THE PEGASUS COMPUTER

VOLUME 4

INSTALLATION AND MAINTENANCE

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SUMMARY

This volume is concerned with the installation and maintenance of a Ferranti Pegasus Computer Installation. The sizes, weights and power requirements of a typical installation are given, and a suggested layout drawing is included. The duties of the maintenance engineer are described under the chapter headings of Routine, Repairs, and Record Keeping.

The volume also contains a suggested Preventive Maintenance scheme, an Elementary Fault Guide, and instructions for setting-up adjustments.

Instructions are given for:-

Writing a Clock Track.

Copying a Clock Track.

Writing an Address Track.

Copying an Address Track.

Writing into the isolated store.

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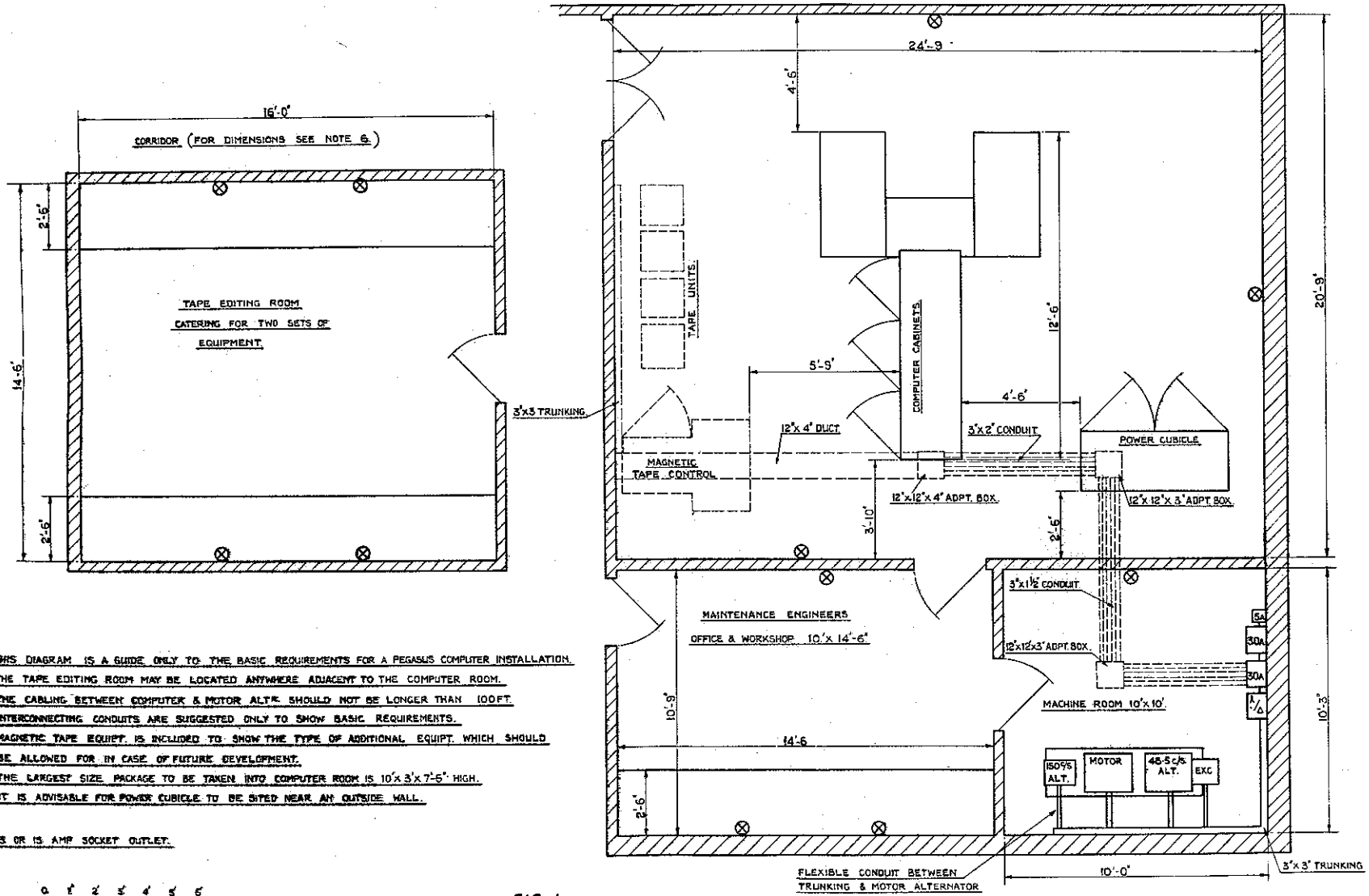


