May 18, 1965 G. MARTENS 3,184,710

METHOD AND ARRANGEMENT FOR CHECKING THE OPERATIVE CONDITION OF A CONTACT MATRIX

Filed April 3, 1961 2 Sheets-Sheet 1

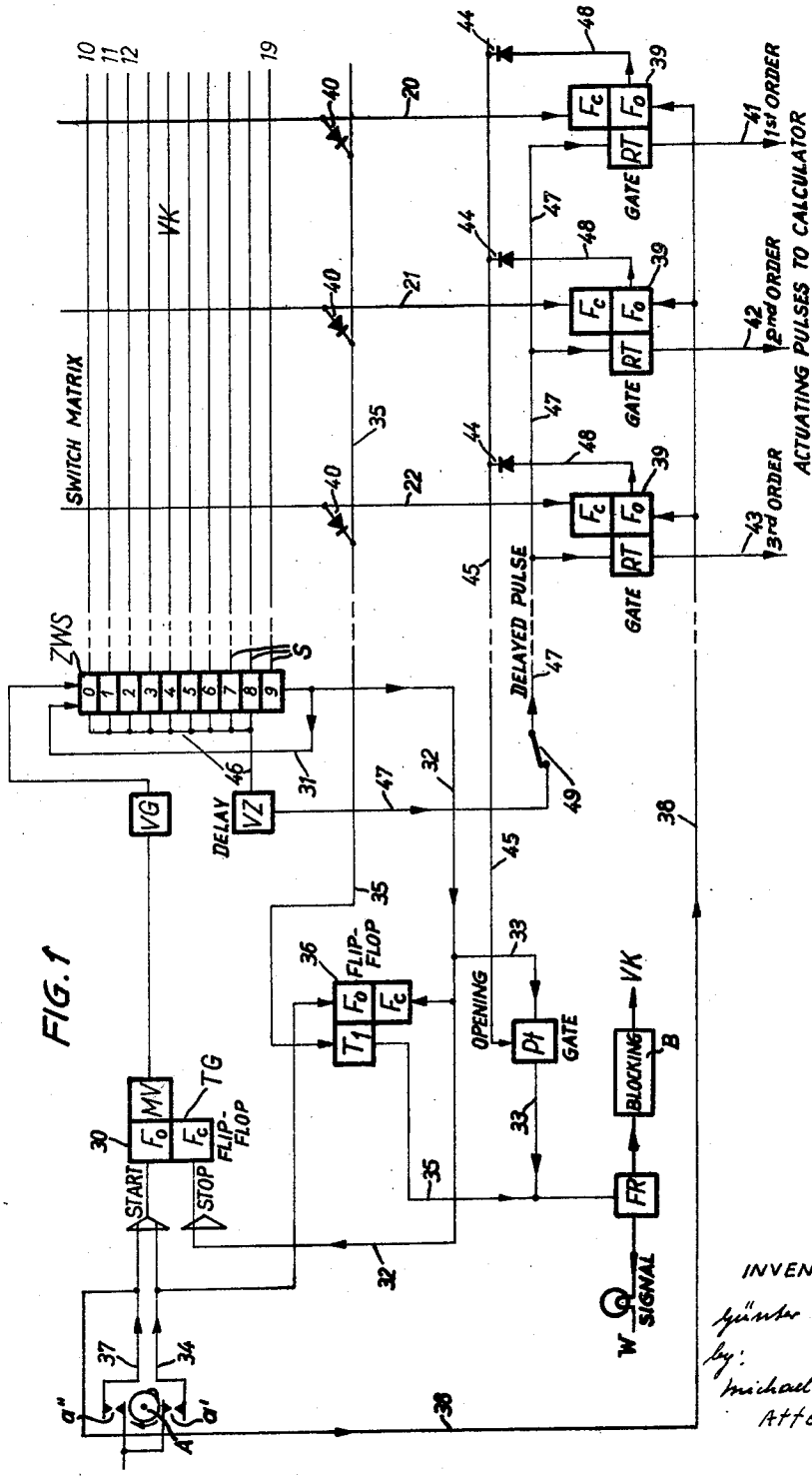

FIG. 1

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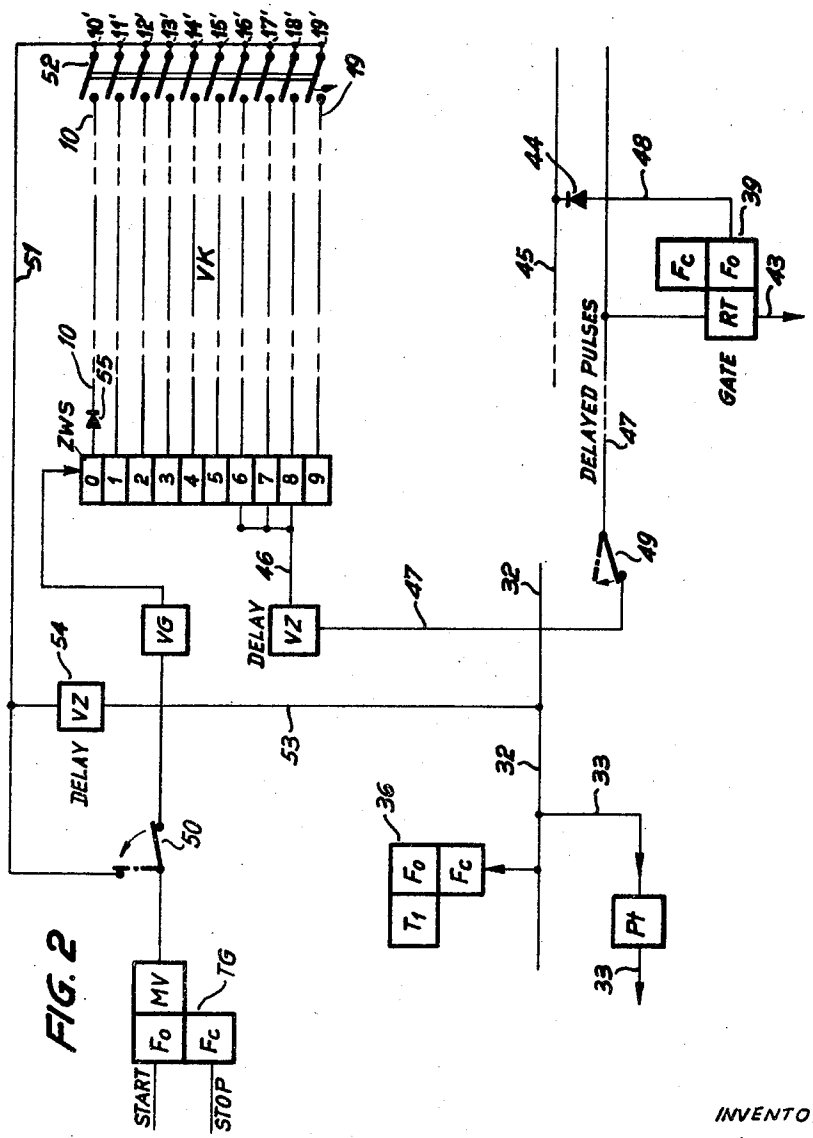

FIG. 2

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3,184,710

METHOD AND ARRANGEMENT FOR CHECKING THE OPERATIVE CONDITION OF A CONTACT MATRIX

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11 Claims. (Cl. 340—146.1)

The present invention concerns electrical calculating, bookkeeping and similar machines.

Machines of this type are conventionally equipped with a printing mechanism and with mechanical means for introducing, or for setting the machines for the particular data or numerical values to be processed. However, for increasing the speed of calculating operations and the like, many machines of this type are equipped with an electric or electronic calculating arrangement. In many such cases an array of electrical contacts is provided which constitutes the operative link between the mechanical and the electrical components of the machine. A numerical value introduced and determined by the actuation of selected ones of the mechanical setting means is represented in the array of contacts by the closing of one or more of these contacts located at selected points within the array so that an electrical or electronic value can be transmitted through such closed contacts to the calculating arrangement for being processed therein.

In many cases the array of contacts is a contact matrix which has a plurality of input lines in parallel array (rows) and a plurality of output lines in parallel array (columns) intersecting all of the input lines, the individual rows being assigned consecutively to different digits while the individual columns are respectively assigned to consecutive