Computing Note
M.S./B./201

THE DEUCE CONSOLE

by

D. G. Burnett-Hall, B.A.

This is a description of the DEUCE console, its reader and punch with emphasis on those parts with which operators engaged on programme testing or production work should be familiar.

The author is indebted to Mr. F. G. Duncan of Bristol Aircraft Limited for permission to copy his technical note, including the two figures illustrating the console and the Hollerith equipment.

Computing Note
M.S./B./201

DEUCE CONSOLE

PANEL I

Row (i) Key 1, marked CONT T.C.I. is normally used only by the engineers. Its effect is to allow a continuous stream of instructions to enter TS COUNT from the instruction highway or via destination 0. (The TCI signal, giving the time at which control is to take a new instruction, is normally regulated by the timing number.)

Key 2, marked CONT TT (continuous transfer timing) causes a continuous transfer to take place between the source and destination specified by the instruction held in TS COUNT. (The TT signal is normally regulated by the wait number and the characteristic.)

Key 3, marked CONT TIL has the effect of causing the programme to take the unnatural side after a "2-24" instruction, irrespective of whether the last row of a card is being passed.

Key 4, marked DISCRIM, is of use in programme testing. In its neutral position it has no effect, the discriminators acting normally. In the OFF position its effect is to cause the programme to take the natural side after all discriminations, irrespective of the condition of the number examined by the discriminator; similarly, with the DISCRIM key ON, the programme will always take the unnatural side.

Key 5, marked PROG DISPLAY, can be a very useful help in programme testing. By means of it the programme stored in the machine can be punched out in binary form, instruction by instruction, in flow diagram order. The punching continues as long as the key is held down. Programme display must be used with Key 7 in the augmented stop position. The yellow lamp above this key is lit while the key is down. Further details of the use of programme display will be found at the end of this note.

Key 6, RELEASE must be depressed during programme display whenever the red lamp above Key 7 is lit - see below.

Key 7, the stop key. The effect of this key in the NORMAL position is to allow the programme to run naturally at the normal speed. In the STOP position it causes every instruction to be interpreted as a stopper. AUG. STOP has the same effect as STOP, with the additional feature that "genuine" stoppers - that is, instructions stored without a go-digit - are distinguished - see below.

Key 8 is the SINGLE SHOT key. Pressed once it will cause a stopped instruction held in TS COUNT to be obeyed. Therefore, if Key 7 is NORMAL, it will allow the programme to proceed to the next stopper. If Key 7 is on STOP, it will allow the instruction in TS COUNT to be obeyed, and the next instruction to be taken in.

In AUG. STOP the same applies unless the instruction in TS COUNT happens to be a "genuine" stopper, when single shots will be ineffective. To pass a genuine stopper it is necessary to depress the RELEASE Key, No.6, and then give a single shot. Key 8 in the up position will give a rapid series of single shots - about 10 per second - which can be heard as clicks. The programme runs at about 1/400 normal speed in this condition. The telephone dial is used to give an exact number of single shots. Note that dialling 2, 7 gives 2 + 7 = 9, not 27 single shots, and that dialling 0 gives 10 single shots.

Key 9 may be used to CLEAR STORE (that is, the mercury stores - it has no effect on the magnetic drum). As this function is also performed by the initial input key on the Hollerith reader, Key 9 is rarely used - ordinarily only to clear store after the buzzer has sounded for a programming failure, or when a programme has settled into a loop.

Row (ii) contains four keys, three of them with indication lamps. The first two are concerned with the reader. The yellow lamp above Key 1 is lit when the programme is calling for the read - that is to say, during "initial input" and during the currency of a 12 - 24 instruction. The key enables a call to be made or cancelled.

"Single shots" on Key 2 cause the cards in the reader to be read one at a time instead of continuously. Key 3 and its yellow lamp are associated with the punch. The lamp is lit when the punch is called (that is, while a 10 - 24 instruction is effective); the key can be used to stop or start the punch. The red lamp above Key 4 is lit when the alarm buzzer sounds. The sound can be switched off by pushing the key up. The light can also be cleared if the key is pressed down; but if the programme is looping on the instruction 7 - 24 both light and sound will come on again, and it will be necessary to clear the store (key 9) before the alarm can be cleared.