NOTES:-

1. THIS DIAGRAM IS A GUIDE ONLY TO THE BASIC REQUIREMENTS FOR A PEGASUS COMPUTER INSTALLATION.
2. THE TAPE EDITING ROOM MAY BE LOCATED ANYWHERE ADJACENT TO THE COMPUTER ROOM.
3. THE CABLING BETWEEN COMPUTER & MOTOR ALT'R. SHOULD NOT BE LONGER THAN 100FT.
4. INTERCONNECTING CONDUITS ARE SUGGESTED ONLY TO SHOW BASIC REQUIREMENTS.
5. MAGNETIC TAPE EQUIPT. IS INCLUDED TO SHOW THE TYPE OF ADDITIONAL EQUIPT. WHICH SHOULD BE ALLOWED FOR IN CASE OF FUTURE DEVELOPMENT.
6. THE LARGEST SIZE PACKAGE TO BE TAKEN INTO COMPUTER ROOM IS 10'x 3'x 7'-5" HIGH.
7. IT IS ADVISABLE FOR POWER CUBICLE TO BE SITED NEAR AN OUTSIDE WALL.

⊗ 13 OR 15 AMP SOCKET OUTLET.

SCALE:- 0 1' 2' 3' 4' 5' 6'

FIG. 1.

TYPICAL LAYOUT FOR A PEGASUS (F.P.C.I.) COMPUTER.

CHAPTER 1

INSTALLATION

1.1 General

A typical layout for a Pegasus computer is shown on Fig.1: this layout is one of a number of suitable arrangements and is included for guidance only. The installation is carried out under the supervision of Ferranti installation engineers who are experienced in this work. The installation engineers should be consulted if any alteration to an existing installation should be required.

1.2 Power Requirements

18.5 KVA. Power Factor 0.86

Normal voltage 240/415 volts 3 phase 50 c.p.s.

Maximum voltage variation ± 15%.

Maximum Frequency variation. Not greater than ± 2%.

1.3 Heat Dissipation

Computer	7 KW
Power Supply Cubicle	5 KW
Motor Alternator Set	3 KW

1.4 Dimensions

Computer	96″ x 28″ x 83″ high. 244 x 68.6 x 211 cm.
Control Desk	99″ x 54″ x 30″ high. 251.6 x 137 x 33 cm.
Power Supply Cubicle	68″ x 28″ x 82″ high. 172.8 x 71 x 208 cm.
Motor Alternator Set	79″ x 22¼″ x 27″ high. 200.7 x 56.6 x 68.6 cm.

1.5 Weights

3 Bay Cabinet and Centre Desk (Complete with racks, back plates, cables, back-wiring, etc., but minus packages, drum and monitor)	1687 lbs	766 Kg.

Magnetic Drum	150 lbs	68.1 Kg.
Packages	400 lbs	181.5 Kg.
Monitor	84 lbs	38.2 Kg.
Input/output Desks	308 lbs	139.7 Kg.
	2629 lbs	1193.5 Kg.
Input/Output Equipment		
High speed Tape Reader (2 per equipment)	37 lbs	16.8 Kg.
No. 25 Reperforator	33 lbs	15.0 Kg.
Auto Transmitter 65/5M	26 lbs	11.8 Kg.
Teleprinter Receiver 54R	97 lbs	44.1 Kg.
Tape Spooler (optional)	23 lbs	10.42 Kg
Tape Editing Equipment		
Keyboard Reperforator 7P/N4	48 lbs	21.8 Kg.
Page Teleprinter 54/N4	122 lbs	55.4 Kg.
Auto Transmitter 65/5M	26 lbs	11.8 Kg.
3 Ganged Multiple Transmitter 71D	40 lbs	18.2 Kg.
Reproducer & Comparator Connecting Unit S3909	54 lbs	24.55 Kg
Rectifier Set (50 & 130V) 22LFEI324A	35 lbs	15.8 Kg.
Rectifier Set (80-0-80) 246/LV36478	26 lbs	11.8 Kg.
Power Supply Cubicle	1778 lbs	808 Kg.
Motor Alternator Set	1610 lbs	732 Kg.
Star - Delta Starter	64 lbs	29 Kg.