order positions of a number. Connector contacts are located at each intersection between a row and a column so that by selectively closing a contact in a particular intersection point between a row and a column the corresponding digit value can be represented thereby in the appropriate order position thereof. The connector contacts may also have the characteristic of storage devices so that in this manner the various digit values can be stored in the matrix. By introducing read-out pulses into the input lines or rows output signals representing respectively the digit values stored or determined by the closed contacts can be transmitted from the output lines or columns to the calculating apparatus in their proper order positions. Similarly, if read-out impulses are introduced into the columns, signals according to the digit values represented by the closed contacts or stored at the intersections of rows and columns can be read out in relation to the respective order position.

As mentioned above, a contact array or matrix in machines of the type mentioned above has the function of transmitting a multi-order number from the mechanical elements of the machine to an electric or electronic calculating arrangement. In this connection it should be borne in mind that in certain calculating machines the contact arrays are constructed as matrix type storage devices from which a stored value, e.g. a constant factor, can be read out whenever desired or required in the course of a calculating operation. The transmission of digit representing signals from a contact array or matrix to a calculating arrangement can be carried out either in serial sequence, i.e. for one order position after the other, or also in parallel for all order positions simultaneously. Which one of these procedures is utilized depends upon the construction of the calculating arrangement and has no bearing on the present invention.

