponding to the lower order of units, that is those situated at the right;

(c) The fixed operative contacts bearing the letter index are multipled on the wire 21 adapted to signal the superiority of the primary number;

(d) And lastly, the fixed operative contacts bearing the index q are multipled on the wire 22 signalling inferiority of the primary number.

The device operates as follows:

Equality of the primary and secondary numbers

In this case, it is obvious that the same numeral is transmitted to both registering devices i. e. primary and secondary of a given group.

It will first be assumed that said numeral is an odd numeral, say 5.

In this case, an impulse is transmitted by the feeler device of the statistical machine over the wire 10, so that relay 3 is energized. It attracts its armature which causes closure of the contacts 3a—3b and formation of a holding circuit for relay 3 which will remain energized even after the impulse over wire 10 will have disappeared. Said holding circuit comprises the wire 8 and a switch not shown in the drawing, the ulterior opening of which alone will permit deenergizing of relay 3.

Energizing of relay 3 has for effect to break at 3c the circuit of relay 5 to bring the contact 3e in engagement with contact 3g and, lastly, to shunt at 3h—3i contacts 3'd—3'c.

But, on the other hand, in the secondary registering device, an impulse is transmitted over the wire 10' so that relay 3' is energized and remains energized by the contacts 3'a, 3'b and the wire 8'. The contacts 3'c—3'd are opened. This has no effect since they are shunted by the contacts 3a—3i; contacts 3'k and 3'm are shifted to operative position; lastly, contacts 3'h and 3'l shunt contacts 3d—3c thus destroying the effect which opening of said contacts may have produced.

Connections between 19 and 20 which initially comprised all the contacts bearing indexes e and f in series was first destroyed by movable contact 3e shifting to operative position, but it is obvious that such connection is reestablished by another path comprising contacts 3g—3'k—3'o since relay 3' is energized. The circuit between 19 and 20 remains the same up to connection 17, then it passes through 3e—3g—3'k—3'o and returns at 2e to the initial circuit.

It will thus be seen that, in this case, the effect is identically the same as if nothing had been changed in the initial connections so that the signaling impulse transmitted through 19 reaches conductor 20, this being characteristic for the equality of the registered numbers. Said impulse thereafter passes into the following commutation device and so on.

If the numeral transmitted had both for the primary and for the secondary registering device, been an even number such as 6 for example, an impulse would then have been sent to wires 10 and 10' as in the case of numeral 5, but moreover an impulse would also have been sent to wires 12 and 12', said impulse corresponding to numeral 9 in the primary number and to the secondary number, the impulse on the wires 10 and 10' would have produced the same operations as previously, but moreover the impulse on wires 12 and 12' would have caused the effects which are now about to be described.

It has been explained that opening of contacts 3c—3d on one hand and 3'c—3'd on the other was cancelled by the simultaneous closure of contacts 3'h—3'i and 3h—3i. Consequently, the impulse on wire 12 energizes relay 13 and the impulse on wire 12' energizes relay 13'.

Upon being energized, relay 13 closes the contacts 13a—13b thereby energizing relay 5 which remains energized by contacts 5a—5b and wire 8. Similarly, the impulse on wire 12' energizes relay 5'.

It will be observed that, in order to avoid leaving relay 13 energized, the circuit thereof could be made to pass through a rest contact cooperating with the movable contact 13a.

Simultaneous energizing of relays 5 and 5' in the same way as described above in connection with that of relays 3 and 3' has for its sole effect, as will be easily understandable without it being necessary to repeat the above description, to transfer the connection between 19 and 18 through the contacts 5e—5g—5'k—5'o. Therefore, the signaling impulse arriving over 19 is further transmitted at 20.

Odd primary number greater than the corresponding odd secondary number

It will be assumed for instance that the numeral transmitted to the registering device is 5, like in the preceding example, while the numeral transmitted to the secondary registering device is 3.

In the primary registering device, the relay 3 is energized as previously and in the secondary registering device the relay 2' is energized, but it is about to be shown that the energizing of relay 2' remains without effect.

The contact 3e disengages the rest contact 3f to engage the fixed operative contacts 3g; relay 3' not being energized, the obvious result is that

the signaling impulse which arrives at 19 and reaches contact 3e through the previously described circuit is directed on wire 21 through the contacts 3'k and 3'n so as to produce the signal "primary numeral greater than secondary numeral." Said impulse may therefore no longer reach contact 2e so that the energizing of relay 2' is no longer capable of producing any effect. It will easily be understood why the signaling impulse may immediately be deflected towards the wire 21 as soon as one of the commutation system ascertains that the registered numeral of the primary number is greater than the registered numeral of the secondary number. For it is obvious thousands of the primary number is greater than the numeral of the thousands of the secondary number, it is superfluous to continue the comparison between the two numbers any further. It is therefore only in the event where the commutation system ascertains equality of both registered numerals, that it will be necessary to extend the circuit of signaling impulses to the commutation system situated further towards the right, that is corresponding to units of a lower order.