CHAPTER 2

ROUTINE

2.1 General

2.1.1 Marginal Testing

It has been found that circuits containing components that are deteriorating are more likely to fail when operated at reduced voltages than when working under normal conditions.

Marginal testing is used, therefore, to detect incipient faults in the computer, enabling the engineer to locate and subsequently replace deteriorating components before they cause a failure of the computer during normal operation.

The marginal tests are applied, during the daily routine testing and maintenance period, by reducing the voltage of the three H.T. lines, +300 V, +200 V, and -150 V, in turn, and running test programmes 0 - 16, i.e., functional, stores, and drum tests.

+300 V supply

The computer should operate satisfactorily with the +300 V line reduced by at least 15% in test programmes 0 - 16.

+200 V supply

Computers using Type 19 packages that have been modified to F.M.I. 17 should operate satisfactorily with the +200 V line reduced by at least 15% in test programmes 0 - 16.

-150 V supply

Satisfactory operation should be obtained in test programmes 0 - 16 with reductions of at least 15% in the value of the -150 V supply.

Tape Readers

The tape reader test, T.P. 17 - 18, may be run on margins using a loop of tape, punched 0 - 31 in normal teleprinter code, in each tape reader. T.P. 17 causes tape reader 'A' and then tape reader 'B' to read the tape at various speeds. T.P. 18 tests the external conditioning switching by comparing the outputs of tape reader 'A' and tape reader 'B'.

Several other tests are available for the tape reader; for particulars of these tests see 5.2.6.

The tape reader tests should be satisfactory at margins of at least 15%.

2.1.2 Punch Resonance Test

The punch resonance test tape causes the punch to operate at different speeds ranging from the full speed of 33 characters per second

CREED MODEL 25 TAPE PUNCH

Punch Resonance Test

Speed Table

Warning Character	Speed - inch/sec	
	Actual	Theoretical
220	33.0	34.1
224	32.9	33.4
228	32.8	32.9
232	32.7	32.4
236	32.5	31.8
240	32.2	31.3
244	31.6	30.9
248	31.0	30.4
252	29.8	29.9
256	29.5	29.5
260	29.0	29.1
292	25.7	26.0
324	23.4	23.6
356	21.8	21.6
388	20.3	19.8
420	18.6	18.4
452	17.3	17.1
484	16.3	16.0
516	15.5	15.1
548	14.8	14.2

down to about 15 characters per second, the moving parts of the punch are resonant within this range of speeds and may cause errors in punching. The resulting punched tape can be read into the computer and compared with a checking programme which has been read in from the punch resonance test tape. Errors in punching cause the computer to stop: the speed at which the punch failed can be ascertained from the punch resonance test speed table.

The punch resonance test should be conducted under normal voltage conditions.

2.1.3 Simple Punch Test

Test programme 19 causes the punch to produce a tape punched continuously in a regular pattern which may be checked visually or by comparison with a master tape in a comparator. This test should be run under normal voltage conditions.

Test programme 19 should be run occasionally with marginal reductions on the +300 V line in order to check the operation of the clutch and selector coils and the type 10 packages. The punch selection staticisers may be checked by running the test with marginal reductions on the +200 V line.

2.1.4 Preventive Maintenance

At the commencement of the daily routine testing and maintenance period, after it has been established that the computer is operating satisfactorily, a number of packages should be removed from the computer and replaced by tested spares. Whilst the computer is in the hands of the operators, all components on the packages which have been removed should be tested and the readings obtained checked against a schedule of test limits. Any component outside these limits should be replaced. Repaired packages can be checked in the computer. See 'Computer Testing of Spare Packages' 5.4.

The preventive maintenance programme should be arranged so as to cycle the computer once every six months, which entails testing four packages each working day.

2.2 Daily Routine

Many of the tasks in the daily routine could be performed by an assistant having no detailed knowledge of the computer but trained only in these tasks.

Although some faults, e.g., Computing store parity failure, could be traced by someone with only an elementary knowledge of the computer, the diagnosis of more subtle faults would require the assistance of an engineer with a detailed knowledge of the computer logic.

