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ELECTRONIC TRAVEL PASS

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(57) Claim

1. A pocketsize electronic pass device, and a plurality of Accountancy Systems, adaptable as a means for making valid payment of fares or purchases of services and goods from one or an other of said accountancy systems, the said pass device comprising electromagnetic coupling means for transferring to and receiving from a communication point of said accountancy system digital data and transferring operating energy, wherein the means for the transfer of data and operating energy from any of the said accountancy systems comprise an accountancy outlet head containing two coils of equal inductance value mounted side by side producing high frequency fields of opposite phase, and wherein the pass device contains two similar coils of similar geometric configuration connected in series, such that any non-signals originating from a random source will appear in the pass device in antiphase to cancel each other.

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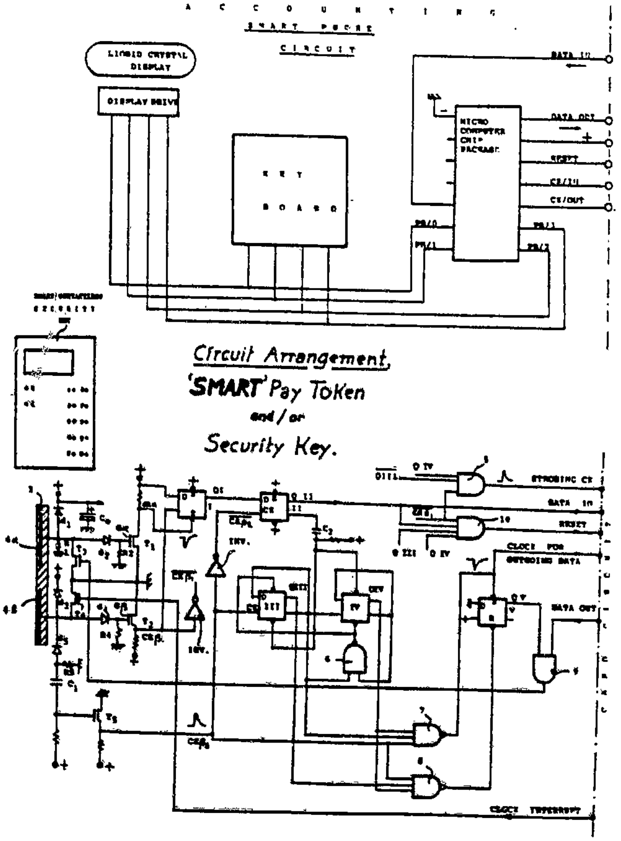
(54) Title: ELECTRONIC TRAVEL PASS

(57) Abstract

A pocket-size electronic travel and commuter pass which can be used for making valid payment of fares or purchases of services and goods, is disclosed. The pass contains capacitive plates or inductive coils (4) in pairs of two and are operated in such a way that their mutual phasing is correct for close proximity signal communication with an accountancy system. Noise and interference signals will appear in antiphase on the plates or coils (4) and will not affect the desired signal communication. As a result, the pass exhibits a high signal to noise ratio.



ELECTRONIC TRAVEL PASS

This paper deals with a portable private database in pocketsize format outwardly resembling a pocket calculator and combining a number of inventive characteristics in order to obtain a few important results: Replacement of on-line transactions by secure off-line point of sale transactions. The device should have a long working life. The user should have access to his data at any time without the cooperation of a terminal. During a transaction, the device shall remain handheld to avoid the delays associated with machine-fed read positions.

Insofar as this patent application is concerned, we shall refer to said private pocketsize data base as a "travel pass", because of the term's brevity and the expected outstanding utility it may come to have for mass transportation applications. Some of the ideas underlying the present concept of an "electronic travel pass" have already been defined by the present author, especially in US 4,661,691 (Proximity Data Transfer System) or US 4,499,556 which deals with the problem of security for long-life cards, or 4,859,837 which describes data entry on the card itself, and US 4,906,828 which describes a simple scrambling circuit for protecting the secrecy of the data interchanged between a card and a transaction Reader.

Further inventive effort was necessary to provide a "travel pass" with greater data transfer speed; to protect the integrity of the data in the face of exterior electronic noise or interference; to enlarge its usefulness; to enable the owner of the "travel pass" to select his/her secret PIN and to change it at any time, without the assistance from a second person or office; to convert a travel pass which normally can only communicate with a terminal at close proximity, into a radio-responsive card capable of passing on its serial number or account number over a distance of several feet.

Descriptions of these various aspects will not be given with the aid of illustrations and drawings, wherein

Figure 1 shows a card with two embedded capacitive antenna plates and a data retrieval circuit associated with them, given for reference only.

Figure 1a is an equivalent circuit explaining data transfer by impedance changes

Figure 2 shows an example of the waveforms at different parts of the circuit.

Figure 3 shows portions of the signal emitter circuit of the Card READER unit which is largely a mirror image of the circuit of Fig.1. (Figs. 3A,B&C, more examples.*)

Figure 4 indicates the modifications of the Figure 1 circuitry when in place of the capacitor antennas flat spiral coils are laid into the card and Reader respectively in accordance with the present invention.

Figure 5 illustrates the basic schematics of a "travel pass" combined with a modified form of the Figure 1 circuit.

Figure 6 shows a Reader and proximity-operated Card or "travel pass" with a a very simple data retrieval circuit connected to a Motorola CMOS microcomputer. chip. In this design, the square pulses imputted in Figure 1, are now replaced by VHF sin waves applied to the same twin capacitor plates in antiphase.

Figure 7 shows a string of α sin waves used for data modulation, and the string of β sin waves used for producing timing pulses.

*) The description for figures 3A, and 3B, 3C is on pages 16 and 17.

Figure 8 represents an example of logic levels transferred to the "travel pass" as data and logic levels applied to the "travel pass" computer chip as clock pulses.

Figure 9 shows again the clock pulses (CK) and the ($\alpha - 3$) output from the differential amplifier representing data transferred from the card to the Reader.

Figure 10 shows two spiral coils connected in phase, in accordance with the present invention, to satisfy the condition for cooperating with short-distance proximity Readers; they are connected via switches in such a manner that they may work in anti-phase with the Reader emitters, and that makes them suitable for working in phase with a radio transmitter at a modest distance

Figure 11 shows the effective card circuit when the switches are in one position

Figure 12 shows the effective card circuit of the coils when the switches are in their other position.

Figure 13 shows two spiral coils connected in phase for short distance Readers, but in antiphase for any 'common mode' signal (usually a noise signal).

Figure 14 shows the same arrangement of coils as in Fig. 13, but the coils are implanted into a silicon chip whereby the upper chip has in the center of the coil an integrated minicomputer, and the lower chip has at its center solid state integrated semiconductor switches.

Figure 15 relates to a fare collection system for use with "travel passes" and relates to program structure for testing the travel pass for various criteria before deducting a fare, and, if the residual value is inadequate to cover a minimum fare or the required maximum fare respectively, the control system puts into operation an updating unit after checking a blacklisting register.

Figure 16 and Figure 17 are even flow diagrams for flat fare and graduated fare operation respectively.

Figures 18 & 19 show a perspective view of the "travel pass".

Figure 19a i a detail of the display window in the card wherein the contrast of the display is improved by a light L derived from a light source in the Reader Unit.

Figure 20 shows an example of a keyboard with numerical and functional keys such as a "universal travel pass" might be equipped with.

Figure 21 provides a guide for the use of the keyboard of Fig. 20

Figure 22 is a logic flow diagram for various optional preparations which the user of a "travel pass" would make dependent on his intentions or anticipations of useage.

Figure 23 displays various optional procedures for using a travel pass at a vending machine or a market point of sale desk.

For many applications, but especially for certain forms of fare collection, it is very important to reduce the total transaction time, and that cannot be done unless (a) the data transfer speed is stepped up substantially, and (b) the card remains handheld during the period of the transaction. Ideally, a passenger on mounting a bus need not do more than hold his travel pass against the surface of a Read/Write unit for a brief period of time during which all the necessary card checking and updating is performed. Alternatively, the travel pass is briefly inserted into a wide open acceptor area (such as a shallow slot) where wide tolerances permit easy and rapid insertion and withdrawal of the card device.

A fast synchronous data transfer circuit is hereunder described. The synchronisation between the operation of the checkout unit and that of the travel pass electronics is obtained by a new approach. The proposal also includes protection against random noise.

To begin with, Fig.3 shows the approximate mutual position of the emitter 1 arranged on the Read/Write terminal, and corresponding antenna 3 arranged on the backside of the "Travel Pass". The spacing between the metal plates 2α and 2β, and the metal plates 4α and 4β would be between 5 to 30 mm. The α line carries square pules and so does the β line but 180° phase shifted against the former. Figs 3A,B&C are described on pgs 16,1.

Figure 2 contains 12 voltage-time diagrams. On rows 1 and 2 the input signals 2α and 2β are shown. The voltages that arise from the reactive transfer on the metal plates 4α and 4β respectively would be similar to those shown on rows 1 and 2 respectively if the impedances of leakages to quasi-ground level were very high, say 50 MOhm, At lower bleeder resistances, say 5 MOhm,the differentiator effect comes into play. See row 3 for the 4α pulses.

The transfer circuit is shown in Figure 1. T1 and T2 are field effect transistors.

The general data transfer parameters can be described as follows: Each data binary bit is embedded in one of three clock pulses; more accurately, it is embedded in the second one of three clock pulse positions. If a number contains many zeros, the monotonous flow of clock pulses continues unchanged. The clock pulses occur in groups of three, counting a,b,c - a,b,c etc. A data bit can appear only during the part period 'b'. A logic one is represented by the absence of a clock pulse during period 'b'.

The basis of synchronization is the two-bit counter using two D-type bistables III and IV. In our example, the repetitive count is given by the states 1,2,3; the state 0 is skipped, using 'and' gate 6 for this purpose.
A high data bit to be transfered from the card circuit 100 to the Reader unit must pass through the AND gate 9 which is enabled only during the 'b' period (count 2) of the counter. If the data to be transfered are held in a shift register the shift clock is obtained as an output from the NAND gate 7 at the beginning of each 'b' period. Any high output from the AND gate 9 is applied to the control gate of the transistor T3 which then virtually shortens the capacitor plate 4α to a reference level, quasi ground level. As a consequence there is a low resistance path from the plate 4α to the plate 4β which amounts to a drastic reduction of impedance to the supply line of the 2α imput pulses. As a consequence there will be a major increase in the load current across the resistor $R\alpha$ in the Reader unit. This is detected by a sensor element dA and used in the further circuitry of the READER UNIT to represent a logic "1" level in the Reader Computer.

The data transfer in the opposite direction, from the Reader to the card, is done as follows:

As can be seen from Figure 3, a high data bit is applied to the gate of transistor T6 which virtually eliminates during time period "b" the clock pulse potential on the antenna 2α. As a consequence, in Fig. 1, this eliminates any voltage on gate $G\alpha$, so that the reset potential of input point R remains high and the already set bistable I remains set with QI output being high. These conditions can be followed through also on the voltage-time curves of Figure 2: On row 4 the gate $G\alpha$ suddenly does not receive the regular spike, nor does the negative going reset spike develop on row 5 ($CK\alpha$). The bistable output QI (row 7) changes from producing square pulses to remaining high over a period of two pulses. This also affects the next bistable II output, row 9. Strobed by clock pulses $CK\beta_2$, QII goes now high shortly after the beginning of time period 'b' and remains so until shortly after the end of period 'b'. To obtain a data output which is cleanly cut off at the end of period 'b', one would have to provide extra gating but this is in practice not needed. The small overlap is not of any consequence. The output of AND gate 5 represents a strobing spike roughly in the middle of each time sector (a,b,c), and therefore, the downstream circuit (the card circuit) can use this spike for clocking the data (Q II) into its register.

Finally, if the READER COMPUTER routinely emits a reset signal to ensure that all the registers and bistables of the receiving circuits are cleared before passing on a command etc., this can also be done by means of the present interface circuit. In this case, after the first data bit is sent in time sector 'b', another data bit is applied immediately following in time sector 'c'. This keeps the data output on line 9 of figure 2 high over the time periods 'b' and 'c'. The $CK\beta_1$ spike during the middle of period 'c' is a unique pulse useable by the downstream circuitry as a reset pulse. It is obtained as an output from the four-input AND gate 10 in Figure 1.

Figure 1A makes clear how a data pulse is transferred. High frequency clock pulses are applied in opposite phases to terminals α and β. When the switch is open the load is 3M Ω, when closed it drops to a few hundred Ω. The capacitor plate on the left having been at normal alternating voltages, now drops to near zero.

Figure 4 shows a circuit according to the present invention, where essentially the same circuitry is used, but in place of the capacitor plates inductive coils (2α-4α, 2β-4β) are used. Such coils are preferably configured as spiral coils on printed film. When a logic "1" is to be sent from the Reader to the Travel Pass (card) the clock pulse in time sector 'b' is stopped by the transistor T7 of the PNP type while the NPN transistor T8 shortens the coil to ground to ensure that no noise spike gets through during period 'b'.
It remains to describe the manner by which the Reader circuit which is essentially identical to the card circuit in Figure 1, synchronizes its counter with that of the card (and vice versa). It is already understood that the terminal and the data card (travel pass) send out a data bit only in the counter period 'b'. It is now assumed that the receiving party's counter circuit is at the moment not in the 'b' period but in the 'c' period of its triple cycle. A high data bit received in Figure 1 will cause, as explained, the bistable II to go high, virtually at the beginning of the time section 'b' in the sending circuit but arrives, according to the present assumption in time period 'c' of the counter in figure 1. What happens is simply this: θ Of the bistable II, having previously been high goes low, applies a low-going pulse to capacitor C2 and thus does the same to the seting input of counter bistable IV as well as to the resetting input of the counter bistable II. This puts the counter immediately back into its time period 'b'. The same would happen if a data bit is sent to the READER circuit, and its counter were not synchronized, the very sending out of a data bit is therefore the synchronizing agent.

As the "Travel Pass" transaction card is intended to be handheld during a data transfer it is important that any stray fields emanating from the hand do not affect the data integrity through distortion or one-sided superimposition of static potentials.

A method for making common mode signals harmless is to apply to both the α and the β channel identical input signals but of opposite polarity, and, at the receiving side apply them to a differential amplifier dA. This is shown in Figure 5. Since in this version both the input channels (α,β) are used for the data input, the clock signals must somehow be derived from the data stream itself. This is performed in the CLOCK PULSE EMULATOR circuit which uses a digital phase-locked Loop. Figure 5 indicates this circuit group as a functional block.

The card 3 contains embedded in it not merely the active metal plates 4α and 4β, but also a shield plate 3a. A purpose of this plate is to ensure that the static potential induced in it from external sources is equal to all points and will thus elevate or reduce the potential of the aforementioned active metal plates by the same amount.

In the lower part of figure 5 the remaining component elements of a "Travel Pass" are shown, namely the Liquid Crystal Data Display, the group of Data Entry Keys, and the Micro-Computer Chip which contains not merely the processor but also the various data registers and memory banks. The main input and output ports of the microcomputer are also indicated which link with those of the interface circuit above. The just described circuit is reckoned to be capable of transferring data at a rate only one third of the injected carrier. Using another interface circuit described below, only much lower data transfer speeds can be achieved.

As fig. 6 shows, the card (3) contains again two metallic layers 4α and 4β. These layers have the form of a spiral coil. The arrangement of the circuit follows the indications of figure 4. Using a high rate of change induces field changes in the immediate surroundings of the two spiral coils 4α and 4β sufficient to produce the operating voltages and currents in the IC circuit of the card. I this present design, however, the periodicity in channel α and channel β is the same but opposite in phase. That means with increasing distance from the signal source (the Reader-emitter), the field forces nearly cancel each other and would thus have no effect on the card receiver antennas at read-card distances of more than a few inches.