Row (iii) consists of a set of 13 lights. On these lights are displayed the NIS, Source and Destination of the instruction which is actually in the control. Note that if the machine is being operated on STOP this instruction is not obeyed until a single shot is given. To the right of these lights and under the telephone dial are three green lamps, marked respectively TCA, TCB and GO. The first two indicate whether TCA and TCB are ON, while the third indicates whether there is a GO digit in the instruction in control.

Row (iv) contains 13 keys directly underneath the lights in row (iii), and two other keys. Of these latter, that to the left, marked CH, has three positions, marked 0, 1 and 2, corresponding to these values of the Characteristic, while the other, marked EXT TREE, has two positions, ON and OFF. When this key is OFF the positions of the other keys are irrelevant. Pressing the key ON causes the NIS, Source, Destination and Characteristic set on the keys to enter TS COUNT, replacing

the corresponding parts of the instruction already held there. The external tree is normally used with the machine on stop; a single shot is needed before the instruction is obeyed. Further details on the use of the external tree will be found on page 7 of this note.

Row (v) consists of a row of 32 lamps called the output staticiser (OPS). It may be used during the course of a programme to display some result that has been calculated. Clearance is effected either automatically by the programme or manually by the key to the right. During punching the number being punched is sent to the lights, but the lights are cleared before the next row is punched.

Rows (vi) and (vii) comprise the input dynamiciser (ID), a double row of 32 lamps and keys. An instruction or number may be set on the lamps by means of the keys - note that each key can act independently of the others to turn its own lamp on or off, and that the number on the ID is that given by the lights rather than by the positions of the switches - and may be picked up during the course of a programme by the machine. The ID may be cleared by means of the key on its right.

Row (viii) consists of 32 metal switches on which a SPECIAL NUMBER may be set. The key to the right of the row, when put up (+ position) will cause this number to appear on the ID. Put down (- position) it will cause the ones-complement to appear on the ID. This facility is used, chiefly by the engineers, when it is necessary to put the same number on the ID at intervals. Note that putting the SPECIAL NUMBER switch up and down lights all the lamps on the ID.

The switches and lights at the right hand end of row (i) have not been mentioned. They give warning when the magnetic controls fall out of synchronisation or when marginal conditions occur. A red light here should be reported to the engineers.

PANEL II

The upper part of Panel II does not usually concern the operator doing production work or programme testing. It contains on and off push buttons, together with red and green indicator lamps, for the H.T., the Hollerith equipment, the fans and the heaters, and a row of 12 warning lights to indicate blown fuses. For operation all green lights should be on, and no red lights. Blown fuses should, of course, be reported to the engineers.

The lower part of Panel II contains the two monitor display tubes, each with FOCUS and BRILLIANCE controls. That on the left displays the contents of the short mercury stores - in order from the top TS13, TS14, TS15, TS16, DS19, DS20, DS21, QS17, QS18. In the case of the double stores the even minor cycle is above the odd; this applies to the quadruple stores, but there is no direct way of distinguishing, say, nos 1 and 3.

The right hand tube can display at once the entire contents of a long delay line - the particular line being selected by the rotary switch beneath the tube. The minor cycle at the top of the

display will always be an even one if an initial card is used. Minor cycle 0 may be moved to the top by means of the push button MC SLIP; this button must be pressed as many times as may be necessary for a minor cycle known to be mc 0 to reach the top of the display. Note that whenever mc 0 or a minor cycle whose number is a multiple of 4 is at the top of the display mc 0 is at the top of the quadruple store display. If an initial card is not used, the top minor cycle will still be even in the machine sense, but the programme may be treating even minor cycles as odd, and so the top minor cycle may appear to be an odd one.

The right hand tube can also display TS COUNT in a special way. It will show 32 copies of the NIS, S, D, the P_{22}-P_{25} digits (if any) and Go digit. One line of the display (that corresponding to the mc of entry into TS COUNT) will show the correct wait and timing numbers, the next line (W-1), (T-1) and so on, one less (modulo 32) each time. The line corresponding to mc 30 will have absolute wait and timing numbers; i.e. the timing number will be the minor cycle of the next instruction, and the wait number will be the number of the first minor cycle of transfer.

THE HOLLERITH READER

The control panel is illustrated in Fig. 2.