2.2.1 The computer should be switched on by the maintenance engineer at the beginning of each working period. The switching-on procedure is detailed in Vol. 1, Chapter 2, paragraph 23.

2.2.2 The engineer's test programmes should then be run at normal voltages, that is, off margins, in order to check that the computer is functioning correctly. If a fault is indicated at this stage it should be corrected before proceeding further.

2.2.3 The packages scheduled for specification checks in the preventive maintenance schedule should be removed from the computer and replaced by serviceable spares.

The use of the suggested programme of package specification checking given in Appendix IX will ensure that the whole of the computer packages will be tested within six months. This is within the life span of the valves used in the packages, assuming normal operation of the computer.

It is useful to keep a record of the progress of preventive maintenance on packages by noting the type of package and its reference number together with the date of testing.

2.2.4 The packages that were removed during the previous maintenance period for specification checks should be replaced in their original positions in the computer.

2.2.5 Marginal testing should be carried out by running the engineer's test programmes at reduced H.T. voltages. Any package which is unsatisfactory when the +300 volt, +200 volt and -150 volt H.T. voltages are reduced by 15%, should be replaced by a serviceable spare. Satisfactory operation is normally maintained with reductions of 20% in the value of these three H.T. voltages.

2.2.6 The tests and adjustments detailed in the weekly and monthly routines that require an operating computer for their performance may be carried out, if required, at this stage.

2.2.7 The computer should then be handed over to the operators.

2.2.8 Data obtained from the daily routine tests should be entered in the log books.

2.2.9 Specification checks should be made on the packages removed in the preventive maintenance schedule and in marginal testing.

2.2.10 Data obtained from 2.2.9 should be recorded in the appropriate log-books.

2.3 Weekly Routine

The reperforator should be lubricated weekly as detailed in "After each 40 hours of operation" T.I.S. No.47, Addendum to Creed Instruction Booklet No. 25.

If the reperforator is in use for a substantially different total time from 40 hours during the week, it should be lubricated when appropriate.

After 60 hours' operation

Maintenance should be carried out on the Auto Transmitter 6S/5 and the Combined Teleprinter Keyboard Perforator and Automatic Transmitter 67 P/N. See Creed Instruction Booklets Nos. 33 and 67 N.

2.4 Monthly Routine

It is convenient to divide the monthly routine tasks into four groups and spread the work over four weeks, as follows:-

1st Week

2.4.1 Check computer stops (See Chapter 4).

2.4.2 Take readings of all meters in the power cubicle and record the readings in the appropriate log book.

2.4.3 Check the insulation resistance of the alternators and the motor. Where these machines are installed in ideal conditions, it is sufficient to make this test at intervals of six months. See 2.5.1.

The insulation resistance of the alternators should be greater than:-

Rated voltage x 10 − (1000 + rated K.V.A. output) megohms.

The insulation resistance of the motor should be greater than:-

Rated voltage x 10 − (1000 + KW.) megohms.

2.4.4 Inspect the brushes on the alternators and exciter; the brush spring pressure should be adjusted, if necessary, to the correct value.

Worn brushes should be replaced by new ones of the correct grade. All the brushes on a machine must have equal pressure. Brushes should slide easily and smoothly in their holders. Insulation, sliprings, commutators and brushgear must be kept clean and free from carbon dust, oil and moisture.

		Brush Grade	Brush Pressure
ACK10G4 AG20K6	Alternator	EG0	32 oz. [910 gm.]
C5G	Exciter	EG12	11 oz. [310 gm.]
AG20J6	Alternator	EG98	38 oz. [1080 gm.]
C8G C8W	Exciter	C2T	19 oz. [540 gm.]
BKB	Drum Alternator	SB5	4 oz. [120 gm.]

For general maintenance of the Motor Alternator set, see Chapter 6.

2.4.5 The relay contacts should be cleaned with a piece of thin card soaked in recommended contact cleaning fluid. Accumulated dust should be removed periodically; a blast of clean, dry, low pressure air is most suitable for this purpose.