Even primary numeral greater than the corresponding even numeral of the secondary number

It will be assumed that the registered primary numeral is 6, i. e. that an impulse is transmitted both over wires 10 and 12 and the registered secondary numeral is 4, that is that an impulse is transmitted both over wires 9' and 12'.

As previously explained, energizing of relay 3 breaks at 3c—3d the energizing circuit of relay 13, but this time relay 3' is not energized so that the broken circuit is not reestablished. If therefore relay 13 is initially energized at the same time as relay 3 (since the circuit thereof is initially closed) said circuit is also broken and relay 3 falls back. When it has been energized and has consequently effected closure of contacts 13a—13b, it has however not yet been possible for relay 5 to become energized because, at the instant contacts 13a—13b had closed the circuit thereof, contacts 3c—3d had broken the same at another point. The result is that the impulse transmitted over wire 12 remains without effect and that the result is to all purposes the same as though numeral 5 had alone been registered by the energizing of relay 3.

For the same reasons, in the secondary registering device, the impulse transmitted over 12' also remains without effect and to all purposes, the effects are the same as though numeral 3 had alone been registered by the energizing of relay 2'.

The result is that comparison is not effected between the two even numerals transmitted, but between the two odd numerals respectively below the same, which is obviously equivalent. The same operations as in the previously described event are repeated in a like manner with like results.

Odd primary numeral greater than odd secondary numeral

It may have been observed from the above explanations that both in the primary and in the secondary registering devices, energizing of a relay 1—2—3—4 or 1'—2'—3'—4' has always for effect to break the energizing circuit of the relay 13—13' except in the special case where the same relay is energized both in the primary and in the secondary registering device (i. e. when primary and secondary numerals are equal). Now, in the event under discussion where the odd primary numeral is greater than the odd secondary numeral, it is obvious that the relays which are energized in the primary and in the secondary registering devices may not possibly be the same. For a single relay corresponds to an odd numeral and to the even numeral immediately above it; therefore, the relay corresponding to a lower even numeral and to an odd numeral is necessarily different. The result is that in the secondary registering device, the registered numeral is the odd numeral immediately below the even numeral which has been transmitted and the comparison is made between two odd numerals as disclosed above.

If, for instance, the numeral transmitted to the primary registering device is 5, relay 3 is energized as described. The numeral transmitted to the secondary registering device being 4 for instance, the relay 2' becomes energized and breaks at 2'c—2'd the circuit of relay 13'. Conditions in the secondary registering device are to all effects the same as in the previous example, so that comparison is made between the nunumerals 5 (primary) and 3 (secondary) instead of 4.

Even primary numeral greater than odd secondary numeral

Two events are to be considered according to whether:

The even primary numeral exceeds by more than one unit the odd secondary numeral, or

The even primary numeral exceeds by one unit only the odd secondary numeral.

In the first case, relay 1—2—3—4 energized in the primary registering device is not the same as relay 1'—2'—3'—4' energized in the secondary registering device. The result therefore is that, in the primary registering device, the circuit of relay 13 is broken as previously explained and that comparison is made between the odd numeral just below the numeral transmitted to the primary registering device and the odd numeral transmitted to the secondary registering device: we are thus brought back to one of the cases previously discussed. If, for instance, the even numeral transmitted to the primary registering device is 8, then the odd numeral transmitted to the secondary registering device is 5, the comparison will be effected between the numeral 7 which alone is registered in the primary and 5 registered at the secondary.

In the second case, relay 1—2—3—4 energized in the primary registering device is the same as relay 1'—2'—3'—4' energized in the secondary registering device. The result, as already explained, is that energizing of the secondary relay cancels the breakage of the circuit effected by the energizing of the primary relay for relay 13, so that said relay is energized and causes energizing of relay 5. The result then is that contact 5e is shifted to operative position by the fifth contact 5g and this has for effect immediately to deflect the signaling impulse to wire 21. In other words, comparison is made in this case between numeral 9 registered at the primary and the odd numeral registered at the secondary.