The most important requirement for the operation of a contact array or matrix is the correct and complete transmission of all the digit values determined or stored in the array or matrix. Care must be taken that all the connector contacts of such an array or matrix open and and close without fail. More specifically this means that in a contact array or matrix in which no digit values have been determned or stored, none of the input lines (rows) must have electrically conductive connection with any one of the output lines (columns). Usually, the contacts at the various intersection points are moved to closed condition by the action of a pin carriage of well-known construction in which pins actuated by the contacts are set in accordance with the numerical values to be introduced into the array or matrix. An unintended closed condition of a contact before the introduction of digit values may occur for instance if due to mechanical damage the contact springs of a contact are bent so that they are in engagement without being moved into engagement by the setting of the associated pin in the pin carriage. Any one such contact which is permanently in closed condition would necessarily falsify the transmission of digit representing signals from the respective column into the calculating arrangement. A malfunction of this type is hard to determine or discover and most likely it would show up only after a substantial number of erroneous calculations have been carried out and checked.

On the other hand, it is also possible that after the introduction of values by corresponding settings or closing of contacts into the contact matrix a contact in any one of the columns which was intended to be closed, has been actually left in open condition so that at the particular intersection of a row with a column no conductive connection has been established. Consequently, when signals representing the stored or set values are to be transmitted to the calculating arrangement, a signal representing a particular digit in the particular column having an ineffective or open contact would never reach the calculating arrangement. Consequently the number transmitted to the calculating arrangement would be incomplete or entirely wrong and would lead to wrong results of the particular calculation.

It is therefore a main object of the present invention to provide for a method and arrangement by which the operative condition of a contact matrix is checked, preferably automatically, before or simultaneously with the performance of a calculating operation in order to determine whether either one or both of the above mentioned malfunctions of the contact matrix exists, and whereby in the case of the existence of either one of the two malfunctions a warning signal is delivered or, preferably, the continuation or completion of the calculating operation is stopped.

It is a further object of this invention to provide for a system which adds comparatively few and reliable components to the standard circuit arrangements of a contact matrix in connection with a calculating apparatus.

With above objects in view the invention provides a method of checking the operative condition of a contact matrix arrangement having a plurality of input lines in parallel array, and a plurality of output lines in parallel array intersecting all of the input lines with connector contacts arranged at the intersection points, respectively, and capable of being independently and selectively changed between open and closed condition, comprising the steps of introducing read-out pulses into all of the input lines in order to determine whether all contacts are in open condition, deriving an output pulse from any output line associated with a contact which is unintentionally in closed position and thus connecting one of the input lines with the particular output line, utilizing such output pulse as a first error signal for signaling that a contact is uninten-

tionally in closed condition, storing information in the matrix arrangement by selectively moving in each output line at the intersection thereof with a selected one of the input lines one of the contacts toward closed condition, introducing read-out pulses again into all of the input lines in order to determine whether in every output line a contact is in closed condition, deriving an output pulse from every one of the output lines associated with a contact which is in closed condition and thus connecting one of the input lines with the particular output line, storing the output pulses individually in storage means respectively associated with the different output lines, and deriving a second error signal from any storage means in which no output pulse has been stored so that this second error signal indicates that the corresponding contact in the associated output line was left in open condition, so that after either the first or the second error signal further operation of the matrix arrangement can be stopped.

In a further aspect of the invention the invention provides, in combination with a contact matrix arrangement a calculating device and having a plurality of input lines in parallel array, and a plurality of output lines in parallel array intersecting all of the input lines with connector contacts arranged at the intersection points, respectively, and capable of being independently and selectively changed between open and closed condition, first checking means for determining whether all of the contacts are in open condition and including signal means connected with the plurality of output lies and actuatable by an output pulse appearing at any output line upon introduction of read-out pulses into all the input lines, provided that any contact associated with the output line is in closed position, and second checking means for determining whether all of the contacts are in closed condition and including a plurality of storage means each connected with a different one of the output lines for storing output pulses appearing at the respectively connected output line upon introduction of read-out pulses into all the input lines, provided that the contact associated with the particular output line is in closed condition, and circuit means connecting the plurality of storage means with the signal means and constructed so as to actuate the latter when at least one of the storage means has no output pulse stored therein, so that after actuation of the signal means by either the first or the second checking means further operation of the matrix arrangement can be stopped.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic circuit diagram illustrating one embodiment of the invention, all mechanical components not necessary for understanding the invention and not forming a part thereof being omitted for the sake of clarity; and

FIG. 2 illustrates in the same manner a second embodiment of the invention differing from the embodiment of FIG. 1 only in certain details.