2.4.6 Examine the air filters and change them if necessary.

2.4.7 Refrigerated Computers

Check the oil level in the crankcase

It will be necessary to remove the soundproofed covers of the compressor to make this inspection. Check the oil level immediately after the compressor has stopped and while it is hot. As it cools off Arcton Refrigerant is absorbed by the oil which increases its volume and may give a false reading. The oil level must not be allowed to fall below the bottom of the sight glass. Special refrigeration oil should be used when adding to the machine, suitable oils being Regent Capella 'D' or Shell Clavus 27 or 33.

Refrigeration equipment employing an evaporative condenser requires a water supply to make up for evaporation losses. In situations where the make-up water is hard or contains mineral impurities, it is

necessary either to empty the tank at suitable intervals, or to arrange a continuous bleed off of water, otherwise the concentration of impurities in the water will cause deposits on the surface of the coils which may be difficult to remove.

If the acid content of the water supply is high enough to make corrosion likely, a water treatment chemical such as "Qualgie" should be used.

When the condenser is installed in the open air and the atmospheric temperature is liable to drop below freezing point, it is necessary to take precautions against freezing the water in the pump and pipe connections when the equipment is not in use, by draining off the water.

For more detailed information on the refrigeration equipment reference should be made to the booklet supplied by the manufacturers.

2nd Week

2.4.8 Check drum track amplitudes. (Both isolated and non-isolated store.)

Non-isolated store

Drum test 3 may be used for the part of this test concerned with the non-isolated section of the drum. This programme writes a pattern on all non-isolated tracks. A pattern is written eight times on all blocks which are then read back and checked. A different pattern is then written once on alternate blocks, which should overwrite the previous pattern completely. The programme then reads back until it is stopped.

Isolated store

The patterns existing on the tracks in the isolated store are satisfactory for the purpose of checking drum track amplitudes.

Even tracks:

The output of even tracks may be monitored at the read amplifier, package 28, socket X.1.

Odd tracks:

The output of odd tracks may be monitored at the read amplifier, package 29, socket X.1.

To measure track amplitudes

(i) Connect a shunt load, consisting of a 0.05 μf capacitor in series with a 1 KΩ resistor, between the low level output socket (X.1.) of the appropriate read amplifier and earth.

(ii) Select the desired track by means of a manual 72 order, reading into Block 6 of the computing store. (This is a non existent block.)

(iii) Monitor, with an oscilloscope, the voltage developed across the shunt load for each track in turn. The oscilloscope should be triggered from 13 R4 with the monitor trigger switch set to 'Drum Trigger' and the oscilloscope adjusted to show one complete drum revolution.

Maximum and minimum amplitude readings should be taken of each track. The maximum amplitude is the maximum envelope amplitude. The minimum amplitude is the amplitude of the 'free path' of a track, this can be seen clearly on a slow time base. These voltages should be of the order of 2 volts and 1 volt respectively.

Close attention should be given to the detection of pin holes and other defects of the drum surface which are indicated by an appreciable decrease in the minimum amplitude readings. By adjustment of the 'Drum Trigger' switches the oscilloscope minimum amplitude display may be moved to the end of the trace, where it may be examined on a faster time base thus facilitating the examination of the track for defects.

Tabulation

The 80 readings obtained should be tabulated in such a way that succeeding sets of readings may be easily compared with them. A 4-page scheme of even/maximums, even/minimums, odd/maximums, odd/minimums is a suitable form of tabulation.

It is often considered sufficient to take readings of the amplitudes of the first and last track of each block, readings of the other tracks only being taken if the former be unsatisfactory.

2.4.9 Check 'P.O.B.T.' facility

This check can be made by depressing the P.O.B.T. hand switch on the programmers' panel and running T.P.16. The punched tape produced may be read in with initial orders warning character '?' set on the hand switches. The resulting punched tape should then give a sensible print-out when fed through the interpreter unit.

2.4.10 Check the oil level in the dashpots in the Star/Delta Starter

The oil level in the dashpots should be within ½" of the top of the dashpot. The oil should be maintained at this level by the addition, when necessary, of dashpot oil No. 12/DP 1, obtainable from Allen West & Co.Ltd. Other mineral oils may not be satisfactory whilst oils of vegetable origin must not be used.

2.4.11 Check the oil level in the motorised potentiometer gearbox. Oil of SAE.20 grade should be added through the hole marked for this purpose in the top of the gear end cover. Overflow of oil through the holes provided in the gear end cover will occur when the oil reaches the required level.