Odd primary numeral smaller than odd secondary numeral

Assume for example that the numeral transmitted to the primary registering device is 3 and

that transmitted to the secondary registering device is 7, consequently relay 2 of the primary and relay 4' of the secondary are energized.

Because of energizing of relay 4' contact 4'*m* engages contact 4'*q* thereby breaking at 4'*p* the normal impulse-transmitting circuit towards the groups placed further right, and deflecting said signaling impulse at once to wire 22, which corresponds to the signal "primary number smaller then secondary number." For the same reasons as above energizing of relay 2 produces no effect since no impulse may any longer reach contact 2*e*; for, even though contact 4'*k* did engage contact 4'*o*, this circumstance is of no consequence as contact 4*e* has remained at rest.

Even primary numeral smaller than even secondary numeral

In this case, as previously discussed in connection with the instance where the even primary numeral is greater than the even secondary numeral, comparison is made between the two immediately preceding odd numerals because relay 1, 2, 3, 4 which is energized is not the same as relay 1'—2'—3'—4' which is energized so that both in the primary and in the secondary registering devices relays 13 and 13' may not be energized by the impulse on wires 12 and 12'. We are therefore brought back to the previous case.

Odd primary numeral smaller than even secondary numeral

Two cases should be considered according to whether the odd numeral of the primary is smaller than the even numeral of the secondary by more than one unit or by one unit only.

In the first case, the relay 1—2—3—4 energized is not the same as the relay 1'—2'—3'—4' energized. The result is, as has been explained, that the relay 13' is not energized by the impulse transmitting wire 12' so that the numeral registered in the secondary is the odd numeral smaller by one unit than the even numeral transmitted. The comparison is then carried out, as previously.

In the second case, relay 1—2—3—4 energized is the same as relay 1'—2'—3'—4' energized. The result is that the circuit of relay 13' is reestablished and relay 5' becomes energized. Contact 5'*m* deflects the impulse transmitted over 19 towards wire 32 i. e. comparison is made between the numeral 9 inscribed in the secondary and the odd numeral of the primary.

Even primary numeral smaller than odd secondary numeral

In this case the relay 1—2—3—4 energized is necessarily different from the relay 1'—2'—3'—4' energized so that relay 13 does not become energized and comparison is effected between the odd numeral just below the even numeral transmitted to the primary and the odd numeral transmitted to the secondary.

Modifications

In the example of Figure 2, according to one feature of the invention, relays 5 and 5' corresponding in both registering devices to the numeral 9 are directly supplied by the energizing impulse transmitted over 12 and 12'.

On the other hand, relays 1, 2, 3, 4 and 1', 2', 3', 4' are provided with additional contacts indicated by the same reference numerals followed by the same indices, *r*, *s*, *t*, *u*, *v*, *x* while the contacts of said relays which, in the case of Fig. 1, bear the same reference numerals followed by the indices *c*, *d*, *h* and *i* are on the contrary suppressed.

The operative contact 5'*q* which was directly connected in Fig. 1 to the inequality circuit 22 (indicating inferiority of the primary number) is now connected thereto through the chain contacts 4'*r*—4'*t*, 3'*r*—3'*t*, 2'*r*—2'*t*—1'*r*—1'*t*. Similarly, the rest contact 5'*n* which is directly connected to the inequality circuit 21 (indicating superiority of the primary number), is now connected thereto by the chain contacts 4*r*—4*t*, 3*r*—3*t*, 2*r*—2*t*, 1*r*—1*t*. Moreover, each contact bearing the index *u* is connected to a movable contact bearing the index *s* whereof the rest contact having index *v* is connected to the wire linking the group of contacts corresponding to the numeral 9 with the group corresponding to the numeral 7, whereas the operative contact thereof having index *x* is connected to the rest contact having index *t* i. e. to the corresponding inequality circuit 21 or 22. The arrangement then operates as follows:

I. Relay 5 is assumed to be energized and relay 5' deenergized.

(*a*) No other relay is energized in the primary registering device, i. e. the numeral entered in the primary registering device is 9.

In that case, the comparative impulse which arrives over 19 is transmitted over unequality wire 21 (superiority of the primary number) by the contact 5*e* operative, contact 5*g*, 5'*k*, 5'*n*, 4*r*, 4*t*, 3*r*, 3*t*, 2*r*, 2*t*, 1*r* and 1*t*.

For, in this case considered, the numeral entered in the secondary registering device not being 9 is necessarily smaller than that entered in the primary registering device.

(*b*) Another relay is energized in the primary registering device i. e. the numeral entered in this registering device is even.