When the operating voltage in the card has risen to an adequate level, its micro-computer 7 is programmed to produce an output at PA0 of chip 7 (fig.6) with the clock pulse applied to it. This is applied to AND gate 5 in Figure 6 whose high output pulse makes the transistor 8 conductive, thereby producing a short pulse α-3 in the Reader Circuit. This pulse serves as a start signal for the Reader computer unit to commence its program of data interchange.

Figure 8 shows the envelope of the waves for the data sequence 0-1-0. Figure 9 shows a data bit at the output of the differential amplifier 6 in the Reader Unit, demonstrating the principle of data flow from CARD TO READER.

Also for this second version of a proximity data transfer, the principle of a fully balanced twin-input can be realized as for the preceding example in Figure 5. Again, the clock pulse channel must be replaced by an inverted second data input channel while the still needed clock pulses are to be derived from the data stream itself. This is facilitated by converting the binary code into the well-known Manchester Code from which the clock pulses can be derived.

A "Travel Pass" to be universally useable, ought to be able to be used also for the automatic paying of parking fees and road pricing fees.

It would indeed be possible to use the 'travel pass' to these ends; if applied to the metering of road useage, however, the delays due to cards having to stop at entry and exit ramps may lead to the build-up of queues. Moreover, at exit ramps such delays could be dangerous because they may cause blockage of the neighbouring fast freeway lane. It would therefore be desireable for electronic check points to read a 'travel pass' at a distance. - Financial transactions at a vending machine or market require the very opposite working conditions: Cards should be readable only at close proximity and reject all signals that derive from any distance beyond a few inches. It would therefore seem that a 'travel pass' could never satify the above contradicting requirements. However, this need not be necessarily so if one envisages the use of (electronic) change-over switches integrated and incorporated into the card circuitry. It would then be possible to enter logic commands via the data entry areas on the 'travel pass' to operate said change-over switches.

With the aid of figures 10 to 14, the possibilities that derive from switched sensors, will be explained.

Fig.10 shows coils 1 and 2, and capacitors 3 and 4,as isolated components connected only to change-over switch elements 5,6,7 and 8.

Figure 11 shows two oscillator circuits operating independently from each other whereas in Figure 12 the two systems operate as a single resonance circuit. The resonance frequency in the two cases need not be the same. In Figure 13, the two resonance systems deployed on the same card subtstrate work in one switch position in counterphase, in the other switch position in phase. It is also possible to embed the coil conductors as very fine lines into a silicon substrate, with very accurately dimensioned spacing between the coil windings. The inter-wire capacity together with the inductance acts as an oscillator circuit. The switches 26,27 and 28 can be used for changing the relative phasing of the two systems. When the flux is as if from a source (23), it is a sink-flux (24) in the other coil, and vice versa. If the switch is changed over, the two coils have uniform flux changes. The changeover switches may also affect additional capacitive elements if a change of frequency is desired.

Those two factors,phase change and frequency change, will permit good separation of the two operational versions, the close proximity one and the moderate distance one.

It has already been mentioned that the switches can be provided in solid state form. In the execution of figure 14 the card comprises two silicon chips, one for the microprocessor and memory, the other for the switch logic. The surrounding area in both chips is used for the placement of the inductive coils 21,and 22 respectively. Manual switches (A,B) arranged on the card cause the microprocessor to generate control signals (l,r) dependent on whether the user intends to make a P O S transaction or a Parking or Road Pricing Transaction. Pinsize LEDs (AA, BB) would indicate at all times which mode is in operation.
The switch logic may be combined with the Microcomputer Chip on the same substrate.In that case, the I.C. may be placed between the two coil areas.

So far, this paper has discussed the important aspects of signal exchange between a 'travel pass' and a Reader unit. Next, a programming feature to be incorporated in the 'travel pass' is to be described, supported by figures 15 and 16 which are event flow diagrams.

The program principles to be discussed relate to the general area of Payment of Fares by a card system, especially at the critical moments when a fare is due but the residual value of the card proves to be insufficient. The principle explained will be particularly useful for revenue collection on buses, but would also be very useful in other small payment situations.

It has long been known that cards can be used as a voucher of credit issued by financially stable institutions (such as Banks or Building Societies). Although the credit issuing company, debits the buyer or the seller, or both, in return for pledging payment, with a certain percentage of the moneys advanced, the procedure often includes a review of the card owner's accounts to see whether credit worthiness still exists. Sometimes it is necessary to transmit the numbers of blacklisted cards directly into a register close to the point of transaction.

Assuming that equipment of this type is available on a bus, there exists also another technical difficulty affecting the cost efficiency of credit card debiting on public transportation in an urban area: it is the sheer number of transactions that occur. The average value for each such transaction is low, say about £1.20, yet for each such transaction sufficient data have to be transmitted to the Bank Computer of the Customer's bank to obtain payment. It can easily be seen that the normal routine for credit card payments such as come into play with the purchase of capital goods, is not applicable least the overheads would become too large.

Faced with this inapplicability of prior art credit card payment to fare collection the present invention provides for measures and card processing software which intend to make its use in travel available for both the daily commuters, occasional travellers, in short for a substantial majority of the travelling public.

This aim is proposed to be achieved by combining the afore-mentioned electronic register for blacklisted numbers, with an accumulator of fares; the same would cause the latest fare to be added to the sum of preceding fares derived from the travel pass, and then updates said sum in the card memory. Everytime the traveller's card is presented to a transaction terminal it reads from the card the sum of earlier fares, adds the current fare, and then compares the new sum with a preset number in a separate register of the transaction unit. This last-mentioned register is non-volatile and represents a reference level with which the value of level of accumulated paid fare memorized in the "travel pass" plus the fare that would be payable for the current trip is compared. For the purpose of explaining the idea, it should be assumed that the comparison shows that the sum of all fares exceeds the reference value level. This condition triggers another program set in the transaction programming unit which

(a) deducts from the reference value the amount by which the sum of all fares exceeds this value

(b) the then remaining value is entered as a refreshment update into the value register of the "travelpass".

(c) the account number of the travel pass, together with the bank code and interbank fund transfer phone nr. are being read out from the travel pass and transferred to a Register in the Transaction Unit.

Throughout the entire regional transportation system the above cited reference value is the same, in other words, all travel passes are at all times updated by a constant value, in some cases by a multiple of that constant value. This arrangement does not only permit the process to be automated, but also reduces the quantity of data that have to be processed, both by the transport operator's computer plant and by the various banks who participate in the project. From the ordinary traveller's point of view this scheme has the advantage that he/she need not worry about fares exceeding the balance in the travel pass which, in other circumstances, may mean interrupting the journey and trying to find a branch of a suitable bank for updating the pass, or a person has to carry enough cash to have the pass updated by the bus driver or the local ticket office, etc. If the travel pass requires updating during a high peak hour, or at a moment when a train has to be boarded, this can be highly inconvenient. Some bus drivers may refuse to do any updating during rush hours. It would be an allround inconvenience to all concerned and reduce the efficiency of the transport system. The new method would in practice mean that on an average 10 times fewer data transmissions need be carried out each day; the cost of the credit system would go down to acceptable levels. Also: Transport companies will receive easily auditable bulk payment for their services to the public made directly by banks to their corporate bank accounts, by-passing all paperwork and the handling of coins and bank notes, cheques, and vouchers. The considerable overheads implicit in fare collection today, can be reduced. In addition, the very drastic reduction of boarding times would reduce turnaround times which amounts to a better service to the public.

The feasibility of the envisaged performance can best be understood with reference to Figure 15 in which the interactions between the "travel pass" 20, the transaction unit 1, a depot computer 14 and a central clearing computer 19 are represented by functional block diagrams. The card Reader consists of a plate containing wire loops 3, an optionally provided lamp 2 and interface circuit 5 for preparing signals for transfer to the card 20 as well as for receiving and adapting signals coming from the card for entry into the microprocessor 7. Between the units 7 and 5 may be provided a scrambling unit 6 which ensures that vital data, such as the systems protection numbers, cannot be deciphered by means of radio equipped clandestine analyzers. An example of such an encryption/decryption circuit has been given in the published patent GB 2130412B. The microprocessor 7 passes the serial number of the card 20 obtained via the Reader 3, to the circuit group 8 which contains the means for comparing the serial number with all the blacklisted numbers of the local traffic region. This is done at a high clock rate.

If any of the numbers contained in the blacklists of block 8 is equal to the serial number of a card being processed, the unit 8 emits a flat signal through its connector line 7-2 and causes the microprocessor 7 to change its program and produces a display on the driver's Console 12 and/or activates a buzzer or the like, and also extinguishes the lamp 2 (Lamp 2 may be used for illuminating solar cells fitted on the "travel pass" card 20). The driver will request fare payment in cash, or request update of the card against cash.

Assuming the card is not blacklisted, the next step would be to assess if it is genuine. This is done by a procedure described in GB 2,092,344, a published patent. The procedure is recapitulated in the flow diagram Fig. 16. Returning to Figure 15, the scramble unit 6 and the register 10 are assumed to be contained on the same silicon chip together with the processor circuit 7 so that no external connection line is required to carry the secret protection number in clear form. This is essential for the preservation of secrecy.

Block 9 is important for our purposes in the present invention. It is a register holding the number which represents a value level to be compared with the accummulated fares since the last update of the card. If there is an excess of fares debt over and above the said reference number in block 9, a program in the microprocessor is started which

(a) deducts from the accummulated fares debt the fixed number in register 9
(b) enters into the register 11 the card serial number of the card 20

No further additional data need be entered into register 11 in support of the serial number since the very fact of a recording of the serial number in register 11 is equivalent to a constant debit as prescribed by unit 9. This level, as already indicated, is the same throughout a given transport region, and would also be agreed with the banks in that region.

When the bus arrives at the depot 14 at the end of the day's shifts, the bus personnel establishes a connection between the transaction unit 1 and the depot computer 14 which then controls the transfer of all the serial numbers of cards which underwent the described update procedure. The data transfer is preferably done via an optical cable link 15-8. On this occasion, the most recent compilation of blacklisted serial numbers are entered by the Depot Computer into the on-vehicle register block 8.

Between the late hours of the dat and the early morning hours of the next day, the Depot Computer translates, based on prepared look-up tables, the serial numbers received from Register 11 of the transaction units of buses into the appropriate account numbers which are then sorted by Bank Codes and branch numbers, enabling a Computer to transmit the list of units debts to the various Head Office Computers of the participating banks. While thus the individual accounts of various transport patrons are being debited with the said units charges in favour of the Banks concerned, each Bank will arrange to send to the various Transport Depot Computers

14, 14', 14'' .... etc the amounts due to the various fleet owners. This last-mentioned step can be omitted, if the various vehicle operators opened bank accounts with the major banks of the region. There by, further savings can be achieved.

Figure 16 shows a flow diagram for the sequencing of the just described processing steps in cases where fares are always straight flat fares pre-payable at the entry of a vehicle or a station platform.

Figure 17 is a flow diagram for graduated fares. Section 'A' in this flow diagram is identical with that shown in figure 16, and is therefore not shown. The diagram also illustrates the differences for railways and buses.

The processing of graduated fares on public transport systems is within the public domain (see UK patent 857,658) and need therefore not to described here. That early publication prescribes the use of magnetically encoded cards whereas the present paper relates to electronically encodable data components endowed with processing capability within the cards. Compared with the apparatus of the old technique, electronic Readers are very small and can be clamped to a support rail or side wall and therefore need much less space which in buses is at a premium. Passengers need not enter the card into machine. The technique used in a "travel pass" is such that the traveller has to hold the pass briefly against the 'Reader' plate. While the new data transfer technology employed in 'travel passes' (see UK patent application 9115408.8) makes possible the mounting of Readers close to entrance and exit doors of buses, there is still doubt whether the same technique can efficiently be combined with turnstiles.

One way for dealing with the problem of graduated fares on buses would be to charge the passenger when he boards the bus, for the entire remaining route of the bus, but, when the passenger checks out at the exit door, he is refunded the excess of the paid fare over the proper fare to the point of exit. However, this method does not exclude that a passenger may choose to check out his/her pass ahead of time, long before he actually leaves the bus.

It is therefore proposed that the following alternative procedure is used on long-distance but routes: The passenger pays upon entry the fare for the whole distance until the end of the line. No equipment is provided for checking out at any of the exit doors of the bus. Instead, all the stops along the route are fitted with so called "REFUND UNITS" where passengers, after having left the bus vehicle, can obtain refund for any excess fare they paid when boarding the bus. The electronics of these 'refund units' would be fully protected by the systems check numbers and the scrambled communication system as described in GB 2057740 and GB 2092344.

In this context, a fully automatic fare collection procedure for long-distance bus lines can be effectively realized without any possibility for fraudulent misuse on the vehicles.

Having described the "travel pass" in some detail with respect to its inventive techniques for communicating with a read-write unit, as well as some of its inventive features in its data processing programs, the further description of the travel pass will now reveal the innovative structures, electrical and mechanical; reference will now be made to the figures 18,19,25 to 28.

Figure 18 illustrates the basic electrical building blocks of a travel pass (at times also called "smart purse"). There is a micro computer 1, a push button aggregate 2 and a display window 3 with its drive circuit 4, a battery 9 and a voltage stabilizer circuit 5 to produce the operating voltage for the microcomputer within the required tolerances, and an antenna 7 cooperating with an interface circuit 6. The latter may also comprise a scrambling/descrambling and security circuit 6a as for example described in full detail in GB patent 2,130,412.

Figure 19 shows the top part of the data carrier 10 with numerical data entry buttons 2a, and functional command buttons 2b, and a special sideways mounted button 2c (for use by the thumb if the right hand holding the device in front of the reader surface). A Display Window using liquid crystal techniques 3 provides feedback to the user. Two holes 11 permit the device to be suspended in a vehicle permitting data to be read while the vehicle is in motion.

Figure 19a shows a possibility of rear illuminating the LCD display during or after a transaction. The LCD glass plates are sandwiched between two parts, 10a and 10b, of the purse device. Part of the rear surface 10d may be used for electricity generating photosensitive layers.

The data component illustrated in Figure 20 employs electronics as shown in Fig. 18 but offers more diversified facilities than the component of Fig. 19.

A larger readout window 3 permits alpha-numeric information in both small and large lettering. Apart from the numbered manual data entry buttons (0-9) there are elongated data entry buttons such as button 15 (marked En), a double arrow button for moving a cursor on the display screen to a desired position. Another square button 2d (marked U) is provided by which the numbers 0-9 are lifted into an upper case, as it were, thereby acquiring a different meaning (see TableI, Figure 21), by pushing button 2d once, the number "1" acquires the meaning of a purchase code for purchasing stationeries. The user is aware that he has pressed button U because of the visual indication provided by the three pin-size LED lamps 19. The lowest one stands for the Lower Case, the middle one for the upper Case, and the third one for the "double upper case" level.

The third level is obtained when the button "U" is pressed twice. The three levels rotate with recurring push on button "U". Also display window indicators may be used to the same end.

The horizontally arranged buttons I, II, III and IV cannot be accessed without prior entry of a personal identifying number to give access to the respective memory sections containing credited sums of purchasing power. If the user wishes to get a visual display of the residual credit present in one of the credit accounts I to IV, he may have to precede this by a number, for example the number '9'. If, then, immediately after entering the PIN the number 9 + III is entered (which appears on the display window to assure correct entry) and thereafter the button EN is pressed, the residual credit amount will become visible, based on the appropriate programming of the micro computer chip 1.

There are, furthermore, buttons marked alpha, beta and gamma, which, combined with number '9' produce a readout of the summed discounts resulting from purchases with Discount Stores alpha, or respectively beta, or gamma.

These sums may normally not be useable for general payments but only for purchases in the same stores who have offered the discounts. However, some stores may in fact offer discounts which do not need entry of a special code by the Discount Store's own terminal but may be used for executing a payment at any terminal. This latter arrangement can best be implemented by arrangement with the Store's Bank, and would be handled like credits from Banks I, II, III etc., in other words, the user may draw from an Alpha Store by transferring an amount to the socalled "money store" (see patent US 4,859,837).

According to the cited system, payments can be made from the money store without requiring prior entry of the PIN number. (The owner's personal secret number).