The main switch is situated beneath the control panel; the reader will not function unless this is on.

The initial input key is fitted with a spring loaded metal sleeve which prevents its being accidentally switched on. The key performs at the same time three functions:

(i) it clears the mercury store;
(ii) it runs cards from the hopper into the reader;
(iii) it "calls read" - equivalent to a programmed instruction, 12 - 24.

The key marked RUN IN, when pressed down, performs the second of these functions only. It is of use during programme testing when a new part of the data or of the programme is to be read, a CALL READ instruction already having been given by the programme or by initial input. Note that if a read is called, and then cards are placed in the hopper those cards will not be read until RUN IN had been pressed down. Similarly the SINGLE READ key is ineffective unless the cards are run in.

The lights to the right of the keys indicate the card positions occupied at any moment. Position 1 is the feed hopper, position 6 is the stacker. Positions 2 - 5 are inside the reader; it is necessary for position 3 to be occupied before a CALL READ is effective - this is the point of running in.

The reader may be stopped at any time by pushing the RUN IN key up to the position marked STOP.

Cards left inside the reader after it has been stopped can be extracted by pressing the RUN OUT key. There is no need to hold the RUN OUT key down - once started, all the cards in the reader will be run out unless the RUN IN key is raised to the STOP position.

An ordinary CLEAR READ instruction or a P_{54}, besides stopping the reader, also clears positions 4 and 5 so that a RUN OUT is not necessary in normal conditions.

The lamps to the left of the keys are well labelled and need little explanation.

The yellow lamp marked CALLED is lit at the same time as the yellow lamp above the READ key on the DEUCE console. The green lamp marked READY is lit when a card is in position 3, but it is then put out if the RUN IN key is pressed to STOP. The red lamp marked NOT READY is lit when DEUCE is in some state which makes reading impossible - for instance, if the EXT. TREE or CONT. T.T. switches were down. These two lights can be on simultaneously.

The red light marked MISSED CARD is a failure warning. This mis-read may be due to either bad cards or a machine fault. When it occurs the top card in the stacker has been missed. The light is cleared by pressing the RUN IN key up to STOP.

THE HOLLERITH PUNCH

The control panel is illustrated in Fig. 3.

The main switch is situated to the right of the control panel; the punch will not function unless this is on.

The green lamp marked CALLED is lit at the same time as the yellow light above the PUNCH key on the DEUCE console, and indicates whether a "10 - 24" instruction is in force. Below it is a yellow lamp, which indicates whether the punch has been run in. If this lamp is not lit, it is necessary to press the RUN IN key.

After the punch has been running, and has been stopped either by the programme or by means of the STOP key or the PUNCH key on the DEUCE panel, the two cards last punched remain inside the punch. They are extracted by means of the RUN OUT key. Do not hold the RUN OUT key down; just a flick is sufficient.

To the right of the control panel, and round the corner, is a set of rotary switches arranged in two columns.

The column to the right contains eight switches; an eight digit decimal number can be set on these, and this number will be punched onto every card that passes through the punch, except the two cards involved in "running-in". The number is punched in (Hollerith) columns 5 to 12. Note that a switch in position 0 punches a hole in the 0-row; for a column to be left blank it is necessary to turn the appropriate switch OFF.

The left hand column is used to number serially the output cards. The setting key beneath the rotary switches sets those switches to zero; the first card will then be numbered zero in columns 13 - 16. The switches can be set individually so that numbering can start at any point; note that the number on the switches is that which will be punched next, not that which has just been punched; note also that the switches cannot be turned backwards, and each of the three lowest causes a "carry" to the one above when it passes the zero mark - it is therefore wise to begin the setting from the bottom if this is necessary.

If the OFF key is left down the left hand switches continue to count, but nothing is punched in columns 5 - 16. If the RESET key is pressed down and held, the four counting switches return to 0000. This switch should be raised before any more punching takes place.

NORMAL OPERATION

It may be assumed that the DEUCE has passed its routine morning tests and has been left on by the engineers. The first thing for the operator is to see that there are no red lights showing. The red light above the STOP may be lit; it can be put out by pressing RELEASE. The four green lamps in the upper part of panel II must be lit.

Suppose now it is required to do a straight forward "production job" - that is to say, to put a standard programme into the machine and and wait for the answers.