Referring now to FIG. 1, a switch or contact matrix VK is shown diagrammatically as being composed of ten input lines of rows **10** to **19** respectively assigned to digital values ranging from "0" to "9," and a plurality of output lines or columns corresponding in number to the number of order positions that can be handled by the associated calculating arrangement. In FIG. 1 only three columns or output lines **20**, **21**, **22** are shown which correspond respectively to the first order, second order and third order of decimal numbers to be handled. It is to be assumed that the calculator arrangement is of the impulse processing type which operates as is well-known in such a manner that in each section thereof assigned to a particular order every impulse introduced causes the particular section to count one step forward corresponding to a digit value "1."

The actuating impulses originate at an astable impulse generator TG which is controlled by a start-stop input circuit arrangement **30** as explained further below. A stepping switch arrangement ZWS is provided for introducing read-out impulses into the matrix VK, this switch arrangement being preferably constructed as a magnetic shift register. Each impulse furnished by the impulse generator TG and applied by a shift generator VG to the register ZWS shifts any information stored first in the register element 0 stepwise from the element 0 into one after the other of the other elements 1 to 9. Each of the register elements has an output winding, not shown, which is connected at S with the corresponding input line or row **10** to **19**, respectively, of the matrix VK, as shown in FIG. 1. A signal or pulse issuing from the last element 9 of the register is transmitted through a connection **31** to the first element 0 of the register. However, such signal from the element 9 is simultaneously applied through the connection **32** to the control circuit **30** of the generator TG for terminating a series of impulses after the register ZWS has been completely passed by the shift of information therethrough.

It may be assumed that at the beginning of an operative cycle of the calculating machine a certain number determined by setting pins in the pin carriage through manual key operation is to be transmitted to the calculating arrangement through the matrix VK. Consequently, the particular number is represented, before the start of the actual operation, by a certain combination of raised pins in the pin carriage. Now the operator may start the operative cycle for instance by actuating the plus key on the keyboard of the machine. At the beginning of the rotation of the main shaft of the operating mechanism, but still before the pin carriage is moved to cause engagement of the raised pins with corresponding contacts of the matrix VK, a cam A rotating together with the main shaft closes the contact pair *a'* whereby from an outside source an impulse is furnished through line **34** to the start input of the generator TG. A series of impulses from the generator TG is shifted once through the whole register ZWS with the result that with every step one read-out pulse after the other is introduced into each of the input lines or rows **10** to **19** of the matrix VK.

All the output lines or columns **20**, **21**, **22**, etc. are connected with a common conductor **35**, but for the purpose of avoiding undesirable interference effects, the connection between each of the output lines and the conductor **35** is made by means of a corresponding decoupling diode **40**. The conductor **35** leads via a gate T_1 to an error relay FR.

The gate T_1 is controlled by a flip-flop **36**, and it can be seen from FIG. 1 that the impulse through line **34** is also applied to the flip-flop **36** whereby the gate T_1 is opened simultaneously with the start of the operation of the generator TG.

As mentioned above, during one shift of impulses along the register ZWS read-out impulses are introduced into all of the input lines or rows **10** to **19** in sequence which has the effect that, if in any one of the rows **10** to **19** a contact is unintentionally in closed condition, an output pulse derived from the corresponding read-out pulse will be delivered from the respective column, via conductor **35** and the opened gate T_1 to the error relay FR. Thus this relay is energized under these circumstances and holds itself in energized condition by a conventional holding circuit, not shown. The relay FR may be connected to control a signal device W, e.g. a signal lamp, whereby the operator is informed that the machine is not in order. In addition, the relay FR may also be connected to control a blocking device B which is operatively connected with the matrix VK in a suitable man-

ner to prevent the setting of the matrix by the pin carriage and the transmission of any digit signals to the calculating arrangement. For reasons which are explained further below, in the arrangement according to FIG. 1 the switch 49 in line 47 must be in open position.

In the meantime the operational cycle of the mechanism has continued, the main shaft and the cam A have continued their rotation, the mechanical control elements have been adjusted in accordance with the previous setting of pins in the pin carriage so that the desired numerical value is represented by the setting of the printing mechanism, and the pin carriage is now ready for being moved into position for moving the desired selection of contacts in the matrix VK to closed position. Consequently, if the above described first test as to whether all contacts in the matrix VK are in open condition has not resulted in an error signal and in stopping the operation, the further rotation of the main shaft causes printing of the set number value and causes engagement of the raised pins of the pin carriage with the corresponding selected contacts of the matrix so as to move these contacts to closed position.

If the arrangement is in proper operative condition, then a number value is properly introduced into the matrix only if in each column thereof one contact has been closed. Of course, it is necessary that if the number to be processed has a number of orders smaller than the number of columns, in all those columns which are assigned to order positions higher than the highest order of the respective number, a contact must be closed at the intersection of these just-named columns with the row 10 of the matrix. This does not constitute any problem because it is known practice to provide for automatic raising of the "0" pins in the pin carriage in those order positions which exceed the highest order of the respective number.

