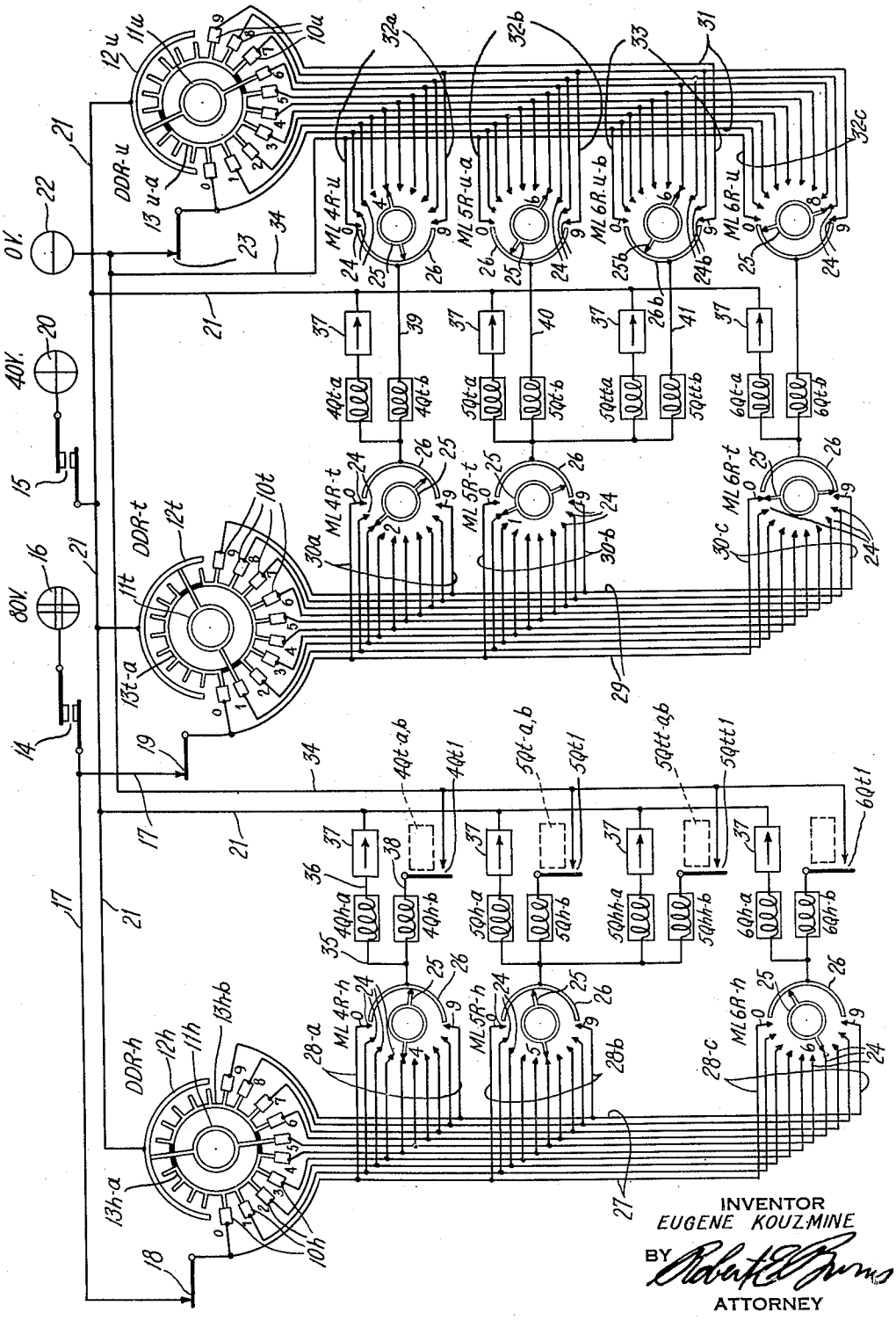
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MULTIDIGIT NUMBER-COMPARING DEVICE

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MULTIDIGIT NUMBER COMPARING DEVICE

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The present invention relates to devices for comparing two numbers to ascertain their relative magnitudes. The invention has particular application to calculating machines in which registers are provided upon which numbers are set as a result of entries made from record cards or key sources. In the type of calculation machine wherein dividing operations are carried out, provision is generally made for setting up on a register a number representing a dividend and another register is set to represent a divisor, and it is desirable to ascertain the relationship between these two factors.