The following procedure is recommended:-

(i) Check the red and green lights as above.

(ii) Clear the ID and OPS.

(iii) See that all the keys in the top row are in the horizontal position, except the stop key, which should be up in the position marked NORMAL. The keys in the second row should be horizontal, and also those marked EXT TREE, CLEAR OPS, CLEAR ID and SPECIAL NUMBER. (It is not necessary to clear the individual ID keys, or those of the external tree).

(iv) Load the punch hopper with the correct cards, if this has not been done already, and RUN IN, and see that the yellow light comes on. Note that the cards are placed in the hopper face down, Y-row entering first.

(v) Set the card numbering switches.

(vi) Place the programme and data cards in the reader hopper, face inwards, Y-row down. This operation needs care - the cards should be as neatly stacked as possible, as the reader is very sensitive to badly fed cards.

(vii) Press the initial input key.

(viii) When the required results have been punched, and the punch has stopped, RUN OUT, and remove the result cards from the punch stacker. (The first two should be blank - these are the cards involved in "running-in".)

This routine can be followed with many programmes; but there are several which require special operation instructions. Therefore the operating instructions given with each programme should be consulted, and appropriate modifications made to the basic routine outlined above.

USE OF THE EXTERNAL TREE

When the EXT. TREE key is down, the machine takes the N.I.S., source and destination of the instruction to be obeyed from the 13 external tree keys, and the characteristic is taken from the characteristic 0, 1, 2 key. The wait and timing numbers and the go digit are those already in T.S. Count. (Normally EXT. TREE will be used with the stop key at STOP.) On receiving a single-shot the machine obeys the instruction thus formed and proceeds to the next instruction as specified by N.I.S. and timing numbers.

EXT. TREE may be used with CONT. T.T. instead of using a single-shot. When both these keys are down the instruction set on the source and destination keys of the external tree is obeyed continuously, and the instruction in T.S. Count is not affected. For instance, if N, 0-8 is set on the external tree keys, and EXT. TREE and CONT.T.T. are depressed, the instruction on the I.D. is transferred to every minor cycle of D.L.8. If N, 11-8 had been set, the contents of D.L.11 would have been transferred to D.L.8. The CONT. T.T. key should be raised before the EXT. TREE key.

Magnetic transfers can be made with CONT. T.T. if the key is pressed down each time reading, writing, or head shifting is required. It is not sufficient to leave CONT. T.T. down and manipulate the external tree keys.

CONT. T.T. cannot be used for certain transfers. These are:-

(i) Transfers to destination 0, T.S. Count. For these transfers, set up the instruction for transfer to T.S. Count on the external tree keys and put EXT. TREE on. Now put on CONT.T.T. and then CONT. T.C.I.; take off CONT. T.C.I. and finally CONT.T.T. It is necessary to keep to this order in manipulating the keys.

(ii) Transfers to destination 24. Trigger instructions cannot be obeyed from the external tree by using CONT. T.T.; a single-shot must be used.

Any transfer can be made by using EXT. TREE and giving a single-shot. However, in a transfer to destination 0, whether using CONT. T.T. and CONT. T.C.I. or by a single-shot, the P_{16} digit is suppressed. An instruction for a double transfer will cause a single transfer; characteristic 3 becomes characteristic 1, which makes no difference except in cases where wait and timing numbers are equal.

EXT. TREE is used with both CONT. T.T. and with single-shots in the following method for punching out the contents of a delay line. It is supposed that delay line A can be overwritten (this delay line must be one of delay lines 1 to 8) and that delay line B is to be punched.

(i) Set 31 in the timing number on the I.D. and have all the other I.D. lights off.

(ii) Set 0, 0-A on the external tree (N.I.S. and characteristic do not matter), EXT. TREE on, CONT. T.T. on and then off. This puts 0, 0-0, 0, 31X in all minor cycles of delay line A.

(iii) Set A, B-29 on the external tree, characteristic 0, EXT. TREE on. The stop key can be at STOP or at NORMAL.

(iv) Clear O.S. Run in the punch (if not already done) and press down PUNCH. When at least three cards have run through, press STOP on the punch and lift up the PUNCH switch on the DEUCE panel.

(v) By changing the external tree keys to A, B'- 29 delay line B' can now be punched by going back to (iv).