The keyboard shown in Figure 20 offers many more ways for personal financial management. The following examples can be considered directives for programming the "travel pass" and are part of this invention.

(a) The combination of a double upper case level, 2x(U), with another of the ALPHA, BETA OR GAMMA buttons produces on the screen window the last expenditure made. Upon pressing the button (say, ALPHA) again, the last-but-one expenditure is displayed; after pressing ALPHA again, the expenditure of the preceding purchase appears. The user may continue along this line and reviewed the successive expenditures stored in the processor stack, and may write them down in his or her note book. He may get the same result when selecting BETA but with the difference that any expenditure item displayed is deleted at the moment the next-earlier expenditure is selected. This way the stack is cleared in preparation for the next day's (or week's) expenditures.

Each stack row would display the following data: Date of purchase, amount, classification code, and the account used for the purchase (i.e. I, II, III, or IV).

(b) Another way of clearing the stack when the display indicates that it is full is to enter a sorting command. The card processor will then be directed to sum expenditures having the same classification code, and add the sum to the amount (if any) present at the same storage address containing already an amount constituting earlier summed expenditures of the same classification code. (See TABLE I, figure 21). This procedure is repeated for all the ten classification codes. After that is done by the control circuit of the purse the stack is cleared of all its data.

The above mentioned 'sorting command' might be entered by means of selecting a number other than 9 plus the upper case button (⇈). If such a command is not issued when the stack is full, the earliest purchase record at the bottom of the stack would be lost at the next purchase transaction which would be entered at the top of the stack.

(c) Still another method for dealing with the stack data is to make its memory large enough for say 63, or even 127 purchases but permit no further purchase transaction if the stack is full. The user must then preset his/her purse for UPDATING. That means, the purse must be connected with a Bank computer of the owner's choice (if he has more than one credit account).

On this occasion, a printout is produced for all purchases contained in the enlarged stack by the bank equipment, and delivered by the Bank to the user. After that, the entire stack is cleared by code signal from the bank; however, the first line of the stack is then used to receive from the Bank computer the date of the update, its bank code, and location code from where the update operation was done.

(d) One important automatic summation store, also managed by the "TRAVEL PASS" processor is a fee payable with each update operation. The fee here referred to is not a bank charge (which may also be levied) but will be a hire-purchase fee which is programmed to stop once the total amount has been paid.

Say, the "Travel Pass" costs fifty Pound Sterling. Most people will prefer to buy it through fifty instalment payments of One Pound each payable every time an update operation is executed. When the summation store reaches fifty, further debits will cease. The banks receiving these amounts together with an appropriate coding flag, will pass on these sums to the manufacturer or to the agents licensed to sell the "travel pass" devices.

A similar principle may be applied to insurance contributions which may be payable to guard against the contingency of inadvertently loosing the "travel pass". The insurance premium payable with each update may be 10 pence, or may be a small percentage of the value turnover. The percentage, however may increase with each incidence of loss affecting the same individual.

Further, electronic purses have no cash value to a finder except what he finds in the so called 'money store' the capacity of which would be kept small; even this quasi cash value may not be available to a finder of the purse or pass because of the 'automatic return-to-credit function that a cautious user would always activate to become operative after a preselected time lapse (see further below). Most finders of a forgotten purse will therefore hand in the device to the nearest bank knowing that a reward will be payable to the finder after contact has been made with the owner to ascertain the circumstances.

(e) When a transfer is made from a selected credit account (I, II, III, IV) of a portion of the residual credit to the so called "money compartment" this invention provides for a time lapse command which the user may enter, ordering the purse processor after the expiry of the preset time lapse to return the residual amount in the 'money compartment' of the memory to the credit account section of the travel pass from which section it had been derived. This command does not require a special command code if the entry of the time lapse is made immediately after the transfer of a sum from a credit account to the 'money store'. Fee Flow Diagram figure 22.

From the example given in the Flow Diagram, the user wants the next payment to be made from credit transferred from his Account IV. The PIN had already been used for obtaining the display of the contents of the money store. It has therefore not to be repeated for obtaining the display of the contents of credit store IV, namely 238.20 (in whatever currency).

The user enters 125.00 units for transfer to the "money store" After that, considering that the shopping trip will be finished in half an hour, the user enters 40 (minutes), the presses En for enactment. This will ensure that the money account will become empty after 40 minutes whether anything was purchases or not.

(f) In order to prepare a purse or pass for an UPDATE, a PIN must be entered correctly. This invention provides in its programming the possibility for two different PINs being used, namely one for all purchase and access transactions, and another for use only for update operations. Such a practice would still further increase the overall security for the account holders. After the PIN entry is successfully carried out, the user will select which of the accounts he wishes to update (I, II, III, IV). The display window will reflect the choice. This preparation also acts as an address selection for the purse sending out a dial signal over the telephone system to reach the respective Bank Computer Center. This signal can only be sent out via field disturbances representing data if the 'purse' or 'pass' is presented to an appropriate Reader Unit.

There would be, according to this invention, two foremost locations where UPDATE TERMINALS are installed. Firstly, in the banks which participate in the "travel pass" scheme. Secondly, for remote fund transfer, there would be terminal units connected to the telephone network. Such units can be connected via the standard telephone switching system to the Bank Computer as "dialled" by the "travel pass". Long-distance and international Codes, however, must be dialled by the user himself before inserting the Pass or Purse into the proximity-coupled data transfer transducer of the phone network terminal. Once the Pass establishes data contact with the Bank Computer concerned, a data dialogue is initiated strictly controlled by protocol during which various security check data are called up y the Pass (including date and time of the last update which remain stored in the Pass) and if these data are in agreement with bank records the depleted credit level in the Travel Pass is brought up to the level as arranged with the branch manager. The end of the transaction is indicated by a buzzing tone or the like, the user removes the pass from the terminal.

(g) The Travel Pass may also be used for storing different telephone numbers Access to the selected telephone number is by viewing it on the display window of the Travel Pass after entering a first or second shift level (using button 'U;) combined with an easily remembered double digit number. (for each frequency telephoned addressee). Telephones equipped with travel pass readers may be built (both home phones and pay phones). When the travel pass is placed on the reader surface of such a telephone, the Travel Pass will pass on its instructions and the full dial number held in memory, responsive to the selected two digit number.

(h) One of the advantages of a financial data carrier equipped with data entry buttons is that the PIN, the secret personal identifying number, can be changed by its owner without reference to a central computer, and that such a change can be enacted virtually as soon as there is any suspicion that someone may have acquired knowledge of the code (see flow chart Figure 27).

As part of this invention, it is also proposed that a programming option is foreseen which would permit the owner of a purse to allow a fried or relative to know one of two Pin numbers, but not the other. The owner, however, would use the other PIN. The owner can also use the second PIN for changing the first PIN whereas the first PIN cannot be used for changing any of the PINs. This provision can be achieved by appropriate hardware and software design.

Another feature according to the invention is the provision that the user may, if under duress to disclose any of the secret access numbers, use them or have them used by a third party but request an additional digit entry as part of the code which, if operated in a credit transfer with a bank, would cause an alarm to sound and also give the location of the payphone terminal from which the UPDATE or Transfer attempt is made. This is intended to enable law enforcement officers to appear on the scene quickly.

Figure 3A illustrates the manner of interfacing a Travel Pass with a transaction terminal: by holding it against the Reader plate RP.

Figure 3B shows an interface terminal with capacitive coupling for use with a thin memory card or smart card.

The card C is inserted into a slot made of plastic material P internally lined with two metallic layers insulated from one another except that they are both connected to input bonds of the LSI chip CH. Each of said layers encompasses the slot gap on both sides forming a kind of Faraday cage into which the card is dipped. The drawing Fig. 3 A shows these layers (α-2, and β-2) in cross section. The internal width would be only marginally wider than the thickest card or travel pass to be employed with that type of Reader terminal.

The card itself may be thought of being made of three sandwiched layers two outer and a middle layer, the latter being cut away to make room for the LSI Chip. The same is microcomputer with only two connector bonds, for connecting to the two transducer elements (capacitive plates or inductive coils). The same chip may also accommodate the extra logic for the scrambling/descrambling of the incoming/outgoing signal and for any extra switching functions which the proper performance of the described systems requires. W is an optional LCD window.

An advantage of the described configuration of the capacitive lining on a slotted Reader unit is that a good coupling factor is obtained with the prospect of injecting enough power into the card or travel pass for powering the LSI circuit CH as well as the liquid crystal display showing the latest balance held in the pass, retaining it legible for up to one minute after a transaction. Inexpensive, non-processing Read-Only readers can also be provided as a complement to the overall system where the public may obtain a quick status readout without having to occupy the time of a transaction device.

Figure 3C provides an indication of the data transfer circuitry in the card of Fig. 3B.

The card C is again shown partly surrounded by the transfer elements (α-2) and (β-2). They are connected to voltage amplifiers A via resistors R, driven by logic level square pulses CLK. If there are no outgoing data pulses Do from the Reader unit, the pair of capacitive plates are charged and discharged by a train frequency pulses of same shape, phase, frequency and amplitude. These electrical conditions will mirrored by similar voltage changes in the card transfer elements (α-1) and (β-1) within the card. The rectifier diodes cause a build-up of positive and negative potential on the operating rails of the chip circuit. This causes a brief transitional charging period, sensed by the Reader circuit by means of the comparator CO across the resistor R. The simultaneous rise and fall of the input potential (α1,β-1) on both input terminals of the Comparator dA will not cause any adequate output from this comparator circuit. The differentiator D generates a strobing clock pulse for any high level applied to output terminal Di so as to clock serial data into a buffer register provided in the Microcomputer circuit of the chip CH (fig. 3B). When said buffer register outputs a high level data bit it is applied to AND gate G which is enabled only during a high-going data bit by means of a simple S/R bistable. The output therefrom is applied to the gate of a field effect transistor TR whereupon the plates α-1 and β-1 are short circuited for the duration of a single clock pulse. In the Reader circuit, this causes a voltage drop across resistor R and an output wave Di from the comparator circuit CO. The logic circuitry on the left is needed to change the input α-2 in such a manner that the differential amplifier dA in the card circuit produces a data bit output (Di) for every data bit of put (Do) on the Reader side.

UK application No. 9514606.4, which is divided from the present application, relates to the use of a non-contact smart card for sending bidirectional data by suppressing the carrier wave by introducing a low impedance into the antenna coupling between the reader and card.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A pocketsize electronic pass device, and a plurality of Accountancy Systems, adaptable as a means for making valid payment of fares or purchases of services and goods from one or an other of said accountancy systems, the said pass device comprising electromagnetic coupling means for transferring to and receiving from a communication point of said accountancy system digital data and transferring operating energy, wherein the means for the transfer of data and operating energy from any of the said accountancy systems comprise an accountancy outlet head containing two coils of equal inductance value mounted side by side producing high frequency fields of opposite phase, and wherein the pass device contains two similar coils of similar geometric configuration connected in series, such that any non-signals originating from a random source will appear in the pass device in antiphase to cancel each other.

2. The ~~arrangement~~ device of claim 1, wherein the transfer of data is obtained through modulation of the energy transfer carrier wave.

3. A ~~arrangement~~ device as claimed in claim 1 or 2, wherein the means for data and operating energy transfer are fitted into the pass device and correspondingly into the accountancy outlet head in such a manner that in the pass device an alternating voltage differential is created between the two transfer coils when brought into a certain spatial relationship to said accountancy outlet head of an accountancy system, said potential difference being utilized to drive electronic processor circuits in the pass device as well as for sending data to the Accountancy system by short circuiting or loading the induced energy for the duration of each logic high data bit to be transferred to the accountancy system.

4. The ~~arrangement~~ device of claim 1,2 or 3, wherein the data and energy means transfer is characterized by a flow of square pulses (CKα) passing through one of the said two coils, and a flow of similar square pulses in antiphase passing through the other of the said two coils in antiphase (CKβ) and wherein both said pass device and the outlet processor of any of said accountancy systems each contain a "COUNT TO THREE" binary counter, and wherein a high logic data bit is represented by the absence of the middle one of a group of three pulses in both the card processor and the reader processor.

5. ~~An arrangement~~ A device as claimed in any preceding claim, further comprising electric change-over switching elements under the logic control of a card-based data transfer processor whereby the usual phasing of said two coils can be switched in such a manner that the pass device becomes non-responsive to proximity signals issued by the outlet processor of one of the Accountancy systems, and responsive to signals from a more distant source.

6. ~~An arrangement~~ A device as claimed in any preceding claim, wherein the off-line terminal of the accountancy system, i.e. the processor terminal, comprises a register for storing the serial numbers of passes or cards in default; means for comparing a pass presented for a transaction to test it against the said list of defaulted passes in said register; further means for comparing a fare price due for payment with the residual value of the pass tested; means in the local processor terminal for updating the value of a pass by a preset amount conditional on the fare being due exceeding the residual value in the pass and furthermore conditional on the serial number of the pass under test having found to be not identical with any of the serial numbers

stored in the default register; and, an off-line debit register in the said processor into which the serial numbers of all those passes are loaded which have received during a current working shift the said preset credit increment.

7. The ~~arrangement~~ device of any one of claims 2-6, wherein said pass device holds data in the form of electronic binary states in semi-conductor or ferrite materials, and wherein said accountancy systems govern the movements of data between registers, signal converters and other retrieval circuits, further comprising a full-scale manual data entry keyboard on the surface of the pass device, and an LCD window.

8. The ~~arrangement~~ device of claim 7 wherein besides said keyboard also dedicated data entry elements are provided which give direct access to certain individual sectors of data held in the form of binary states within the said data carrying component.

9. The ~~arrangement~~ device of claim 8 wherein a part of the data entry elements are dedicated memory access buttons which address data groups representing credited spending allowances, the said data carrying component als~~o~~ comprising means for visually displaying these data.

10. The ~~arrangement~~ device of claim 8 wherein a part of the data entry elements are dedicated to address data held in the data carrier which accumulate the monetary values of discounts transferred via said electromagnetic coupling means and representing a discount percentage on purchases bought in order to display the said accumulated discount values or to use them for another purchase transaction.

11. The device of claim 8, wherein at least one of the dedicated data entry elements, consists of a command button U which selects one of the several "upper case" levels for the aforementioned data entry elements in order to multiply the number of address codes or command codes available to the user.

12. The device of any one of claims 7 to 11 wherein the said pass device holds data using an addressable buffer register, and said processor can by command entry from the said keyboard deduct a specified amount from the balance of one of the said data groups representing credited spending allowances, and transfer said specified amount together with attributive data into said addressable buffer register which, unless otherwise directed, is in permanent connection with the said transducers for transferring its data to an external terminal as part of a purchase transaction.

13. The device of any one of claims 7 to 12 wherein said processor the various memory and register elements and their addressing circuits, signal converters, scrambling and descrambling circuits and output circuits are combined in a single large-scale integrated circuit chip mounted in the interior of said data carrying pass device.

14. The device of any preceding claim wherein the signal and data transfer to and from an accountancy system is carried out by phase modulation of a carrier.

15. The device of any one of claims 1 to 13 wherein the signal and data transfer is carried out in the form of an F/2F pulse transfer technique.

16. The device of any one of claims 1 to 13 wherein the transfer data from said pass device to an

accountancy system is carried out in the form of a pulse interval modulation or a Manchester Code alteration.

17. The ~~arrangement~~ device of any preceding claim wherein the pass device contains an electrically alterable Read Only memory (Earom) into which various procedural programs and user identifying data are written, and which also holds two personal secret number (PIN1 and PIN2), a register into which a PIN can be entered via a manual entry key board on the data carrying component, a command signal to the processor circuit to compare the entered PIN with the said two personal secret numbers held in memory, and if there is agreement with one of them, to permit access to the data or readout thereof.

18. The ~~arrangement~~ device of claim 17 comprising command programs in its Read Only memory enabling a user of the pass device to change PIN1 or PIN2 upon correct prior entry of PIN2, and PIN2 ONLY.