As now the operational cycle continues and the main shaft continues its rotation, the cam A causes closing of a second pair of contacts *a''* whereby from an outside source an impulse is supplied to the start input of the generator TG whereby the process of transmitting the values set or stored in the matrix VK in the form of corresponding numbers of pulses to the calculating arrangement is started.

Simultaneously, however, the impulse in line 37 is also transmitted through a line 38 to the flip-flops 39, respectively associated with the columns or output lines 20, 21, 22, etc. and controlling, respectively, the corresponding transfer gates RT. All the flip-flops 39 are hereby switched to that condition in which they open the associated gates RT. As can be seen the output terminals of the transfer gates RT are respectively connected by lines 41, 42, 43 with the corresponding calculator sections assigned to the respective first, second and third order of the number to be processed.

As mentioned above the pulse through line 37 starts the pulse generator TG which delivers the sequence of pulses to the register ZWS whereby information is shifted once through the entire register. With every shift of a signal from one register element to the next following one a read-out impulse is introduced into the corresponding row or input line of the matrix VK. However, as can be seen from FIG. 1, every register element, with the exception of element 9, has a second output through which together with every shift or step a pulse is delivered into a common line 46. These nine sequential pulses are applied to a delay circuit VZ and from there transmitted, with a predetermined delay, through line 47 to the transfer gates RT. Of course, it is to be understood that for this purpose the switch 49 is in its illustrated closed position.

Upon the first impulse applied from the shift generator VG to the register ZWS the first register element 0 delivers one read-out impulse into line 10 and simultaneously a pulse into line 46. The read-out impulse in line 10 is transmitted without delay via any closed contact in line 10 into the respective column and from there to the corresponding flip-flop 39 whereby the respectively associated gate RT is closed. The simultaneously appearing pulse in line 46 is delayed by the circuit VZ and reaches via line 47 correspondingly later the transfer gates RT. At those gates RT which have been closed as described above by a pulse transmitted through a closed contact in row 10, the pulse in line 47 cannot be passed on to the calculating arrangement. Consequently any digit-representing stored information in the corresponding section of the calculator arrangement will not be changed which is correct in the case of the setting of "0" in the corresponding column of the matrix. However the pulse appearing in line 47 will pass through all other gates RT which are associated with a column in which a contact has been closed previously in a row other than row 10. Consequently, upon the first pulse applied to the register ZWS an output pulse will be transmitted from the open gates RT to the corresponding sections of the calculator and will shift information stored therein one step corresponding to the numerical value "1."

Upon the application of the second pulse from shift generator VG to the register ZWS a read-out pulse is introduced from the register element 1 to the row 11 while at the same time again a pulse is delivered into line 46. Similarly as described above, in that column in which a contact has been closed previously in row 11 a pulse is delivered to the associated flip-flop 39 so as to close the associated transfer gate RT so that the following pulse appearing in line 47 again finds its path blocked. Consequently from this particular transfer gate only one shift impulse has been delivered to the corresponding section of the calculator arrangement and no further pulse can be delivered thereafter which means that the information in this section of the calculator arrangement has been shifted only one step corresponding to the digit value "1" which, in turn, corresponds to the setting of the contact in the corresponding column at its intersection with the row 11.

However, in all other columns shift impulses have been transmitted through the still open transfer gates RT so as to produce, upon the second read-out impulse from the shift register, a corresponding shift of information in the respective section of the calculator arrangement.

This means that ultimately from that column of the matrix VK in which in row 19 a contact has been closed to represent the digit value "9" a sequence of 9 impulses coming via line 47 are transmitted through the transfer gate RT of the particular column into the corresponding section of the calculator arrangement. Only upon the application of the tenth read-out pulse from register element 9 the transfer gate RT of the particular column is closed.

As can be seen from FIG. 1, each of the flip-flops 39 is composed of a portion F_c which causes closing of the associated gate RT, and a portion F_o which causes opening of the associated gate. From each of the portions F_o of the flip-flops 39 a line 48 is taken via a decoupling diode 44 to a line 45 which leads to a gate P*t*. Consequently, whenever anyone of the flip-flops 39 is in that condition in which it keeps the associated transfer gate RT in open condition, voltage is applied from the respective portion F_o to the control input of the gate P*t* whereby the latter is held in open or conductive condition.

As can be seen from FIG. 1, the last register element 9 of the register ZWS is connected by line 32 to the stop input i.e. the closing portion F_c controlling the multivibrator MV of the pulse generator TG. Consequently upon the tenth pulse from the generator TG the corresponding output pulse from register element 9 causes the flip-flop 30 to stop the operation of the generator TG.