This is a quick method of punching out a delay line, but the user may have some difficulty in finding which of the instructions punched out was in minor cycle zero. It may be possible to get round this difficulty in the way described in the two paragraphs following, but R.A.E. 145 - programme testing aid - should be used if any quantity of data is to be punched out, since the information is then punched out in the correct minor cycles.

It may be possible to line up the monitor by identifying some instruction and pressing the M.C. SLIP button until this appears in the correct row. It is often easy to identify 0, 13-0, 0, 0 in 1_{28}: or, when the programme is running, the links in 1_{30} and 1_{31} will change frequently. If all else fails, stop the reader after reading in the initial card and look at T.S. Count display; press the M.C. SLIP button until the top row is blank.

When the monitor has been lined up, the following addition to the method given above will punch out the delay line starting from minor cycle 28. The last eight rows of the first card and the two following cards will therefore have minor cycles 0 - 31. After (iii) should be inserted:-

(iii,a) Look at T.S. Count display (right hand monitor tube). Give single-shots until the instruction in the top row is 0, 0-0, 26, 25X. Clear output staticiser, or the top row of the first card will carry rubbish.

Then proceed to (iv).

When running in R.A.E. 145 it is necessary to have a zero word in T.S. Connt. The common method is to clear the I.D. and put all the 13 external tree keys and the characteristic level, so that it reads 0, 0-0, characteristic 1. Put EXT. TREE on and give a single-shot. Put EXT. TREE off and stop key to NORMAL - it is only too easy to forget to do this.

During the testing of a programme it may be found necessary to inspect the contents of certain tracks of the drum. If the programme is stopped (either with the STOP key or by a "stopper" instruction) this can be done without touching the instruction in T.S. Count, so that the programme can be continued after the inspection has been made.

Make a note of the position of the reading heads and of the writing heads. (It is better to stop the programme in a place where you know what these are). Write D.L. 11 on to track 15/13 (say) as follows:-

0, 15-31, characteristic 1, EXT. TREE on, CONT T.T. on and off.
0, 13 30 (characteristic 1, EXT. TREE on, as before), CONT T.T. on and off.

Now track a/b can be brought down to D.L. 11 and inspected:-

0, a-31, characteristic 0, (EXT. TREE on) CONT. T.T. on and off.
0, b-30, (characteristic 0, EXT. TREE on), CONT. T.T. on and off.

This can be done for several tracks of the drum. After the inspection is finished, the contents of D.L.11 are restored by:-

0, 15-31, characteristic 0, (EXT. TREE on), CONT. T.T. on and off.
0, 13-30, (characteristic 0, EXT. TREE on), CONT. T.T. on and off.

Then 0, x-31, (characteristic 0, EXT. TREE on), CONT. T.T. on and off;
0, y-31, characteristic 1, (EXT. TREE on), CONT. T.T. on and off,
where x and y are the reading and writing head positions when the programme was stopped.

Lastly EXT. TREE off, and restart the programme by raising the stop key or by giving a single-shot, depending on how the programme was stopped. It should be noticed that during the inspection of the drum no single-shots were given; if they had been, it would not be possible to restart the programme since the order in T.S. Count would have changed.

PROGRAMME SURGERY

An article under this title will be found in DEUCE News 2 of August 1955. It contains methods for stopping the programme, performing various operations such as altering an instruction, and re-entering the programme. It is rather easy to make a mistake while carrying out these instructions, and it is certainly very slow. Generally it will be better to alter the programme cards, if only to keep a record of the change made. These methods are therefore not recommended.