19. The ~~arrangement~~ device of claim 17 or 18 wherein the said electrically alterable Read Only memory, (Earom, or erasable EEROM) also holds a third secret personal number (PIN3), a register into which the user can manually enter a personal number, a command signal to the said processor to compare the entered PIN with the PIN3 held in memory, and logic inhibitor means in the output of a Comparator circuit to prevent communication with an update terminal if the comparison is negative.

20. The ~~arrangement~~ device of claim 17, 18 or 19, wherein the register responds to an "update" command issued by an update terminal to the pass device when presented to its Reader unit, on the condition that the PIN2 had been correctly entered prior to the intended update process, but will not respond in the same manner after an entry of PIN1.

21. The device of any preceding claim, further comprising a data scramble and descramble circuit.

22. The device of claim 21 wherein the said scramble/descramble circuit is designed in accordance with the principles and logic sequences described in GB130412B.

23. The device of claim 21 or 22, wherein these circuits are combined in a single large-scale integrated circuit chip mounted in the interior of said pass device.

24. The device of claims 21, 22 or 23, wherein at least some of the logic sequences of the scramble/descramble circuit are implemented by programming a microcomputer to produce the required functions.

25. The device of any of the preceding claims, wherein there is provided at least one telecommunication terminal and at least one central Bank Computer, and wherein the existing telephone switching networks are used to establish connection between one of the said telecommunication terminals which are installed at diverse locations for the convenience of travellers, characterised by the storage of a bank computer dialling number in said pass device, which number is transmitted via said telecommunication terminal converting it into a proper dialling code, and after contact with the Bank Computer is established, to put into effect a pre-programmed routine of interrogation to verify mutual identification prior to transacting an update operation.

26. The device of claim 25, wherein part of the mutual verification procedures are executed in

accordance with the principles disclosed in GB2075732B and 2092344B.

27. The device ~~arrangement~~ of claim 26, wherein during each update transaction the date and time of the transaction is recorded in both the computer memory of the accountancy system concerning and also in the said pass device involved in the update operation, and no subsequent update attempt is executed without first testing the equality of the two records of the dates and times of the preceding update, and if these are not equal the telecommunication connection is aborted.

28. The device ~~arrangement~~ of claim 25, 26 or 27 wherein said pass device is relieved from executing any computational tasks by delegating them to the computerized telecommunication terminal insofar as calculations required in the course of a transaction are carried out by said terminal's own computing facilities, and wherein assurance for correctness of the results entered into a pass device is obtained by a procedure which comprises:

(a) calculation of a transaction result in the terminal along one of several possible ways of performing the calculation
(b) transmission of the result to the pass device
(c) readout of the result from the pass device
(d) calculation of the transaction by the terminal electronics along a second of possible ways of obtaining the required computing result
(e) comparing the second result with the figure returned through readout from the pass as under (c)
(f) if the compared figures are equal, a comparator output is generated, and a "tested" signal is produced or visibly displayed, permitting the processor of the pass device to enter the result into its memory register.

29. The device ~~arrangement~~ of any of claims 25 to 28 wherein the pass device contains a ROM or EEROM memory containing a number of programs which cannot be selected by the manual data entry means incorporated in the said pass device but only by program selection code transferred from the telecommunication terminal to the pass device, after successful completion of the interrogation identification and verification phases.

30. The device ~~arrangement~~ of any preceding claim characterized by a method for transferring digital data in serial form between a system "A" and a system "B" by proximity wherein system "A" generates a continuous chain of clock pulses which appear in system "B" either as pulses of similar shape or as more or less differentiated spikes, and wherein the transmission of a high data bit occurs by the suppression of one in a group of three clock pulses by lowering the reactive transfer impedance either in a system "A" or in system "B" dependent on the direction of transfer, and that the synchronization of the triple pulse cycles in "A" and "B" occurs automatically by the transmission of the first (high) data bit.

31. The device ~~arrangement~~ of claim 30 characterized by a method of transferring digital data in serial form by which is obtained an enhanced immunity from noise, firstly on account of the energy absorption coincident with the transmission of a (high) data bit causing also the energy level of a noise signal to collapse or to be reduced below an effective threshold, and secondly if a noise spike does shift the coupling state between the counters of systems A and B from their synchronization, this is immediately corrected with the transmission of the next high data bit.

32. The device ~~arrangement~~ of claim 31, wherein the

transmission of a reset signal from system A to system B, or vice versa, occurs only in the time sector of the third pulse of the said synchronized triple pulse cycle.

33. The ~~arrangement~~ device of any preceding claim wherein a terminal processor of the Accountancy system may produce an interrupt in the data transfer either to or from the pass device by shorting out the clock pulse channel.

34. A pocketsize electronic pass device, and accountancy systems as claimed in any preceding claim, wherein the data transfer system between the two entities further comprise a differentiator circuit (4α, R1) an amplifier (T1) having a low-going output (CKα), applied to a reset input (R) of a first D-type bistable (I), a second differentiator circuit (4e, R4) producing low going output spike (CKβ1) applied to the clock input (CK) of said first bistable (I) which has its on-state output (QI) connected to the D-input of a second bistable (QII), a third differentiator circuit (4β, R5) producing by its amplifying transistor (T5) a third high-going clock spike (CKβ2) applied in inverted form to the clock input (CK) of said second bistable (II) which normally fails to trigger the said bistable to set at its high output (QII) except when the first bistable is not reset by a low-going pulse, i.e. when said pulse (CKα) is missing.

35. The ~~arrangement~~ device of any preceding claim wherein the wave form of the electrical energy applied to the transfer means in the pass device or accountancy system are nodulated waves or sin waves.

36. The ~~arrangement~~ device of any preceding claim; wherein said accountancy systems are mounted on public transport vehicles preferably close to the points of

passenger entry, or on buildings or posters close to bus or tram stops where passengers, after they have left the transportation system, may check out their passes to obtain refund for any excess payment made for the journey.

37. The ~~arrangement~~ device of any preceding claim, characterized by the provision of a fare debiting system wherein the fares are calculated fully automatically on the basis of data entered into the pass device upon boarding the vehicle when the passenger is debited for a hypothetical journey to the next major stage stop, and by the further provision that the data entered on the vehicle are being read from the pass device by stationary data transfer outlets of the Accountancy System, close to stops along the vehicle route.

38. The ~~arrangement~~ device of any preceding claim, with read/write outlets for communicating with the aforesaid pass, further comprising display window is subdivided into (a) a smaller area or strip on which the processor of the pass displays abbreviated words, letters or symbols representing confirmative or rejective responses to entries executed by the card holder

(b) a separate area only for P IN entry displays (visual feedback)

(c) a separate area for programming command codes (visual feedback)

(d) a larger area for data displays (alpha-numeric)

(e) a dedicated small area for displaying a number or letter representing a Classification allotted to a transaction.

39. The ~~arrangement~~ device of any preceding claim, with read/write outlets for communicating with the aforesaid pass or card, wherein the read/write unit consists of a

vertical transparent proximity sensor plate through which a bus driver can see the read side of the pass device (which may contain a photo) when it is briefly placed by a card holder against said sensor plate for the checking and interchanging of data as claimed in any of the preceding claims.

DATED this 9th day of February, 1996

JOHN W. HALPERN and WILLIAM WARD
By their Patent Attorneys
DAVIES COLLISON CAVE

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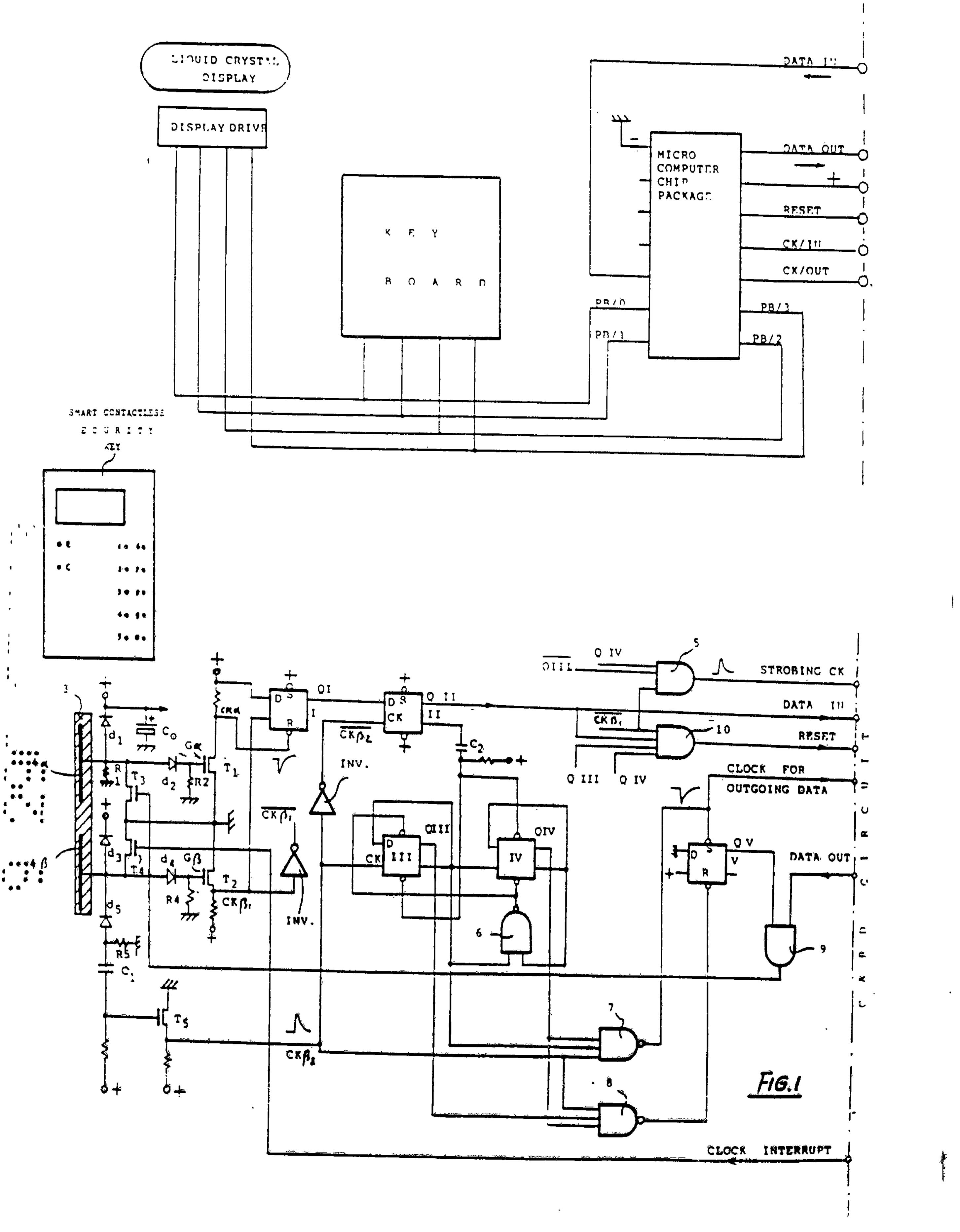


FIG.1

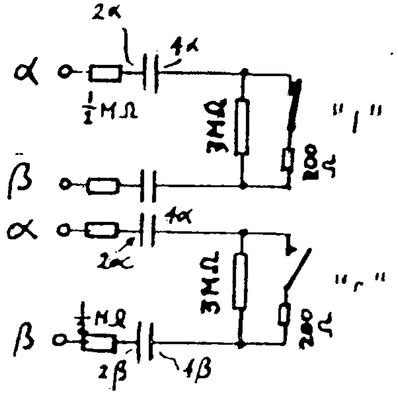

2α
4α
α
½ MΩ
3MΩ
"1"
200
β
α
4α
2α
3MΩ
"r"
200
β
½ MΩ
2β
1β

FIG. 1a

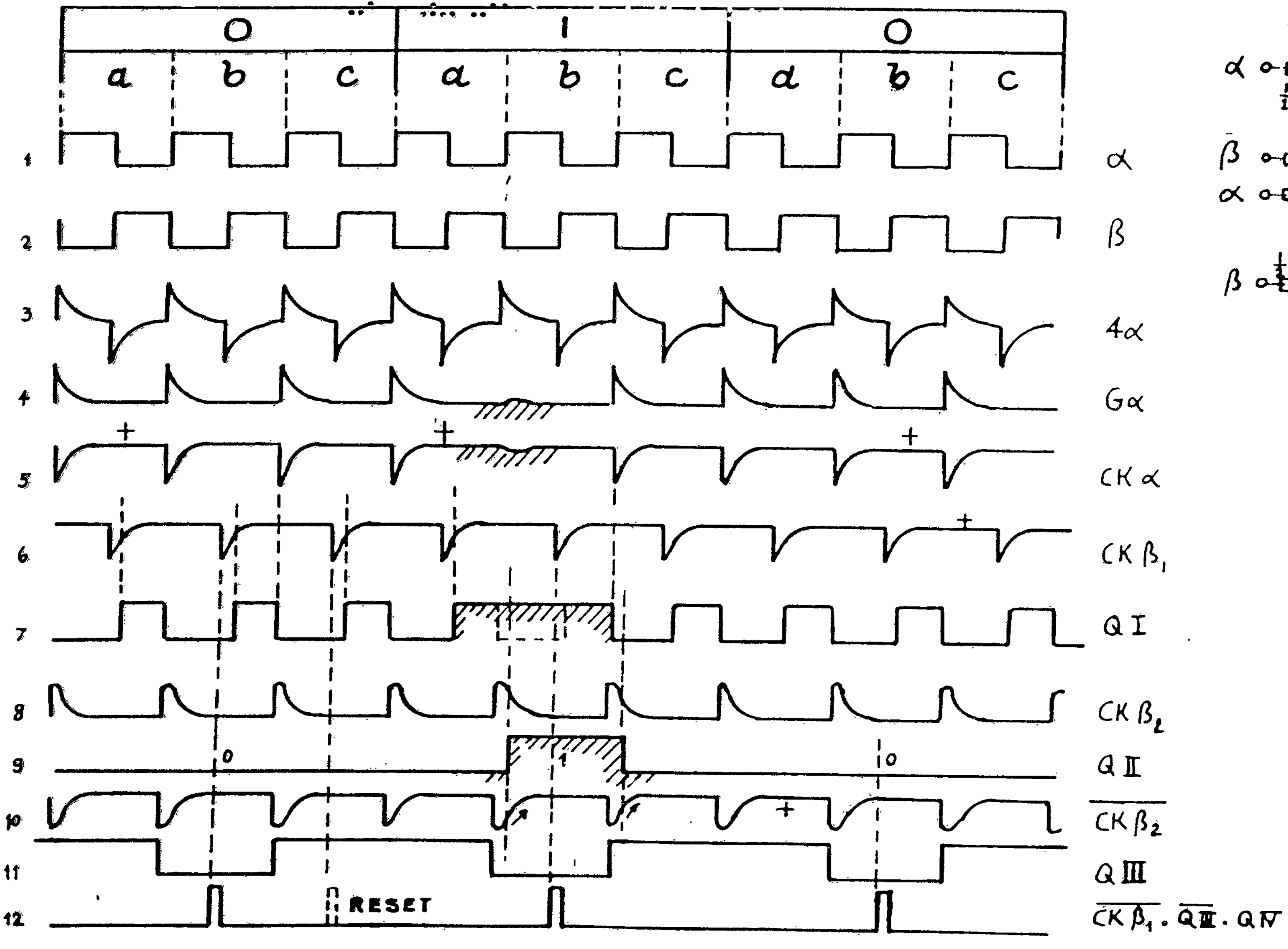

0
1
0
a
b
c
a
b
c
a
b
c
1
2
3
4
5
6
7
8
9
10
11
12
α
β
4α
Gα
CK α
CK β_1
Q I
CK β_2
Q II
$\overline{CK\beta_2}$
Q III
$\overline{CK\beta_1} \cdot \overline{Q III} \cdot Q IV$
+
+
+
+
+
0
1
0
RESET
DATA (D$_i$)
DATA STROBE
(FOR D$_i$)