The oil may require changing occasionally; the old oil can be drained by removing the gear end cover screw at the lowest point.

3rd Week

2.4.12 Check the Tape Reader lamps. The illuminated lamp may be viewed through the tinted light shield; if the filament is seen to be kinked a new lamp should be fitted. It is sometimes found desirable to fit new lamps each month. Only lamps having straight filaments should be used.

2.4.13 Clean the photocells and fan in the Tape Readers.

2.4.14 The instruction manual for Tape Reader contains instructions for the lubrication of the differential gear after 500 hours running, and for the lubrication of the bearings of the tape pressure rollers. Great care must be taken not to overlubricate the Tape Reader as oil on the brake drums is the commonest cause of malfunctioning.

4th Week

2.4.15 Check low levels. (See 3.6 for list of low level test points.)

2.4.16 Monitor nickel lines unchecked by parity.

2.4.17 Check the Creed equipment. Maintenance and lubrication instructions are given in the Creed instruction booklets I.B. Nos.25, 33, 47K, 54, 67N, 71, R/5; and amendments T.I.S.47, T.I.S.54 and etcetera. These instructions are concerned with adjustments and lubrication recommended after specified periods of running.

Particular attention should be given to the condition of motor

brushes. Brushes shorter than 0.25" should be replaced by new ones of the correct grade.

2.5 After 6 months' operation

Check the insulation resistance of the alternators and the motor.

The insulation resistance of the alternators should be greater than:-

Rated voltage x 10 ÷ (1000 + rated K.V.A. output) megohms.

The insulation resistance of the motor should be greater than:-

Rated voltage x 10 ÷ (1000 + K.W. or B.H.P.) megohms.

Lubrication of the Motor Alternator bearings, (See 6.13.3.)

2.6 After 1 year's operation

It is recommended that the bearings in the Teleprinter Auto-Transmitter 6S/5 should be removed, cleaned and repacked with grease after one year's operation, or more frequently if they become noisy. See Creed instruction book I.B.33.

2.7 After 2 years' operation

The bearings in the Motor Alternator should be removed, cleaned and repacked with grease. See 6.13.4.

CHAPTER 3

ELEMENTARY FAULT GUIDE

3.1 General

Fault finding

First it should be confirmed that there is a fault; an operator may complain that the computer is faulty when the programme or the method of operating the computer is in error. If the computer is found to be at fault the particular operational function in which the fault lies should be determined. This can usually be done by using the monitoring facilities, the logical diagram and the engineers' test programmes. If the test programmes are run and the computer is found to fail in some part of a programme, examine U5 for non-identity as described in 4.3.2. Determine functions that are incorrect from the first non-identity. Then cycle T.P. and using O.N. triggering ascertain the first instruction not correctly obeyed in the relevant group. The failing order can then be investigated using either beat trigger operation or continuous manual operation of the same function if that is possible.

Fault finding must be systematic, it is a waste of time and effort to make adjustments and change components without reason. Such action can only result in confusion. Experienced engineers may locate a fault almost immediately, apparently without deliberation but it is certain that they have, perhaps almost unconsciously, considered all the possible faults and chosen for investigation the most likely of them.

The fault finding procedures given in this chapter are intended to help the maintenance engineer to locate certain faults. It is impossible to cover every contingency in a book of this size but the procedures described may serve as an example of the approach most likely to lead to quick identification of the faulty component.

Section 3.2 describes, in stages, the correct operating sequence of the power supply unit from the closing of the main isolator switch to the operation of the 'H.T.On' button. Section 3.3 deals with each of these stages, describing the operation of the circuits concerned and indicating the tests to be made in the case of a fault in these circuits.

In section 3.4 a method of tracing computing store parity failure

faults is described. The methods of diagnosing this type of fault, where the logical design of the computer is involved, are quite different from the methods described in section 3.3 where the circuits are of the simple switching type.

Drum parity failures are dealt with similarly in section 3.5.

3.2 Power Supply Switching on Sequence

3.2.1 It is assumed that the main supply is available at the input to the power cubicle.

3.2.2 Main Isolator

When the isolator switch on the power cubicle is moved to the 'On' position the 'A.C. supply' indicator on the power cubicle and the 'Mains' indicator on the computer monitor panel should light.