It can be seen now that after a complete read-out operation applied to the matrix VK and transfer of all

the digit values set or stored in the matrix to the calculator arrangement as described above, all the flip-flops 39 must have been changed to their second stable condition which means that not later than after the ninth pulse delivered by the generator TG (resulting in closing the transfer gates for a signal corresponding to the digit value "9") no voltage is applied anymore to the line 45 with the result that now the gate P*t* is in closed condition. However, the tenth impulse delivered from the register element 9 of the register ZWS via lines 32 and 33 is in this case blocked from passing through the gate P*t* and from reaching the error relay FR so as to energize the latter. However, if only one of the flip-flops 39 has not been changed to its second stable condition because no pulse has been applied to the particular flip-flop from the associated column due to the fact that no contact has been closed previously at any intersection of this column with anyone of the rows of the matrix, then the associated transfer gate RT has remained open and potential has been applied and is still being applied from the respective portion F_0 to line 45 so as to keep the gate P*t* in open condition. Consequently the above-mentioned output pulse from register element 9 will travel through lines 32 and 33 through the open gate P*t* to the error relay FR and energize the latter. This means that in this case where one of the contacts in the matrix in at least one column has been left open unintentionally, the error relay will, as described above, cause the appearance of a warning signal and block further operation of the whole arrangement.

In view of the above described type of operation of the calculator arrangement, the lack of a closed contact in a particular column would have the result that through the corresponding transfer gate RT being left in open condition nine consecutive shift impulses would be transmitted into the corresponding section of the calculator arrangement. Consequently during the read-out operation applied to the matrix VK a digit value "9" would be added in this case to whatever information is stored in the respective section of the calcuator arrangement. Therefore it does not make any difference whether, as mentioned above, in a particular order position or column on account of a not closed contact in the matrix VK no digital value (i.e. the value "0") is transmitted or, as in the above explained example, a digit value "9" is transmitted. Which one of these possibilities takes place depends only upon whether the pulses delivered from the output lines or columns are used for opening or for closing the transfer gates RT. In both cases the values transmitted to the calculator arrangement are wrong and must not be used in the further calculating operation.

It is important to recognize that the second checking operation as to whether in every column of the matrix one contact has been closed, can be carried out during the transmission of information from the matrix VK to the calculator arrangement also when multiplication (multiple-addition) is to be effected, because this checking operation can be carried out every time when the respective information concerning the multiplicand is transmitted. Consequently a malfunction of the matrix arrangement will be discovered immediately even if the transmission of information has been carried out correctly several times in sequence. This feature certainly constitutes a remarkable advantage entailed by the invention.

It should be understood that the contact setting pins, no matter whether they are arranged on a pin carriage or otherwise in which case only one contact pin is to be provided for each column, and which causes the closing of contact between a column and a selected row, should be preferably positively connected operatively with mechanical control elements of the machine so that one can be sure that in the matrix VK that digit value is set or stored which is available to the operator for checking by means of it being printed. Preferably, the contact setting pins are so constructed that it is impossible to simultaneously actuate or set two adjacent contacts. In addition means are provided making it impossible that two adjacent contacts are actuated simultaneously.

Since both the above-described checking operations concerning the establishment of "open condition" or "closed condition" of all the contacts which should be open and closed, respectively, are carried out according to the invention by a purely electronic means i.e. in an extremely short period of time, it is possible to insert these checking operations without any difficulty even during a series of operations, whenever a change in the setting of the matrix occurs.

It is well possible that under certain circumstances numerical information is already stored in the calculator arrangement so that it must be avoided to destroy such stored information by transmitting to the calculator arrangement a wrong or incomplete digit information from the matrix VK. In this case the second checking operation as to whether in every one column of the matrix 1 contact is in closed condition must be carried out independently of the transfer of information from the matrix into the calculator arrangement. This can be carried out by moving the contact 49 to open position. If now after carrying out the first checking operation which determines whether all the contacts in the matrix are in open condition a desired number value has been introduced into the matrix by means of the mechanical setting devices, the read-out operation is applied to the matrix as described above. However due to the opening of switch 49 no pulses appearing in line 46 can now be transmitted through line 47 to the transfer gates RT. Consequently none of these pulses will be transferred through lines 41, 42, 43 to the corresponding sections of the calculator arrangement so that the information stored therein will not be disturbed. If the second checking operation under these circumstances has shown that there is no malfunction in the matrix VK, i.e. that in every column one contact is closed, then the switch 49 may be closed again and the generator TG is to be started again so that now the transmission of the information stored in the matrix VK is transmitted in the regular manner to the calculator arrangement while the second checking operation is nevertheless repeated once more.

It can be seen from the above that in the course of a calculating operation either the one or the other checking operation, or both, may be applied. Both checking operations may be carried out as a preliminary step before the actual transmission of stored information from the matrix to the calculator arrangement. However during the transmission of information from the matrix to the calculator arrangement (single transmission in the case of addition, repeated transmission in the case of multiplication and division) the second checking operation can be carried out concurrently with the individual transfer operation.