FIG. 2

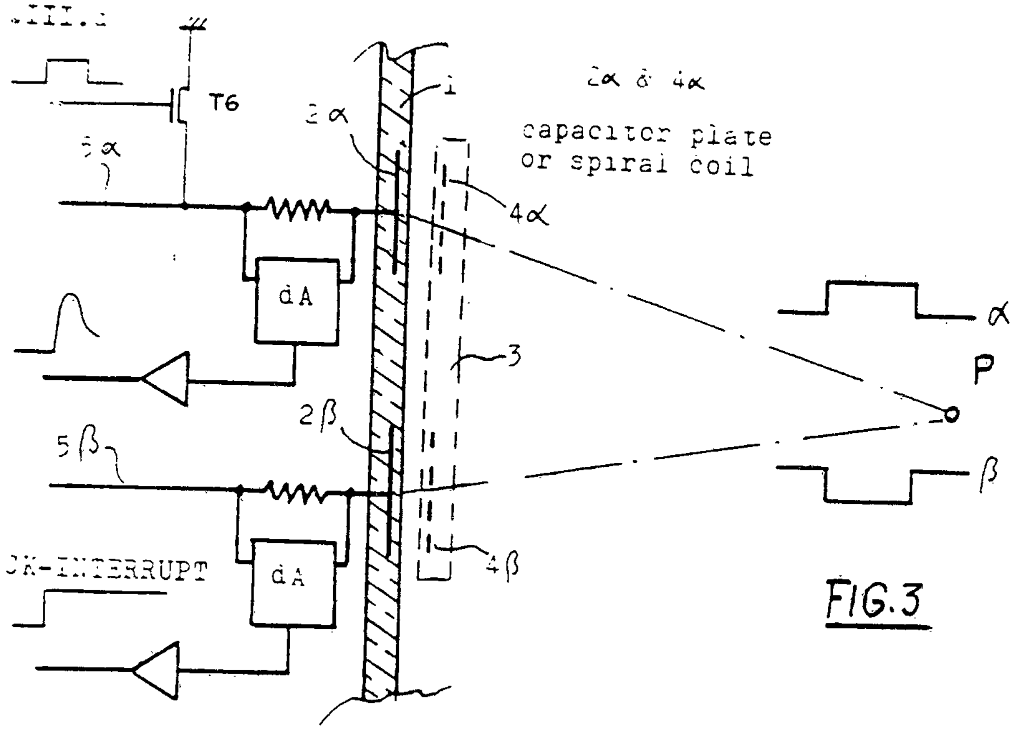

T6
5α
2α
1
2α & 4α
capacitor plate
or spiral coil
4α
dA
3
α
P
2β
5β
β
CK-INTERRUPT
dA
4β

FIG.3

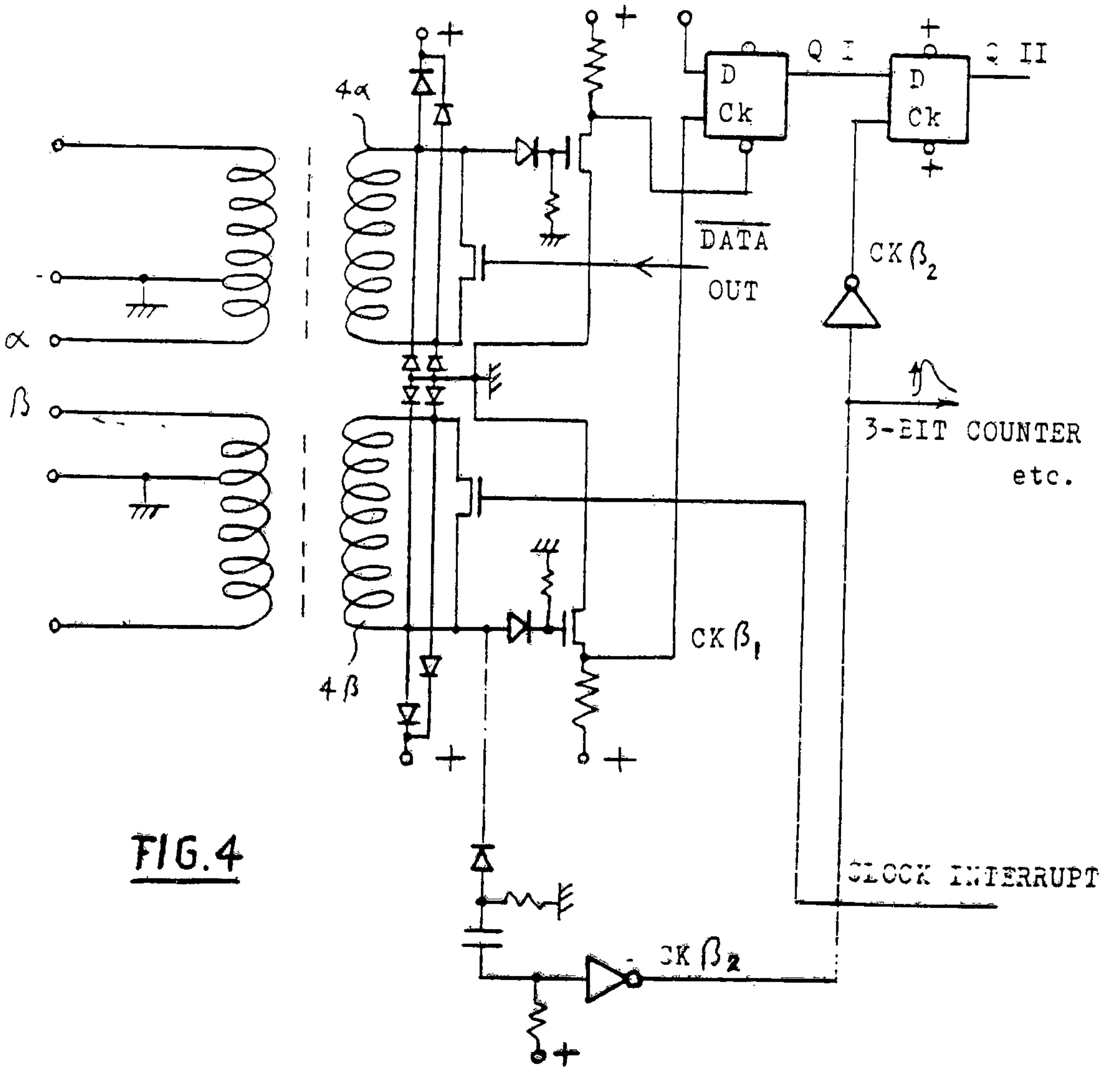

+
4α
+
D
Ck
Q I
+
D
Ck
Q II
+
DATA
OUT
CK β₂
α
β
3-BIT COUNTER
etc.
4β
CK β₁
+
+
CLOCK INTERRUPT
CK β₂
+

FIG.4

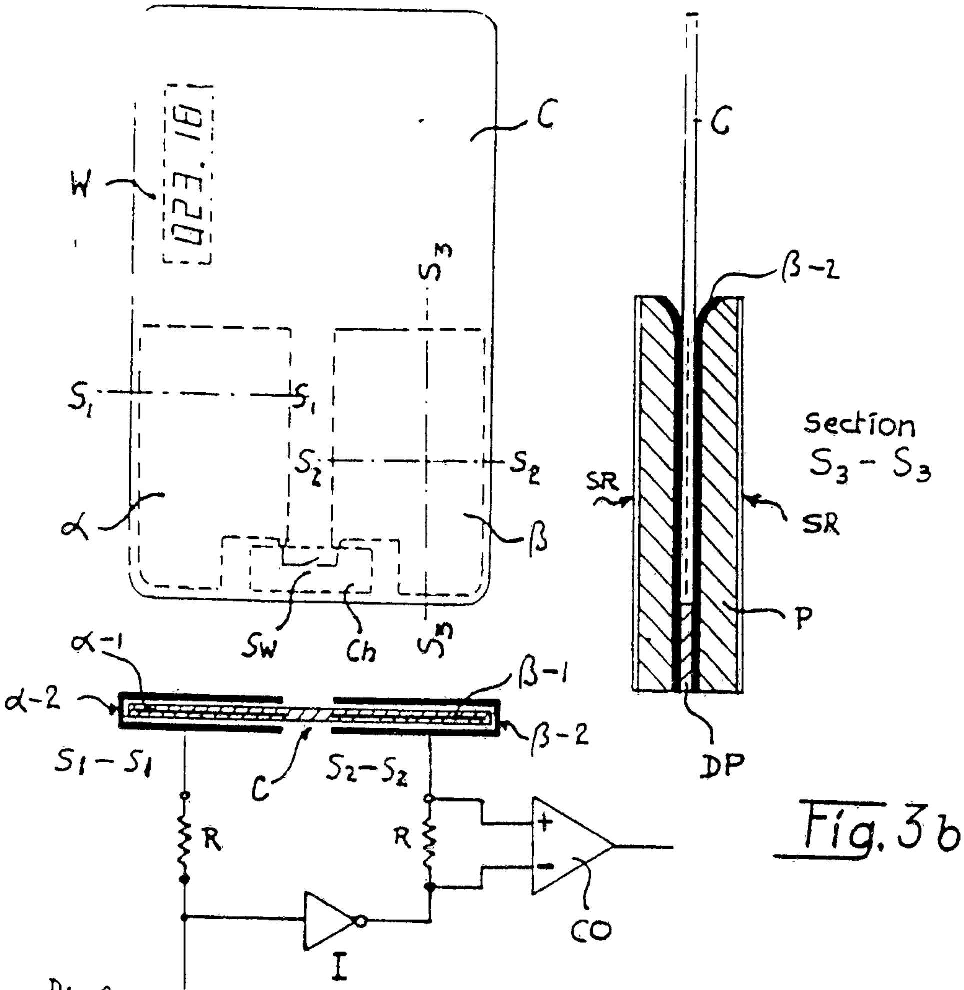

W
023.18
C
S3
S1
S1
S2
S2
α
β
SW
Ch
S3
α-1
α-2
β-1
β-2
S1-S1
C
S2-S2
R
R
+
-
CO
I
C
β-2
Section
S3 - S3
SR
SR
P
DP

Fig. 3b

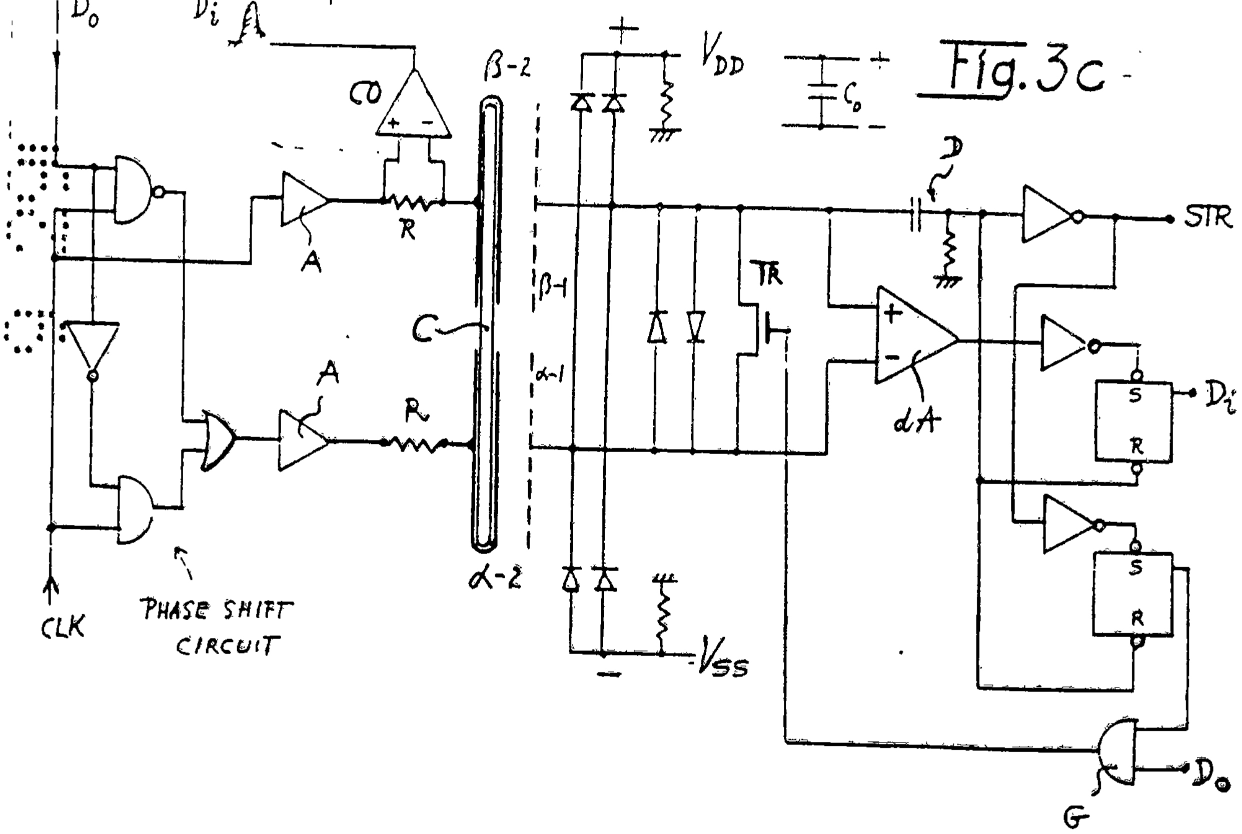

D0
Di
CO
+
-
β-2
+
VDD
C0
+
-
D
STR
A
R
β-1
C
TR
α-1
A
R
+
-
dA
S
R
Di
S
R
α-2
CLK
PHASE SHIFT
CIRCUIT
-
VSS
G
D0

Fig. 3c

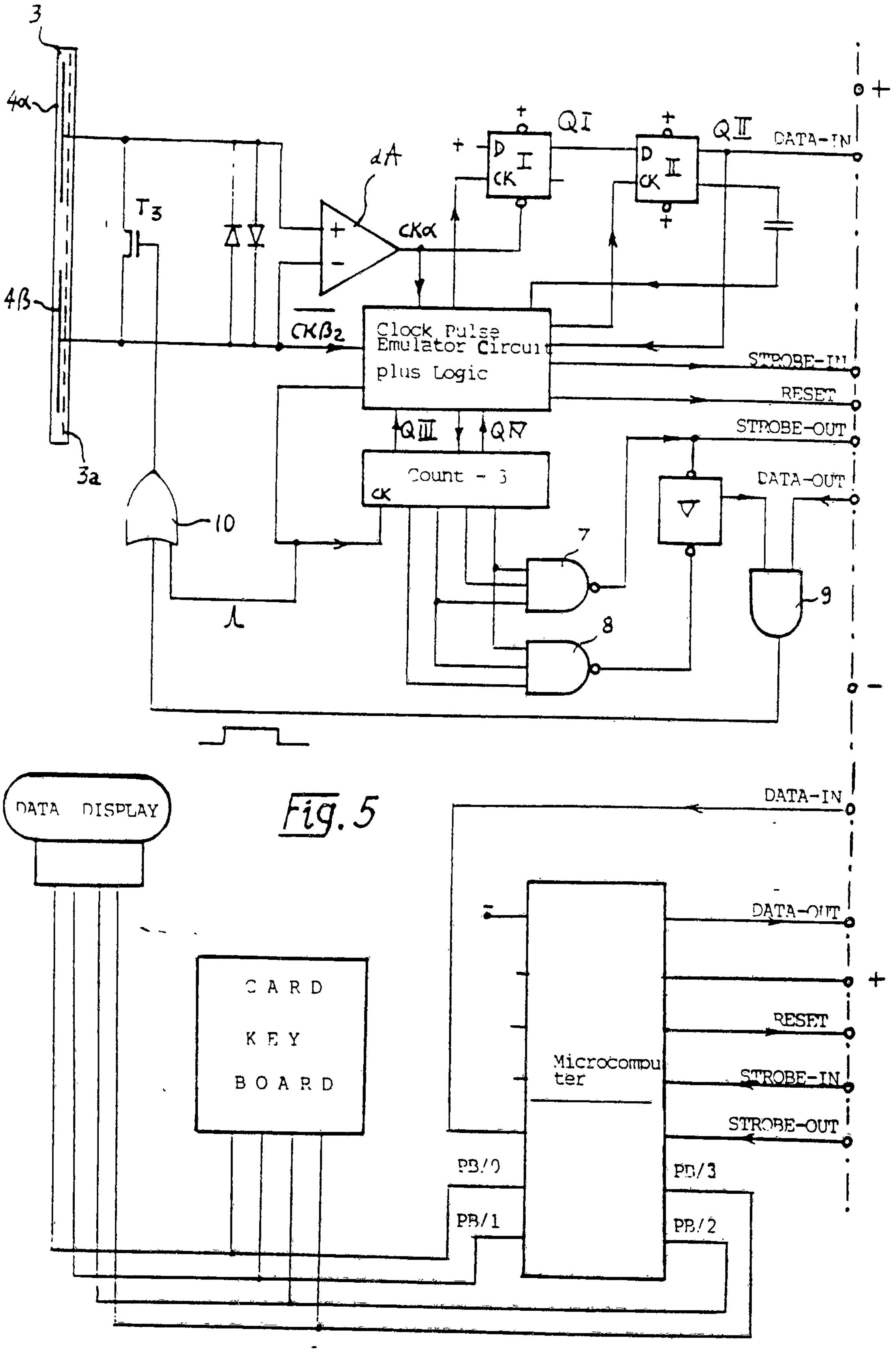

3
4α
4β
3a
T3
dA
CKα
CKβ2
QI
QII
D
CK
I
II
+
-
DATA-IN
Clock Pulse Emulator Circuit plus Logic
STROBE-IN
RESET
STROBE-OUT
DATA-OUT
QIII
QIV
Count - 3
CK
7
8
9
10
λ
DATA DISPLAY
CARD KEY BOARD
Microcomputer
PB/0
PB/1
PB/2
PB/3