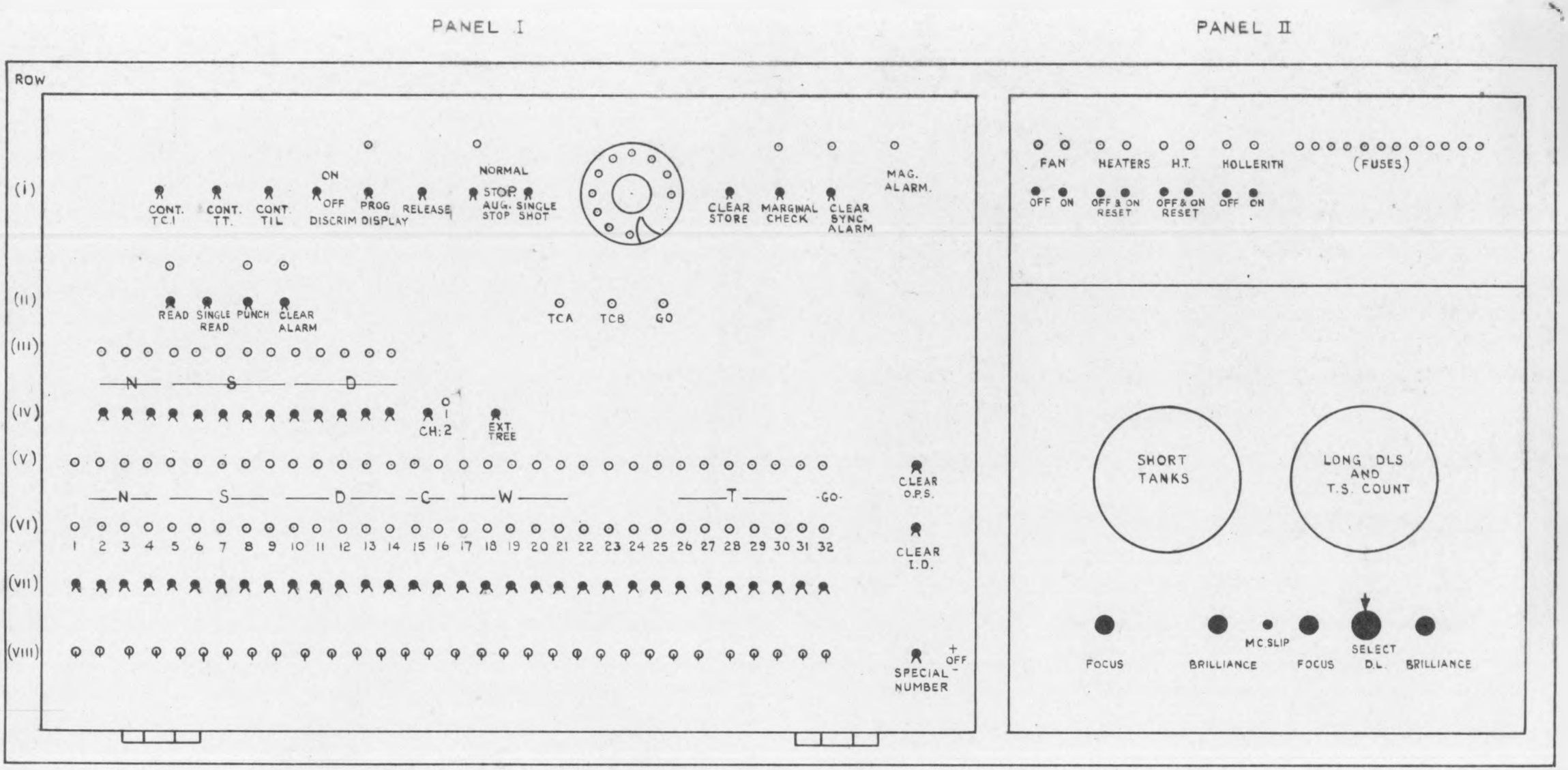
PROGRAMME DISPLAY

When the stop key is at AUG. STOP the only difference from the ordinary STOP occurs when the instruction in T.S. Count does not have a go digit. When on AUG. STOP the red light above the stop key is lit and single-shots are ineffective. It is necessary to press the RELEASE key to clear the light and carry on.

Programme display is used with the stop key at AUG. STOP. When PROG. DISPLAY is pressed the punch is called. Each instruction is punched as it enters T.S. Count; that is, before it is obeyed. When the programme reaches a "stopped" instruction this instruction will be punched; then the punch is cleared and the red light appears. Press RELEASE and carry on, either by pressing PROG. DISPLAY again or by going back to normal.

The time between successive single-shots supplied by the punch may be shorter than the time of the interlock if a magnetic head shift instruction is followed immediately by another magnetic instruction. In this case a blank row will appear with more instructions following it. (At present the second magnetic instruction is superimposed on the following row.)

Since the orders punched by PROG. DISPLAY are normally on data cards, it is useful to have a programme card with all holes in the Deuce field punched. When this is put on top of a card produced by PROG. DISPLAY it is easier to read the orders punched out.