It is well known in calculating machines that a register may be set up to represent a dividend and a plurality of other registers may be set up each representing a different multiple of the divisor, so that concurrent comparison may be made between the dividend and the various divisor multiples to ascertain the highest multiple that will go into the dividend.

The present invention contemplates the provision of a simplified apparatus that will effect comparison between a dividend amount and one or more divisor amounts, together with devices actuated in accordance with the result of the comparison.

Other characteristics and advantages of the present invention will also be made more evident on reading the following description and from an inspection of the drawing which is a diagram of the circuit arrangement for comparing one amount with one or more other amounts.

In the drawing:

Three denominational orders of the comparing mechanism are illustrated by way of example and designated DDR—*h*, DDR—*t* and DDR—*u*. In the upper part of the drawing are shown three stationary arcuate conductors 12*h*, 12*t* and 12*u*, each of which has associated therewith ten so-called steps 10*h*, 10*t* and 10*u*. Within each set comprising a conductor and ten steps is a brush or wiper arrangement comprising a central wiper 11*h*, 11*t* or 11*u* and two sets of multiple brushes such as 13*h*—*a* and 13*h*—*b*. This brush structure may be positioned angularly to represent any of the digits, and for purposes of explanation the separate orders are generally designated DDR—*h*, DDR—*t*, DDR—*u* to designate the hundreds, tens and units orders of a register upon which a dividend amount is set. For illustrative purposes, the dividend amount 516 is indicated as being set on these devices, which is done by positioning the central brush 11 in contact with the step 10 corresponding to the digit to be represented. Such positioning will cause all steps 10 of lower value to be electrically connected together through brushes 13*h*—*a* and all steps 10 of higher value to be connected together through brushes 13*h*—*b*, as is apparent from inspection of the drawing.

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For representing a second amount such as a divisor, angularly positionable brushes 25 are provided which may be positioned to connect any one of ten steps 24 to an arcuate conductor 26. Three of such devices for representing a three place divisor amount are designated generally as ML4R—*h*, ML4R—*t*, ML4R—*u*. In the diagram this set of devices is set to represent the amount 424 and the brushes 25 thereof may be positioned automatically in known manner by the registers of a calculating machine. If further divisor amounts are to be considered, additional sets of brushes 25 and related steps 24 are provided as indicated. Thus, for example, on the set prefixed ML5R the value 516 is represented in the drawing and on the third set prefixed ML6R the amount 608 is represented. For simplicity of the disclosure, only three divisor amount settings are provided, and it will be understood that where it is desired to compare a dividend amount with all nine multiples of a divisor, there will be nine sets of three brushes 25 and related contact devices.

In the hundreds order of the apparatus, the steps 24 are connected through the wires 28—*a*, 28—*b* and 28—*c* to a common set of wires 27 which extend to the steps 10*h* so that all like value steps are connected together. In the tens order similar connection through wires prefixed 30 and the group of wires 29 is made. Each of the common conductors 26 in the units and tens orders is connected to a pair of relay windings generally prefixed 4Q for the upper set, 5Q for the central set, and 6Q for the lowermost set. The two windings of each pair are on a common core. In the units order, the steps 24 are connected through wires prefixed 32 and a group of wires 31 to steps 10 with a one unit shift in their relationship. Thus, for example, the 9 wire 32 is connected to the 8 step 10, the 8 wire 32 is connected to the 7 step 10, and so on.

For completing circuits through the apparatus, three terminals designated 16, 20 and 22 are provided which are at different electrical potentials, for example, 80, 40 and 0 volts, respectively, and when contacts 14 and 15 are closed, circuits will be established in accordance with the relative values of the dividend and divisor as set on their respective sets of brushes.