Fig. 5

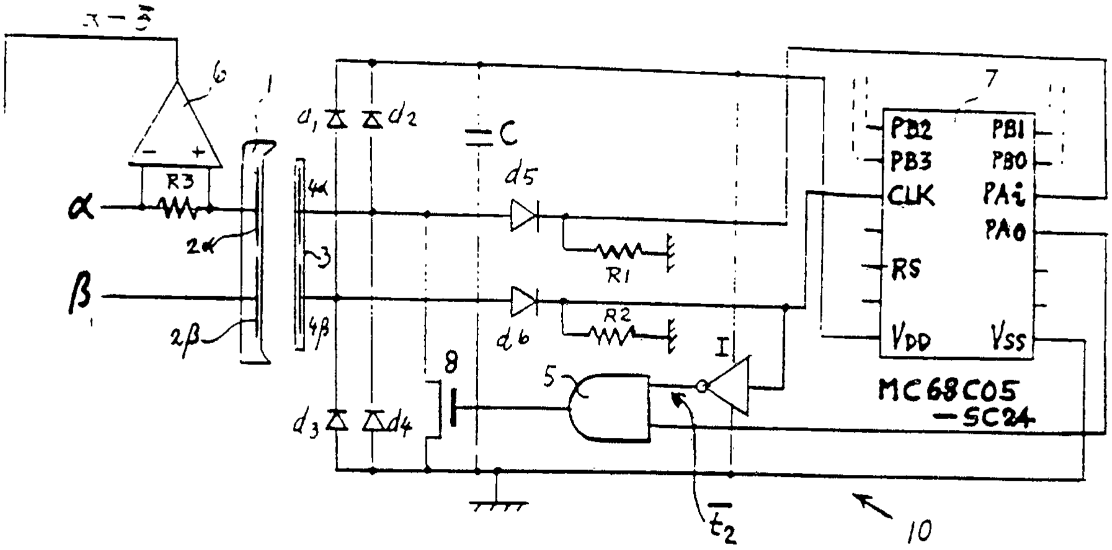


FIG. 6

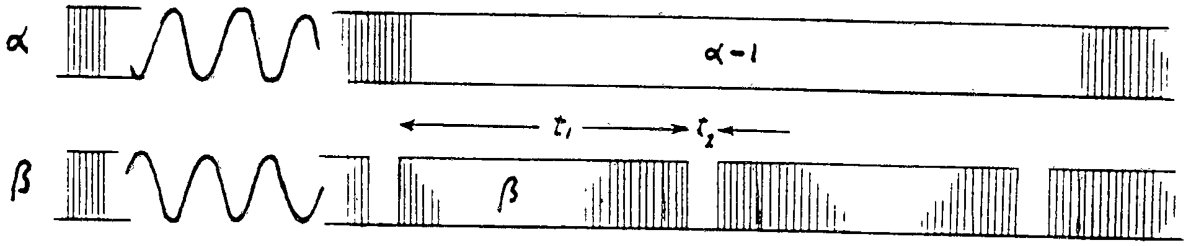


FIG. 7

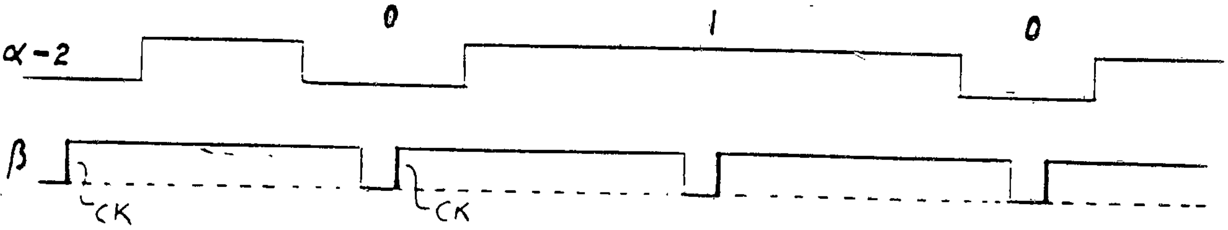


FIG. 8

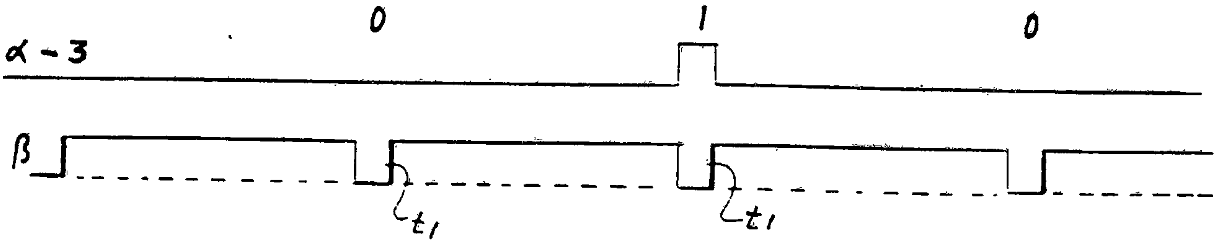


FIG. 9

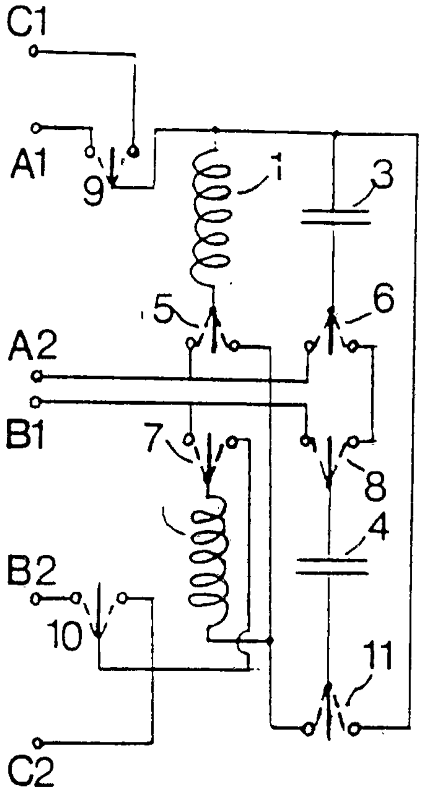


FIG.10

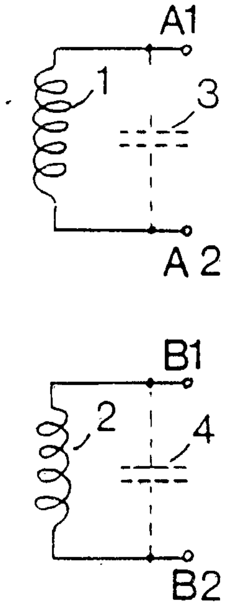


FIG.11

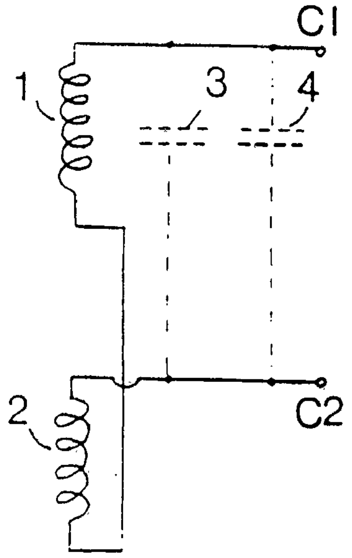


FIG.12

FIG.13

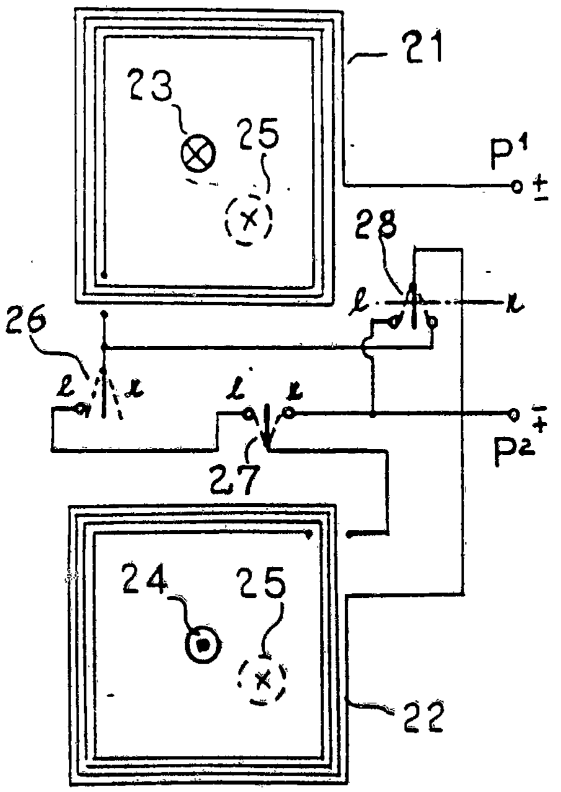
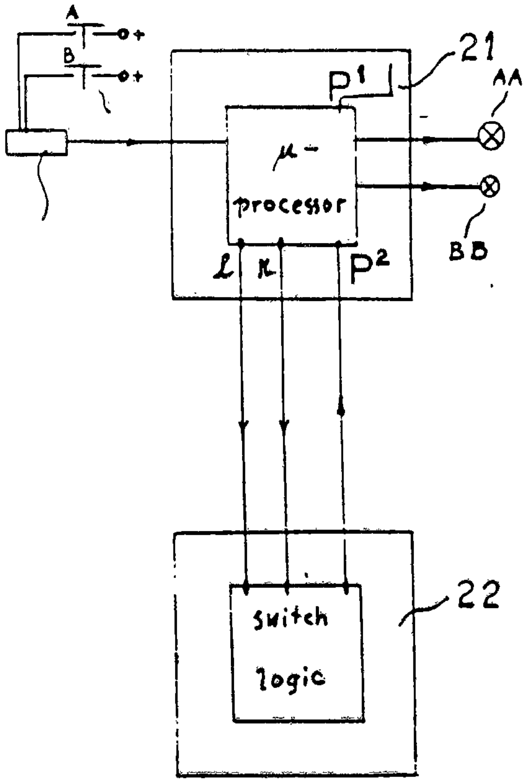