THE DEUCE CONSOLE FIG I

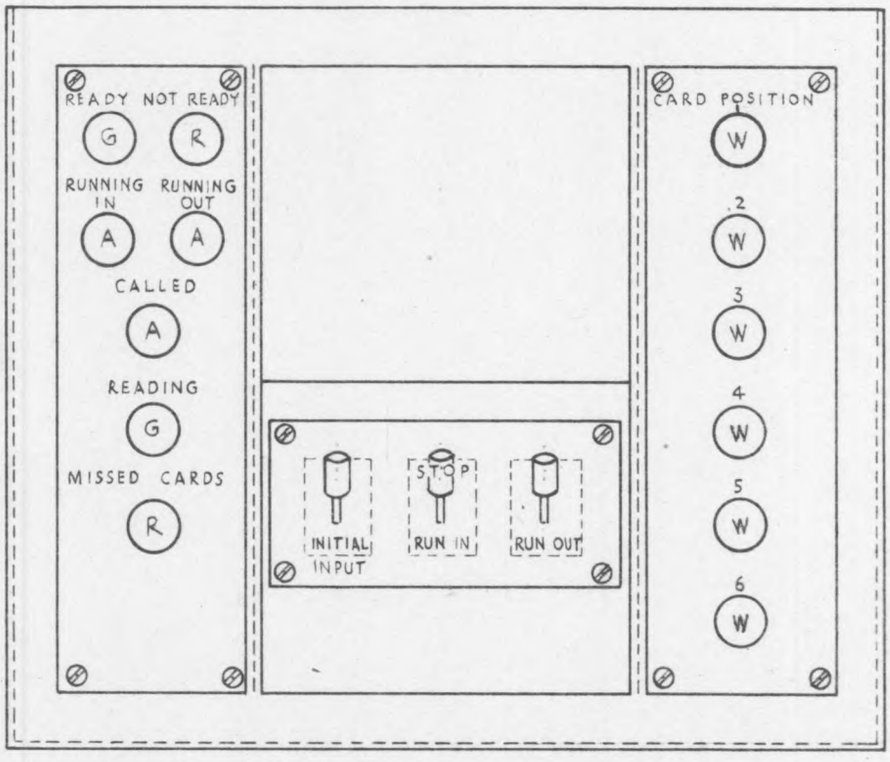


FIG 2

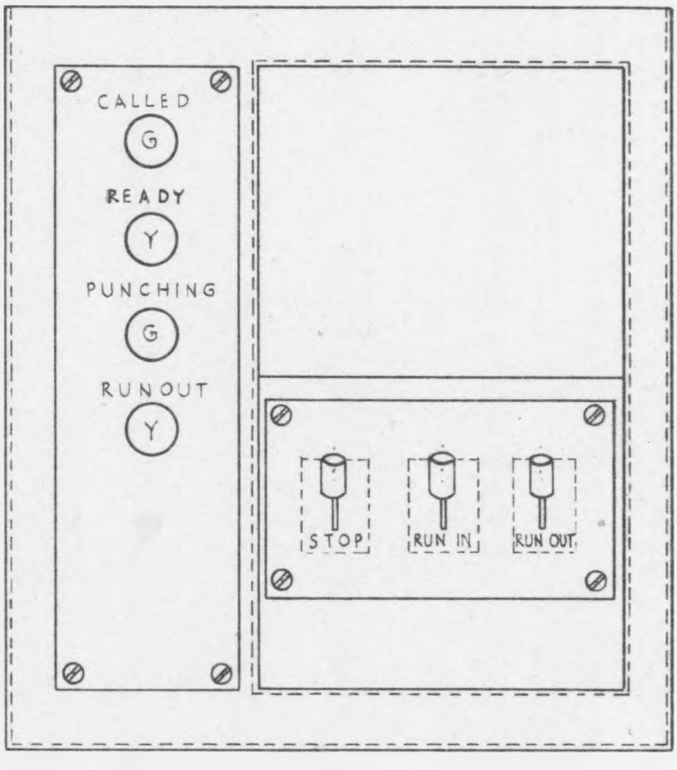


FIG. 3

LAMP AND KEY PANELS
HOLLERITH PUNCH & READER