In the hundreds or highest order position, the relay winding 4Q*h*—*b* has a pair of contacts 4Q*t*—1 in series therewith which are closed by relay 4Q*t* of the tens order when either of its windings receives current. The upper winding of each pair, for example, winding 4Q*h*—*a* has a unidirectional current flow device designated 37 in series therewith.

Let us first consider a comparison of the dividend amount 516 with a divisor amount 424, and trace the specific circuits involved upon closure of contacts 14 and 15 which, for purposes of ex-

planation, may be presumed to be closed manually after the values have been set on their respective sets of brushes. A first circuit is traceable from the 80 volt source 16 through contacts 14, wire 17, contacts 18, 0 step 10*h* and through the brushes 13*h*—*a* to the 4 step 10*h*, the 4 wire 27, the 4 wire 28—*a*, to the 4 step 24 at which brush 25 is set in the hundreds order, conductor 26, upper winding 4Q*h*—*a*, unidirectional current flow device 37, wire 21 and contacts 15 to the 40 volt current source 20.

It may be mentioned that contacts 18 in the hundreds order as well as contacts 19 and 23 in the two lower orders are normally closed and are opened through any suitable means when the dividend digit in the related order is 0. Thus, provision is made to prevent possible back circuit conditions.

In the tens order for the example under consideration, where the dividend digit is 1 and the divisor digit is 2, there will be no circuit completed since current is supplied from the 80 volt source to the contacts 14, thence through contacts 19 to the 0 step 10*t*, whose 0 wire 29 extending to the 0 step 24 is not connected to the conductor 26.

In the units order likewise, no circuit is completed since the wire 30 extending from the common conductor 26 in the units order runs to coil 4Q*t*—*b* whose opposite side is connected to the conductor 26 in the tens order. Accordingly, for the chosen example where the dividend 516 is greater than divisor 424, relay 4Q*h*—*a* is energized and represents by such energization that the dividend is greater than the divisor. For simplicity in the disclosure, the device which is controlled by the relay upon energization is not illustrated.

Let us consider now the comparison of the dividend 516 with a divisor 516 of the same magnitude. In the highest or hundreds order there is no energizing circuit completed and instead a short-circuit is provided around the settable devices, which is traceable from the 40 volt source 20, through contacts 15, wire 21, conductor 12*h*, central brush 11*h*, 5 step 10*h*, 5 wire 27, 5 wire 28—*b* to the 5 step 24 (see the central setting), brush 25 (set at 5), conductor 26, winding 5Q*h*—*a*, device 37, back to wire 21 and the same potential source 20.

In the tens order where both digits are set to represent 1, a similar short circuit exists which is also traceable from 40 volt source 20, contacts 15, wire 21, conductor 12*t*, central brush 11*t*, 1 step 10*t*, 1 wire 29, 1 wire 30—*b*, the 1 step 24, brush 25 (set at 1), conductor 26, to winding 5Q*t*—*a* and its related device 37, back to wire 21 and the 40 volt current source 20. This circuit also branches from the conductor 26, through the second winding 5Q*t*—*b*, wire 40 to the conductor 26 in the units order, where it continues through the brush 25 set at 6, the 6 step 24 which is connected to the 6 wire 32—*b*, 5 wire 31 extending to the 5 step 10*u*, thence through the connected brush structure 13*u*—*a*, 0 step 10*u*, contacts 23 to the 0 potential source 22.

There is thus a circuit completed through the winding 5Q*t*—*b* which will close its contacts 5Q*t*1 (corresponding to 4Q*t*1) to thereby complete the first traced circuit from conductor 26 in the hundreds order, through winding 5Q*h*—*b*, contacts 5Q*t*1 (now closed), wire 34 to the 0 potential source 22, thus energizing the relay 5Q*h*—*b* as a manifestation that the two numbers compared are equal.