FIG.14



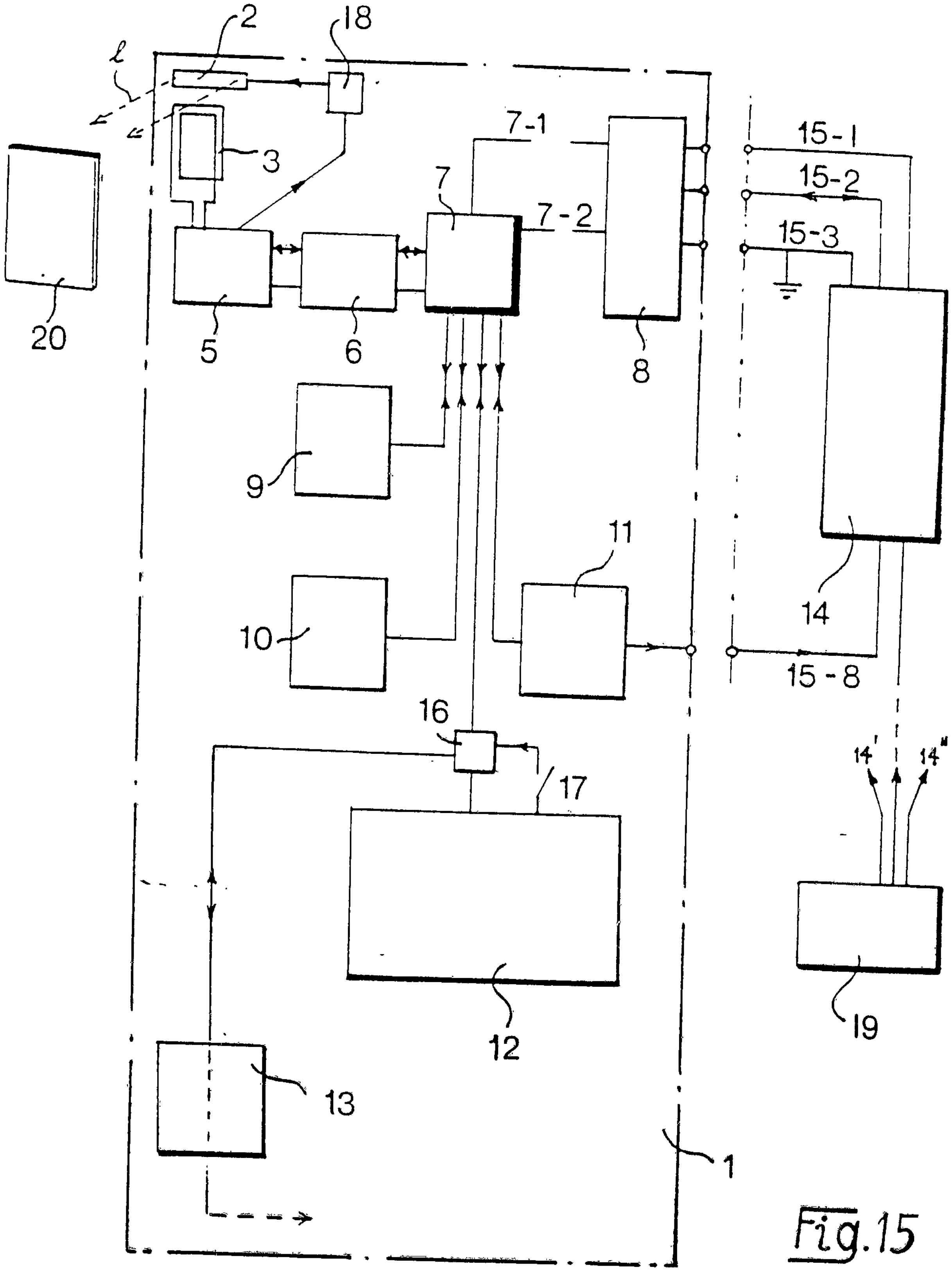


Fig.15

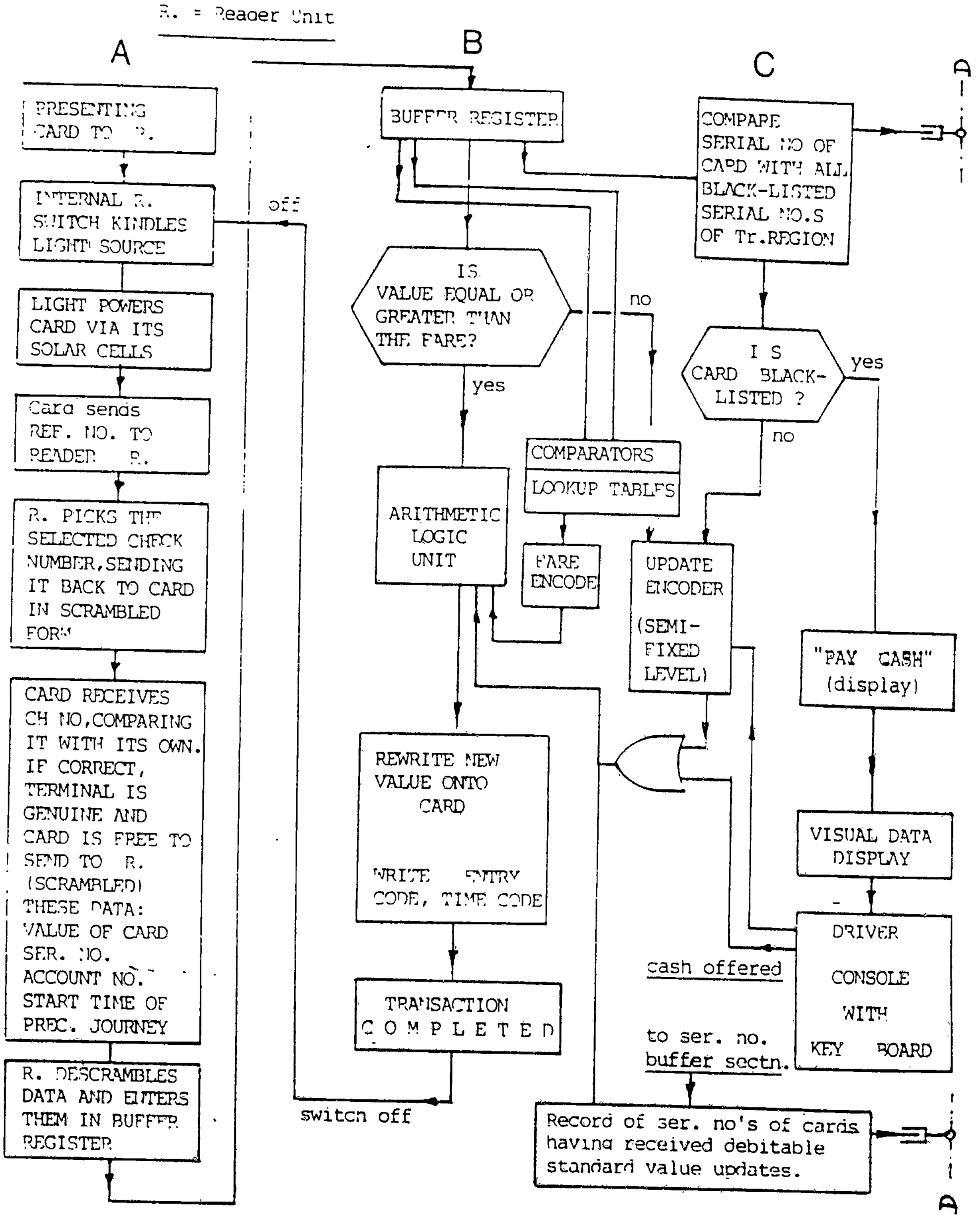

R. = Reader Unit
A
B
C
A
PRESENTING CARD TO R.
INTERNAL R. SWITCH KINDLES LIGHT SOURCE
LIGHT POWERS CARD VIA ITS SOLAR CELLS
Card sends REF. NO. TO READER R.
R. PICKS THE SELECTED CHECK NUMBER, SENDING IT BACK TO CARD IN SCRAMBLED FORM
CARD RECEIVES CH NO, COMPARING IT WITH ITS OWN. IF CORRECT, TERMINAL IS GENUINE AND CARD IS FREE TO SEND TO R. (SCRAMBLED) THESE DATA: VALUE OF CARD SER. NO. ACCOUNT NO. START TIME OF PREC. JOURNEY
R. DESCRAMBLES DATA AND ENTERS THEM IN BUFFER REGISTER
off
BUFFER REGISTER
IS VALUE EQUAL OR GREATER THAN THE FARE?
no
yes
ARITHMETIC LOGIC UNIT
COMPARATORS
LOOKUP TABLES
FARE ENCODE
REWRITE NEW VALUE ONTO CARD
WRITE ENTRY CODE, TIME CODE
TRANSACTION COMPLETED
switch off
COMPARE SERIAL NO OF CARD WITH ALL BLACK-LISTED SERIAL NO.S OF Tr.REGION
IS CARD BLACK-LISTED ?
yes
no
UPDATE ENCODER (SEMI-FIXED LEVEL)
"PAY CASH" (display)
VISUAL DATA DISPLAY
DRIVER CONSOLE WITH KEY BOARD
cash offered
to ser. no. buffer sectn.
Record of ser. no's of cards having received debitable standard value updates.
A

Fig. 16

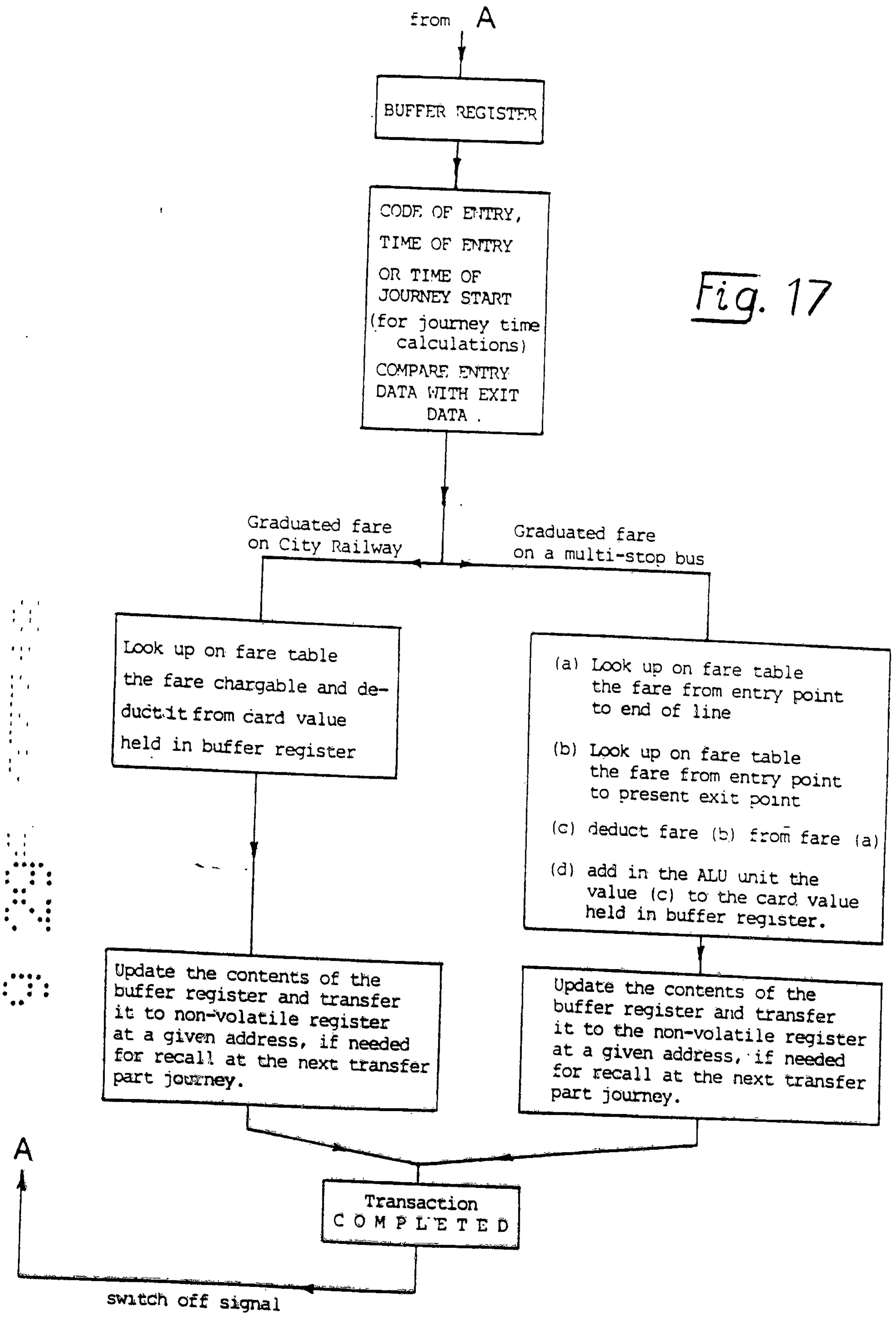

from A
BUFFER REGISTER
CODE OF ENTRY,
TIME OF ENTRY
OR TIME OF JOURNEY START
(for journey time calculations)
COMPARE ENTRY DATA WITH EXIT DATA .
Graduated fare on City Railway
Graduated fare on a multi-stop bus
Look up on fare table the fare chargable and deduct it from card value held in buffer register
(a) Look up on fare table the fare from entry point to end of line
(b) Look up on fare table the fare from entry point to present exit point
(c) deduct fare (b) from fare (a)
(d) add in the ALU unit the value (c) to the card value held in buffer register.
Update the contents of the buffer register and transfer it to non-volatile register at a given address, if needed for recall at the next transfer part journey.
Update the contents of the buffer register and transfer it to the non-volatile register at a given address, if needed for recall at the next transfer part journey.
Transaction COMPLETED
A
switch off signal

Fig. 17

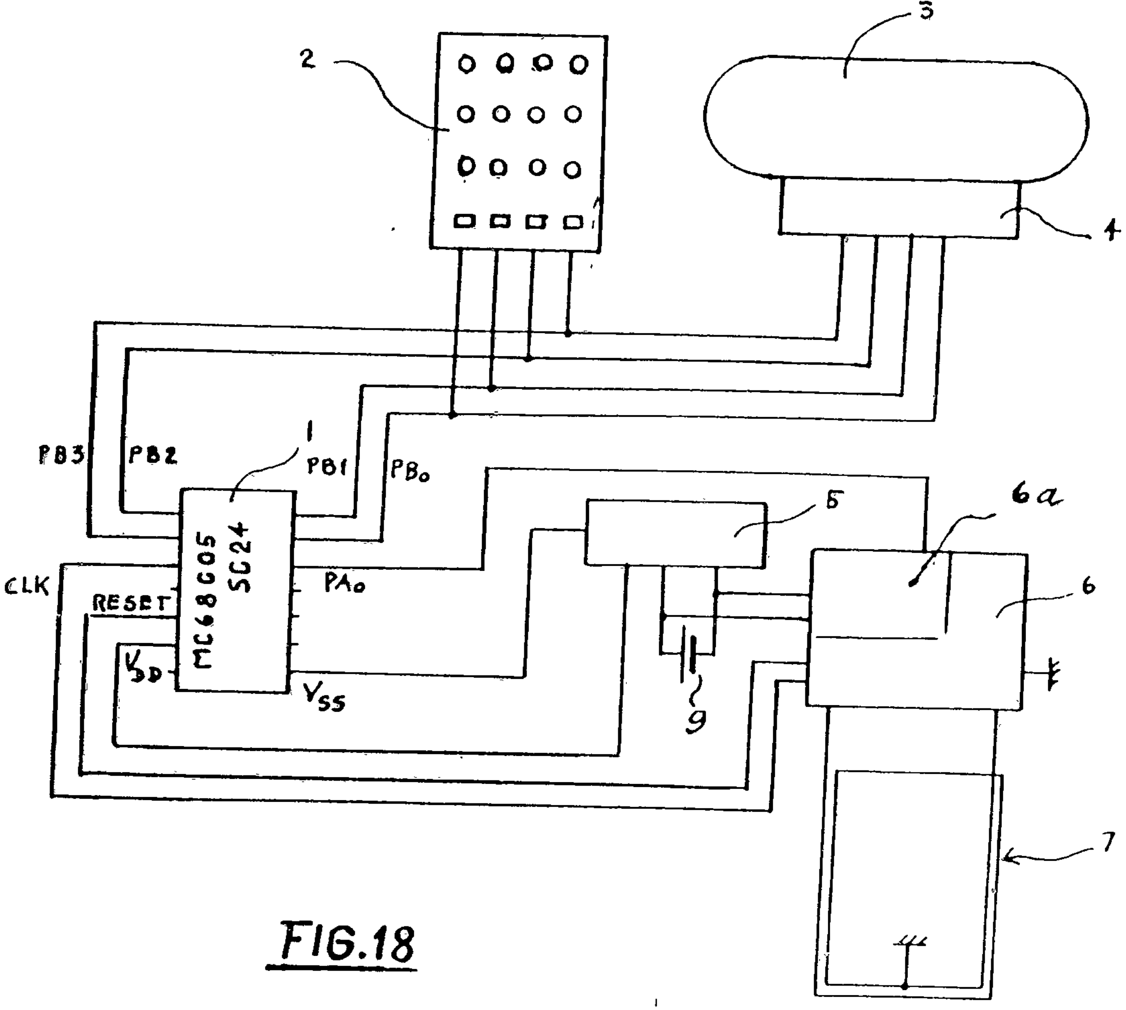
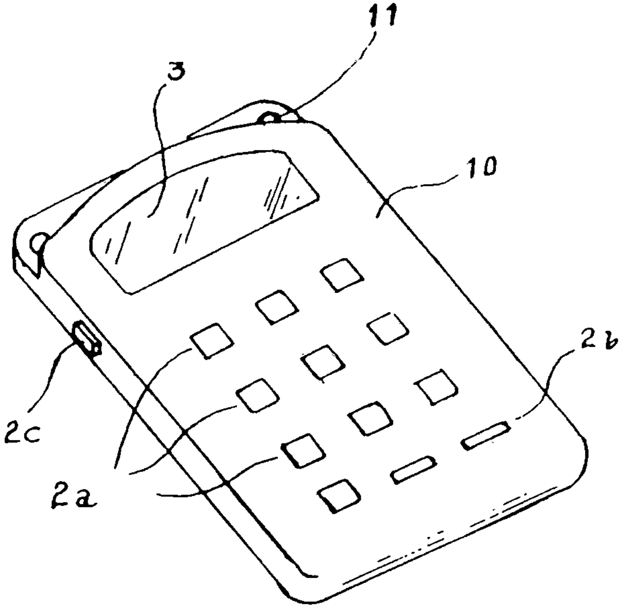