The above described embodiment according to FIG. 1 is characterized by the fact that the read-out operations concerning the matrix VK are carried out stepwise in accordance with the delivery of read-out pulses sequentially and simultaneously with the shift pulses which shift information through the register ZWS. The embodiment illustrated by FIG. 2 is based on a procedure in which read-out pulses are introduced simultaneously into all of the rows of the matrix. While generally the circuit arrangement is very similar to that of FIG. 1, so that all like parts and elements are marked by the same reference symbols and numerals, the following differences are to be recognized. A switch 50 is interposed between the generator TG and the shift generator VG for connecting, in one position, these generators with each other, and for connecting, in a second position, the generator TG via a line 51 with a multiple switch 52 which in closed position connects line 51 with all the lines or rows 10 to 19. Moreover, a second delay circuit 54 is connected by

means of a line 53 between the line 32 and the line 51. Moreover, a diode 55 is connected between the first register element 0 and the line 10.

In operation of the embodiment according to FIG. 2, both switches 49 and 50 are moved to their second positions, respectively, as indicated in dotted lines, before the two checking operations of the matrix VK are carried out. At the same time the multiple switch 52 is moved to closed position. After being started by an impulse via line 37, by the multivibrator MV of the pulse generator TG a read-out pulse is transmitted via line 51 and the closed switch contacts 52 into all of the rows or lines 10–19 of the matrix simultaneously. The diode 55 prevents the already energized or activated core of the register element 0 to be returned to its non-energized or non-activated condition. Since all the other cores of the remaining register elements are still in non-energized or non-activated condition the application of the read-out pulses via line 51 will not disturb the condition of the elements 1–9. The connection 53 and delay circuit 54 has the effect that immediately after the delivery of the single read-out pulse, but by all means before a second pulse is delivered by the multivibrator MV, a closing impulse is applied to the flip-flop 36 whereby the first checking operation is terminated. In the same manner as described in reference to FIG. 1 the delayed pulse appearing in line 53 and in line 32, causes the pulse generator TG to stop delivering pulses. For the purpose of the second checking operation the pulse generator TG is started, as in the first described example after information has been set or stored in the matrix VK, and delivers again a read-out pulse via line 51 and closed switches 52 into all of the lines or rows 10–19. As in the first example the answer to the checking operation is obtained through the gate P*t*, however the pulse indicating whether in every column one contact has been closed, is now not derived from a last output from the register ZWS, namely from its last register element 9, but in this case this pulse controlling the gate P*t* is obtained from line 53 as delivered by the delay circuit 54. Otherwise the components of the arrangement according to FIG. 2 operate in exactly the same manner as those of the embodiment according to FIG. 1.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of method and arrangement for checking the operative condition of a contact matrix differing from the types described above.

While the invention has been illustrated and described as embodied in method and arrangement for checking the operative condition of a contact matrix for determining whether all the contacts of the matrix are in open condition and whether after storing of information therein in every column of the matrix one contact is closed, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can be applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In combination with a contact matrix arrangement serving a calculating device and having a plurality of input lines in parallel array, and a plurality of output lines in parallel array intersecting all of said input lines with connector contacts arranged at the intersection points, respectively, and capable of being independently and selectively changed between open and closed condition, each of said connector contacts representing a digit different from the others of said connector contacts and comprising a single input line and a single output line, first checking means for determining whether all of the contacts are in open condition and including signal means connected with the plurality of output lines and actuatable by an output pulse appearing at any output line upon introduction of read-out pulses into all the input lines, provided that any contact associated with said output line is in closed position; and second checking means for determining whether in all of said output lines at least one contact is in closed condition and including a plurality of storage means each connected with a different one of the output lines for storing output pulses appearing at the respectively connected output line upon introduction of read-out pulses into all the input lines, provided that the contact associated with the particular output line is in closed condition, and circuit means connecting said plurality of storage means with said signal means for actuating the latter when at least one of said storage means has no output pulse stored therein, and including means responsive to signals actuating said signal means for blocking the output lines of said matrix arrangement so that after actuation of the signal means by either the first or the second checking means further operation of the matrix arrangement can be stopped.

2. In combination with a contact matrix arrangement serving a calculating device and having a plurality of input lines in parallel array, and a plurality of output lines in parallel array intersecting all of said input lines with connector contacts arranged at the intersection points, respectively, and capable of being independently and selectively changed between open and closed condition, each of said connector contacts representing a digit different from the others of said connector contacts and comprising a single input line and a single output line, first checking means for determining whether all of the contacts are in open condition and including read-out means for introducing read-out pulses into all the input lines, respectively, and relay means for controlling an emergency circuit, connected with the plurality of output lines and actuatable by an output pulse appearing at any output line upon introduction of read-out pulses into all the input lines, provided that any contact associated with said output line is in closed position; and second checking means for determining whether in all of said output lines at least one contact is in closed condition and including a plurality of storage means each connected with a different one of the output lines for storing output pulses appearing at the respectively connected output line upon introduction of read-out pulses into all the input lines, provided that the contact associated with the particular output line is in closed condition, and circuit means connecting said plurality of storage means with said relay means for actuating the latter when at least one of said storage means has no output pulse stored therein, said circuit means including means responsive to signals actuating said relay means for blocking the output lines of said matrix arrangement so that after actuation of the relay means by either the first or the second checking means further operation of the matrix arrangement can be stopped.