1. Moreover, the homologous relay of the secondary registering device is likewise energized. For example the relays 5 and 3 are energized in the primary registering device and the relay 3' in the secondary registering device.

In that case, the comparative impulse is returned over the inequality wire 21 (superiority of the primary number) by way of the following circuit: contacts 5*g*, 5'*k*—5'*h*—4*r*—4*t*—3*r* operative 3'*u*—3'*s* operative—3'*x*—2*r*—2*t*—1*r*—1*t*—.

For the numeral inscribed in the primary registering device is 6 while that inscribed in the secondary registering device is 5.

2. The secondary registering device contains no energized relay or a relay other than the relay homologous to that of the first registering device. For instance, relays 5 and 3 of the primary registering being energized, no relay is energized in the secondary registering device or else relay 4' is energized.

In both cases, the comparative impulse is returned to the entrance of the group of contacts corresponding to the numeral 7, i. e. to contact 4*e*. For, this impulse passes over the following circuit: contacts 5*e* operative, contacts 5*g*, 5'*k*—5'*n*—4*r*—4*t*—3*r*—3*u*—3'*s*—3'*v*—wire 23—contact 4*e*. The comparison operation then proceeds as described in reference to Fig. 1.

Thus, in the first case (no relay energized in the secondary registering device), such impulse continues by way of: contacts 4*e*—4*f*—4'*m*—4'*p*—wire 17—contact 3*e*—operative, contact 3*g*—3'*k*—3'*n* and unequality wire 21 indicating

superiority of the primary numeral. For, this primary numeral is 6 whereas the secondary numeral is 0.

In the second case (relay 4' energized), the comparative impulse passes by way of contact 4e—4f—4'm operative-4'q and wire 22 indicating superiority of the secondary numeral. For, this secondary numeral is 7 while the primary numeral is 6, as stated above.

II. Relays 5 and 5' are both at rest or both energized.

If they are both at rest, the comparative impulse is directed towards the right through contact 5f, 5'm, 5'p, wire 18, contact 4e and the comparison proceeds as indicated in reference to Fig. 1.

This is so because both numerals are odd and smaller than 9.

If relays 5 and 5' are both energized, the comparative impulse is then directed towards the right through contact 5e operative—5g—5'k operative—5'o operative—wire 18—contact 4e and the comparison again proceeds as indicated hereinabove.

This is so because those numerals are even and the comparison is carried out between the odd numerals respectively immediately below them.

The functional feature of the above described device is therefore the following:

The inequality impulse which derives from energizing of one only of relays 5 or 5' corresponding to the numeral 9 in both registering devices is transmitted to the corresponding unequality wire by the chain contacts bearing the index *r* in such a way that the energizing of another relay of the said registering device interrupts said transmission and returns the impulse through the contacts bearing the index *u* towards the contacts 4e; except however if the homologous relay of the latter relay, but contained in the other registering device is energized at the same time, this having for effect to reestablish by way of the contact bearing the index *s* the connection broken off at the contacts bearing the index *r* with the previous inequality wire.

What I claim as my invention and desire to secure by Letters Patent is:

In a device for comparing primary and secondary multidenominational arithmetical numbers for relative magnitude, wherein said numbers are represented in a combinational code and wherein comparison of corresponding denominations of the two numbers is effected seriatim beginning with the highest order by means of a comparison electrical signal, in combination, a primary register for registering the primary number, a secondary register for registering the secondary number, said registers being each composed, in each denomination, of a set of electrical relays energizable singly or in combination to represent every possible digit of a notation, of a set of wires each of them for energizing the relays, the grouping of which corresponds to the digit to be entered in the corresponding register and of means for holding said relays when in energized position, said relays being arranged in two parallel rows, one corresponding to the primary number and the other one to the secondary number, so as to form successive stages of pairs of homologous relays, and, for each denomination, a comparing structure comprising a contact receiving the comparison signal, a circuit having three lines for respectively indicating the equality between the primary and secondary numbers, the superiority and the inferiority of said primary number with respect to said secondary number, the equality line being connected at rest with said contact and with the comparison contact of the subsequent denomination, means for transmitting said signal to said equality line when all pairs of homologous relays forming a primary and a secondary grouping are in the same electrical conditions, means for transmitting said signal to said superiority line when in one of the pairs of homologous relays forming a primary and a secondary grouping the primary relay is alone energized and means for transmitting said signal to said inferiority line when in one of the pairs of homologous relays forming a primary and a secondary grouping the secondary relay is alone energized.

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