FIG.18

FIG.19



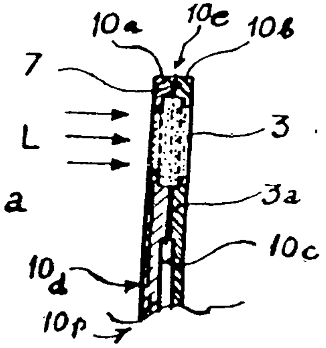


FIG. 19a

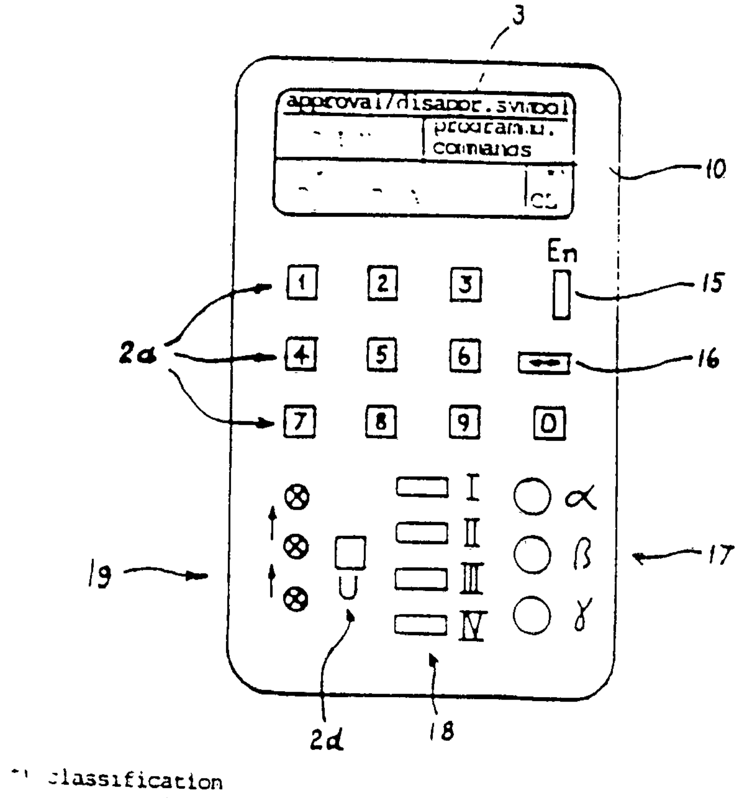


FIG. 20

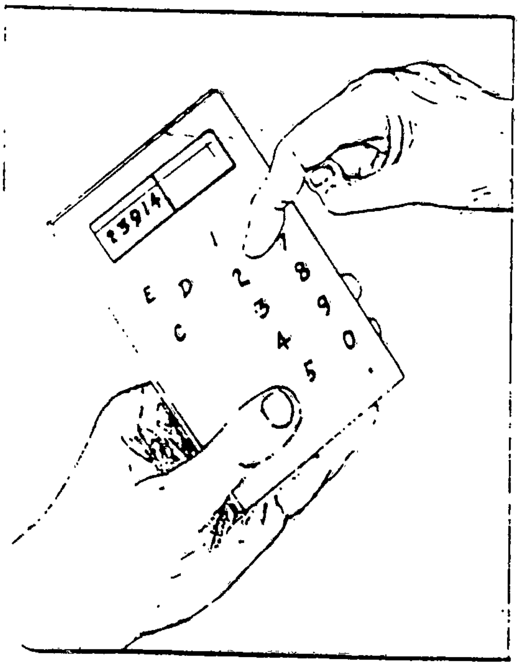


FIG. 20A

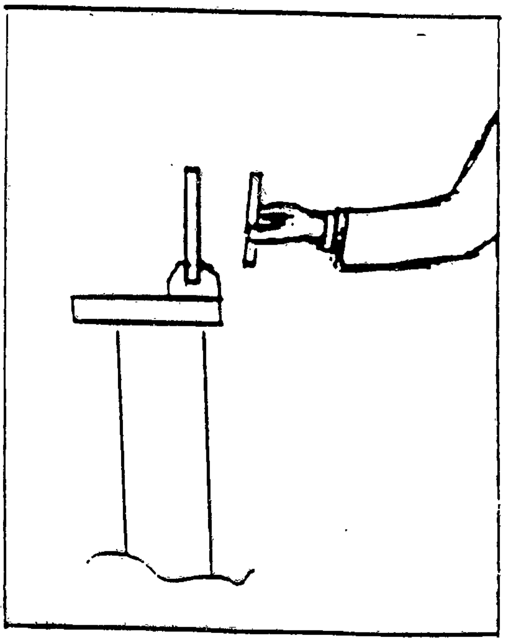


FIG. 20B

PAPERLESS ACCOUNTING

Manpower Building
2nd Floor
2 Dyke Road, Brighton BN1 3FD
SUSSEX

(0273) 202754

Encoder Buttons: 0 - 9, numerical entries,
En , initial reset and data entry into processor
U , upper case for numbers with meaning as given below if pushed twice, (double upper case), see other meaings.
I, II, III, IV. stores for bank issued credit amounts
α, β, γ = stores for summed-up discounts data, for three by customer chosen selling houses.
double arrow button: for moving cursor forward/backward.

Single Upper Case combined with:

1 ... Air Travel,
2 ... Other Travel
3 ... banking (Updates only)
4 ... Health and Household
5 ... Restaurants
6 ... Groceries etc.
7 ... Stationaries
8 ... Business
9 ... Display expenditure only irrespective of category

Double Upper Case combined with:

1 ...total air travel since update
2 ... " other " " "
3 ... date of last update (for I -IV resp.)
4. ... total expenditure on HH since update
5 ... total on restaurants " "
6 ... " " groceries " "
7 ... " " stationaries " "
8 ... " " business items " "
9 ... display of cash in money store

For the following, the PIN must be entered afresh just prior to the codes:

Single Upper Case combined with:

9+I ...display of residual credit in Credit Store I
9+II .. " " " " " " II
9+III.. " " " " " " III
9+IV .. " " " " " " IV

9+α ...display of accummulated discounts derived from purchases in Discount Shops (normally, it is expected that customers will select no more than three shopping sources offering recovery of discounts either for additional purchases or as cash).

9+β as above

9+γ as above

Double Upper Case combined with :

0 ... Cancel the preceding data entry
En ... Display instant time and Date (Correction of time and date can only be obtained from a clock terminal).

TABLE I

FIG.21

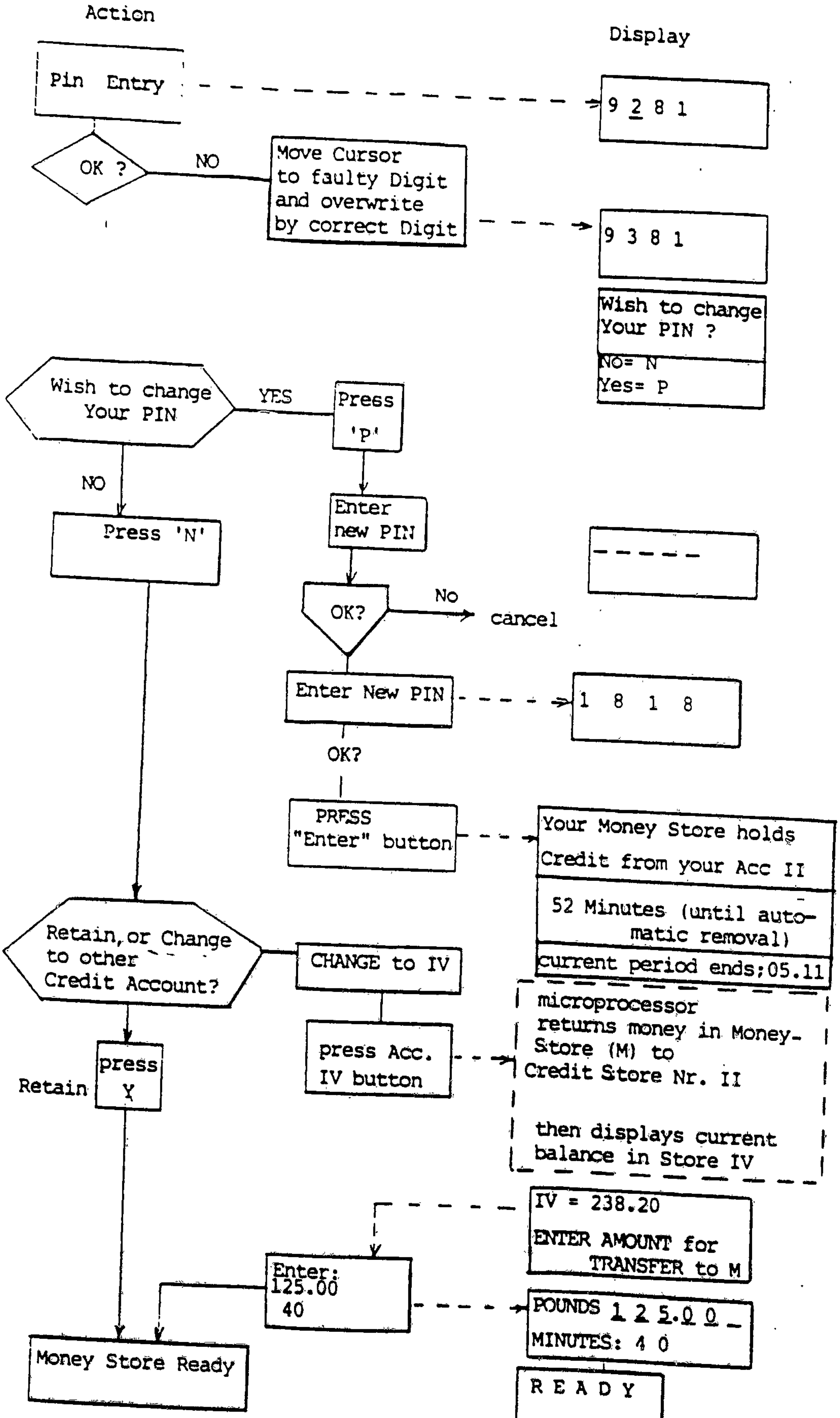

Action
Display
Pin Entry
9 2 8 1
OK ?
NO
Move Cursor to faulty Digit and overwrite by correct Digit
9 3 8 1
Wish to change Your PIN ?
No= N
Yes= P
Wish to change Your PIN
YES
Press 'P'
NO
Press 'N'
Enter new PIN
- - - - -
OK?
No
cancel
Enter New PIN
1 8 1 8
OK?
PRESS "Enter" button
Your Money Store holds Credit from your Acc II
52 Minutes (until automatic removal)
current period ends;05.11
Retain, or Change to other Credit Account?
CHANGE to IV
microprocessor returns money in Money-Store (M) to Credit Store Nr. II
then displays current balance in Store IV
press Acc. IV button
Retain
press Y
IV = 238.20
ENTER AMOUNT for TRANSFER to M
Enter: 125.00 40
POUNDS 1 2 5.0 0 _
MINUTES: 4 0
Money Store Ready
R E A D Y

Fig.22

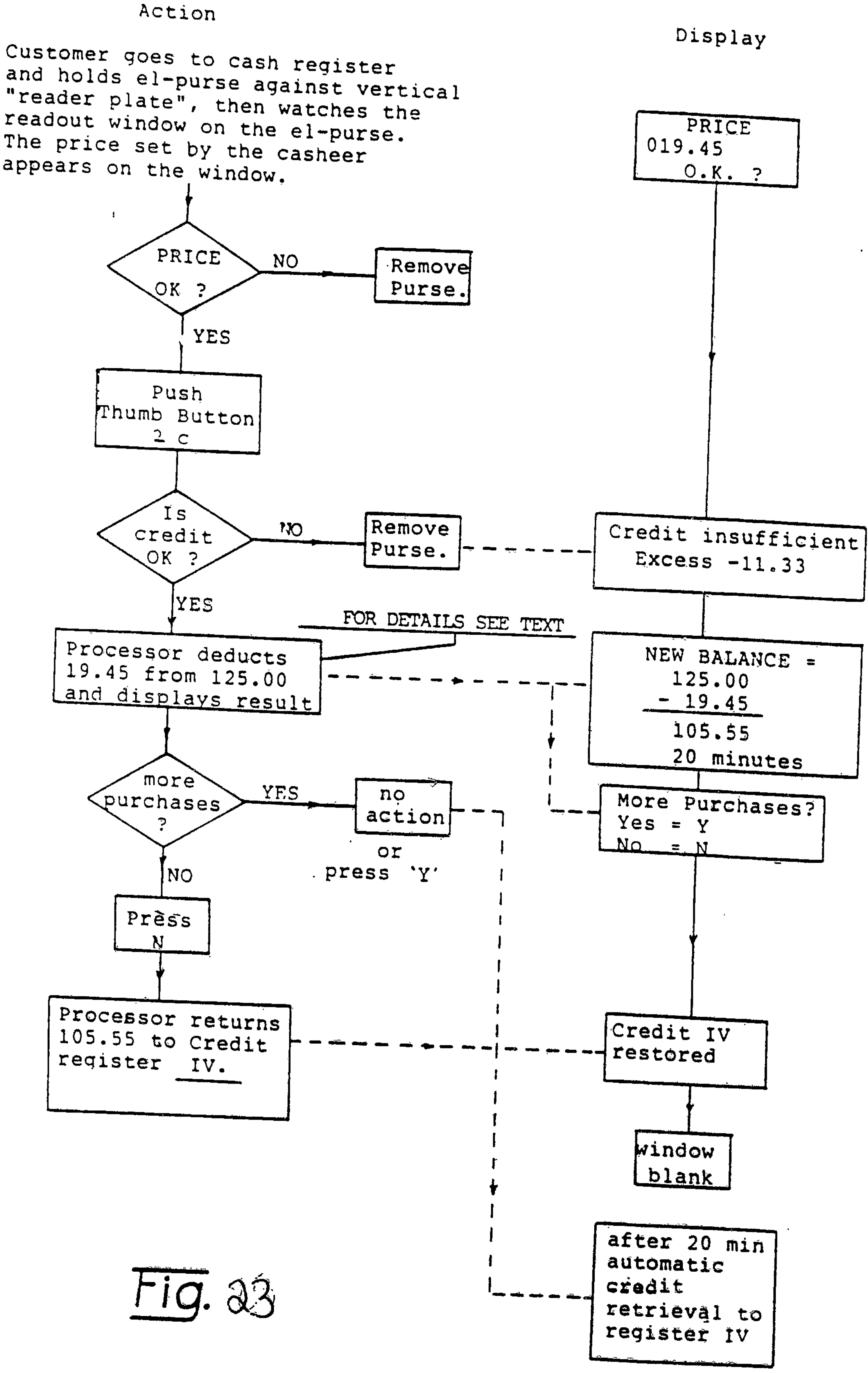

Action
Display
Customer goes to cash register and holds el-purse against vertical "reader plate", then watches the readout window on the el-purse. The price set by the casheer appears on the window.
PRICE 019.45 O.K. ?
PRICE OK ?
NO
Remove Purse.
YES
Push Thumb Button 2 c
Is credit OK ?
NO
Remove Purse.
Credit insufficient Excess -11.33
YES
FOR DETAILS SEE TEXT
Processor deducts 19.45 from 125.00 and displays result
NEW BALANCE = 125.00 - 19.45 105.55 20 minutes
more purchases ?
YES
no action
or press 'Y'
More Purchases? Yes = Y No = N
NO
Press N
Processor returns 105.55 to Credit register IV.
Credit IV restored
window blank
after 20 min automatic credit retrieval to register IV

Fig. 23

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 92/01309

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl.5 G 06 K 7/08 G 06 K 19/07

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl.5	G 06 K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X Y	WO,A,8706747 (AMERICAN TELEPHONE & TELEGRAPH COMPANY) 5 November 1987 see page 12, line 5 - page 13, line 14 ---	1,4 42
Y	EP,A,0260221 (ZEISS IKON AG) 16 March 1988 see figures 1-3 ---	42
A	EP,A,0435137 (SONY CORPORATION) 3 July 1991 see column 5, line 1 - column 9, line 54; figures 3-10 -----	1,4,43

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 15-01-1993	Date of Mailing of this International Search Report 08.06.93
International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB92/01309

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

For further information see Form PCT/ISA/206 sent on 15.02.93.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1, 4, 42 and 43.

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9201309

SA 65412

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 19/05/93
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A- 8706747	05-11-87	US-A- 4795898	03-01-89
		CA-A- 1292802	03-12-91
		DE-A- 3777334	16-04-92
		EP-A,B 0267231	18-05-88
		JP-T- 1500340	09-02-89
EP-A- 0260221	16-03-88	DE-A- 3630456	17-03-88
		CA-A- 1294043	07-01-92
		JP-A- 63067696	26-03-88
		US-A- 4876535	24-10-89
EP-A- 0435137	03-07-91	JP-A- 3189786	19-08-91
		US-A- 5175418	29-12-92

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82