A comparison of these two equal values serves to illustrate the reason for the connections in the units order between wires 32 and 31 with the 1 unit offset. If the connections were made in the same manner as in higher orders, there would have been no completed circuit in the units order, since its brush 11*u* is connected to the 40 volt source. By making a 1 digit offset in the connections, the circuit is directed through 0 volt source, so that the circuit through 5Q*t*—*b* is completed to in turn complete the circuit through 5Q*h*—*b*.

Let us now consider the circuits involved where the dividend 516 is compared with divisor digit 608. In this case the hundreds digit of the dividend is less than the corresponding digit of the divisor, and no circuit will be completed in the highest order since the related brush 25 set at the 6 step 24 is now connected through the 6 wire 27 to the 6 step 10*h* whose related brushes 13*h*—*b* are not connected to any source of current. In the tens order, a circuit is completed from the 80 volt source 16 to contacts 14, wire 17, contacts 18, 0 step 10*t*, 0 wires 29 and 30—*c*, 0 step 24, brush 25, winding 6Q*t*—*a* (for example), its related unidirectional current flow device 37, wire 21 and contacts 15 to the 40 volt source 20. This completes a circuit to energize winding 6Q*t*—*a*, representing that the tens order digit of the dividend is greater than that of the divisor. It will close its related contacts 6Q*t*1 but this will have no effect, since the left hand connections to the 6Q windings cannot be completed back to a current source, as already stated. The circuit through 6Q*t*—*a* will not extend through the companion winding 6Q*t*—*b*, since the brush 25 in the units order is connected to the 8 step 24 and the 8 wire 31 to the 7 step 10*u* whose connected set of brushes are not connected to any current source.

From the three examples whose circuits have just been traced, it will be noted that where the dividend is greater than the divisor, winding 4Q*h*—*a*, for example, will become energized. Where the two amounts are equal, the winding 4Q*h*—*b*, for example, is energized, and where the dividend amount is less than the divisor amount, neither of these relays will be energized, so that these two relays by their selective energization or lack of energization will serve to manifest the relationship between the two amounts compared.

From the foregoing, it is also apparent that, where the highest order of the dividend is greater than the corresponding order of the divisor, comparison of lower orders is immaterial and likewise, if the highest order of the dividend is less than the highest order of the divisor, comparison of lower orders is immaterial since the highest order relays cannot be energized. In the case where the two highest orders are equal, there is a partial circuit completion which is dependent upon comparison conditions in the lower orders. Thus, where the next lower order of the dividend is greater than the divisor, comparison will result in the completion of a partially established circuit in the highest order to indicate the result.

The device is employed in a dividing machine and a set of brushes 25 is provided for each multiple of the divisor, that is, the divisor is set up in the form of the divisor times 1, the divisor times 2, etc. up to the divisor times 9. All related Q*h* relays whose related divisor multiples are equal to or greater than the dividend will be energized, and others will not. Inspection of the condition of energization or deenergization of these relays will accordingly enable selection of the highest divisor multiple that is contained in the dividend.

In the drawing one of the sets of divisor set-

table devices is provided with a second set of windings designated in the hundreds order, for example, 5Q*hh*—*a* and 5Q*hh*—*b*, and a second brush arrangement 25*b* in the units order with the steps 24*b* thereof connected to the wires 31 through connections 33 in such manner that the steps are connected to correspondingly numbered steps 10*u*. This arrangement has utility where the divisor value represents the 5 times multiple of a divisor which is to be compared with a dividend. The operation may best be explained by assuming a dividend of 516 and a divisor setting of 516, which latter is the 5 times multiple of a divisor 103.2. As traced previously, circuits through the normal settings resulted in energization of relay 5Q*t*—*b* with the resulting energization of 5Q*h*—*b* to denote equality. The second brush 25*b* in contact with the step 24*b* in the 6 position is connected through the 6 wire 31 to the 6 step 10*u*, at which brush 11*u* is set so that this circuit extends back to the 40 volt source, and no circuit is completed through 5Q*tt*—*b* since both ends of the circuit terminate at the same potential.