3. An arrangement as claimed in claim 2, wherein gate means are arranged between the output lines and said relay means and so connected with said read-out means that output pulses can be passed to said relay means only during said sequential introduction of read-out pulses into the input lines.

4. In combination with a contact matrix arrangement serving a calculating device and having a plurality of input lines in parallel array, and a plurality of output lines in parallel array intersecting all of said input lines with connector contacts arranged at the intersection points, respectively, and capable of being independently and selec-

tively changed between open and closed condition, each of said connector contacts representing a digit different from the others of said connector contacts and comprising a single input line and a single output line, first checking means for determining whether all of the contacts are in open condition and including read-out means for introducing read-out pulses into all the input lines, respectively, and relay means for controlling an emergency circuit, connected with the plurality of output lines and actuatable by an output pulse appearing at any output line upon introduction of read-out pulses into all the input lines, provided that any contact associated with said output line is in closed position; and second checking means for determining whether in all of said output lines at least one contact is in closed condition and including a plurality of storage means each connected with a different one of the output lines for storing output pulses appearing at the respectively connected output line upon introduction of read-out pulses into all the input lines, provided that the contact associated with the particular output line is in closed condition, and circuit means connecting said plurality of storage means with said relay means and including gate means connected between said readout means and said relay means for actuating the latter by one of the read-out pulses, said gate means being open only when at least one of said storage means has no output pulse stored therein, said circuit means including means responsive to signals actuating said relay means for blocking the output lines of said matrix arrangement so that after actuation of the relay means by either the first or the second checking means further operation of the matrix arrangement can be stopped.

5. An arrangement as claimed in claim 4 wherein each of said storage means includes each a flip-flop device which is in a first stable condition before an output pulse is applied thereto, and in a second stable condition after application of an output pulse from the respective output line, all of said flip-flop devices being connected to said gate means in such a manner that the latter is in open condition as long as at least one of said flip-flop devices is in said first stable condition, so that a read-out pulse will pass through said gate to said relay means if after introduction of read-out pulses into all the input lines any one of the flip-flop devices has not been changed to said second condition.

6. An arrangement as claimed in claim 5 wherein each of said storage means further includes a transfer gate device adapted to pass counting pulses from said read-out means to a calculating device, said transfer gate device being controllable by the respective flip-flop device of the particular storage device so as to be kept open thereby until said flip-flop device is changed to its second stable condition, control circuit means being provided between said readout means and all of said transfer gate devices and including delay means for transmitting, in synchronism with said readout pulses, counting pulses to all of said transfer gate devices with a predetermined delay, so that counting pulses are transmitted to the calculating device through all the transfer gate devices until individual transfer gates are closed depending upon the change of the respectively associated flip-flop devices to the second stable condition thereof by an output pulse representing a decimal value to be transmitted through the particular transfer gate and identical with the number of said counting pulses passed through the particular transfer gate before its being closed.

7. An arrangement as claimed in claim 6, wherein said control circuit means include switch means for disconnecting said read-out means from all of said transfer gate means for rendering the transmission of counting pulses to said transfer gates impossible, while any of said first and second checking means are operated.

8. An arrangement as claimed in claim 5, wherein second gate means are arranged between the output lines and said relay means and so connected with said read-out means that output pulses can be passed to said relay means only during said sequential introduction of read-out pulses into the input lines.

9. An arrangement as claimed in claim 8 wherein a control flip-flop device is arranged for controlling said second gate means, and wherein means are provided for applying a starting impulse to said readout means for starting the latter and for simultaneously applying a control pulse to said control flip-flop device for causing the latter to open said second gate for the passage of an output pulse in case that any of the contacts of the matrix arrangement is in closed condition.

10. An arrangement as claimed in claim 9, wherein said read-out means are provided for sequentially introducing said read-out pulses into the input lines.

11. An arrangement as claimed in claim 9, wherein, in addition to said read-out means, alternatively operable checking pulse means are provided for introducing said readout pulses simultaneously into all of the input lines while said read-out means are idle.

References Cited by the Examiner

UNITED STATES PATENTS

2,716,230	8/55	Oliwa	340—146.1 X
2,946,984	7/60	Breed et al.	340—146.1 X
2,978,641	4/61	Voegtlen	340—166
2,989,729	6/61	Schafer	340—146.1

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