If brush 25*b* had been set at any lower valued digit, for example 5, the circuit extends from the 40 volt source 20, contacts 15, wire 21, conductor 12*t*, brush 11*t*, 1 step 10*t*, 1 wires 29 and 30—*b*, 1 step 24, brush 25, conductor 26, winding 5Q*tt*—*b*, wire 41, conductor 26*b*, brush 25*b*, 5 step 24*b*, 5 wire 31, 5 step 10*u*, connecting brushes 13*u*—*a* contacts 23 to negative source of current 22. Relay 5Q*tt*—*b* will close its related contacts 5Q*tt*1 to complete the circuit through relay 5Q*hh*—*b*. This latter relay by its energization represents that five times the divisor is less than the dividend and that, if operations are not to be extended, the last quotient digit may be rounded. Thus, if 5 times the divisor goes into a dividend exactly, there is no indication while, if there is a remainder, manifestation is made in the nature of a relay energization to indicate that this quotient digit of 5 may be rounded, that is, called a 6 where results are desired in such manner.

What I claim is:

1. Apparatus for comparing two multidenominational numbers for relative magnitude, comprising a first series of settable devices, one for each order and settable to represent a first number, a second series of settable devices, one for each order and settable to represent a second number, a trio of terminals each at a different electrical potential, circuit connections in each order interconnecting the related settable devices of the two said series, a circuit partially completed between the two lowest potential terminals by the settable devices in the highest order and through said connections when both devices are set at the same significant digit, a second circuit completed between the two highest potential terminals by the settable devices in the next lower order and through the related connections, when the device of the first series is set at a higher digit than the device of the second series, means included in said second circuit for completing the said partially completed circuit and a current responsive device included in the latter circuit to represent by its energization that the first number is greater than the second.

2. Apparatus for comparing two multidenominational numbers for relative magnitude, comprising a first series of settable devices, one for each order, settable to represent a first number, a second series of settable devices, one for each order, settable to represent a second number, a trio of terminals each at a different electrical potential, circuit connections in each order interconnecting the related settable devices of the two said series, a circuit partially completed between the two lowest potential terminals by the settable devices in the highest order and through said connections when both devices are set at the same significant digit, a second circuit completed between the two lowest potential terminals by the settable devices in the next two lower orders and through the related connections, when the two devices of the first series are set at the same value as the related devices of the second series, means included in said second circuit for completing the said partially completed circuit and a current responsive device included in the latter circuit to represent by its energization that the first number is equal to the second.

3. Apparatus for comparing two multidenominational numbers for relative magnitude, comprising a first series of settable devices, one for each order, settable to represent a first number, a second series of settable devices, one for each order, settable to represent a second number, a trio of terminals each at a different electrical potential, circuit connections in each order interconnecting the related settable devices of the two said series, a circuit partially completed between the two lowest potential terminals by the settable devices in the highest order and through said connections when both devices are set at the same significant digit, a second circuit completed between the two lowest potential terminals by the settable devices in the next two lower orders and through the related connections, when the two devices of the first series are set at the same value as the related devices of the second, or at a higher value, means included in said second circuit for completing the said partially completed circuit and a current responsive device included in the latter circuit to represent by its energization that the first number is equal or higher than the second.

4. A device for comparing two digits for relative magnitude, comprising a device settable to represent a first digit, a device settable to represent a second digit, a trio of terminals, each at a different electrical potential, circuit connections between said devices, arranged so that when the devices are adjusted with the first digit greater than the second digit, a circuit is completed between the two highest potential terminals; when the devices are adjusted with the digits equal, a partial circuit is established between the two lowest potential terminals; and when the devices are adjusted with the first digit lower than the second digit, no circuit is completed or partially established, means for completing the partially established circuit and current responsive devices in both the completed and partially established circuits to represent by their respective energization that the first digit is greater than or equal to the second digit.

EUGÈNE KOUZMINE.

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