3.2.3 Motor Alternator

Depression of the 'Start M/A' button on the engineer's panel should cause the ignition, after a delay of several seconds, of the 'Alternator Running', 'Alt.' and 'M/A On' indicators on the power cubicle, computer monitor panel and engineers' panel respectively.

3.2.4 Bias

The 'Bias' switch in the power cubicle is normally left in the 'On' position. When this switch is in the 'Off' position the H.T. and Bias supplies cannot be switched on and the field of the 150 c.p.s. alternator cannot be energised.

3.2.5 Heaters On

This step in the sequence cannot be initiated until the 'Start Heaters' lamp on the engineers' panel is alight. This lamp should light within two minutes of the operation of the 'Start M/A' button.

Depressing the 'Heaters On' button should start the fans on the computer and should also initiate the excitation of the alternators. The main alternator output voltage should increase gradually up to 415 volts at which level it should be stabilised. At this stage the drum motor should start and a thermal delay of 90 seconds be brought into operation. After the specified delay, the 'Heaters On' and 'Heaters' lamps should light. At about the same time, the drum should reach its correct operating speed, and the 'Drum' lamp on the monitor should light.

3.2.6 H.T. On

Depressing the 'H.T. On' button should cause H.T. voltages to be applied to the computer. 'H.T. On' indicating lamps on the engineers' panel, monitor panel and power cubicle should then light.

3.3 Power Supply and Protective Circuitry. Elementary Fault Diagnosis

3.3.1 The following drawings are referred to in the text:-

Figs. 2/11 Vol. 3A Sheets 1, 2 and 3. General Circuit diagram of Power Supply Equipment.

Fig. 2/16 Vol. 3A. Power Supply and Protective Circuit.

Fig. 2/1 Vol. 3A. Type 'S.C.D.2.' Star-Delta Starter.

Fig. 2/5 Vol. 3A. Control Amplifier Circuit Diagram.

3.3.2 Main Isolator

If the operation of the isolator does not produce the desired results make the following tests:

(i) Check that the mains voltage is available at the cubicle by monitoring with the meter.

(ii) If the mains voltage is present, check fuses F1, F2, F6, F8, and the appropriate indicator lamps.

(iii) If the mains voltage is not present, check the meter fuses F3, F4, F5. If these fuses are whole, check that the main input breaker and the isolator on the star-delta starter are made. If these tests are satisfactory, check the main input fuses, after opening the main breaker.

The action of switching on the isolator applies phase B.C. (415V. 50 c.p.s.) across the primary of the auto-transformer TR.2. (See Fig. 2/11 Vol. 3A.) The secondary voltage is applied to TR.7 causing the 'A.C. Supply' indicator on the power cubicle to light.

A control voltage of 220V.50 c.p.s. is derived from TR.2 for the protective circuitry of the computer. This voltage is applied across terminals 39 and 44 of the power cubicle and thus across A.B. and B.D. of the computer causing the 'Mains' lamp on the monitor panel to light.

The protective voltage causes energisation of RL.1, RL.3, RL.5, RL.13. (See Fig. 2/16 Vol. 3A.) These relays will not be energised in the following circumstances:

RL.1. Fan fuse blown in Bay 1

RL.3. Fan fuse blown in Bay 2

RL.5. Fan fuse blown in Bay 3

R..13. Bias or Drum H.T. fuse blown in Bay 1.

The failure of a fan fuse would be indicated by the ignition of the appropriate fan fuse neon lamp.

If a thermal trip has operated this will be indicated on the engineers' panel. Assuming that no thermal trips have operated, the 220V.50 c.p.s. control voltage is applied to R9 and BR9 causing RL.9 to be energised. (See Fig. 2/16 Vol. 3A.) The closing of RL.9 will cause the line voltage of 220V.50 c.p.s. to be applied to terminal 50 of the power supply cubicle. (See Fig. 2/11 Vol. 3A.)

The motorised potentiometer is operated by energisation of one of its two field windings. The field current to any particular winding is directed by the operation of a microswitch which is operated by a cam secured to the shaft of the motorised potentiometer assembly. The cams which operate the microswitches are circular with a cut-away portion. When the microswitch plunger is on the cut-away portion the microswitch will be unoperated. This phase of operation will be defined as 'off-normal'.

3.3.3 Start M/A (See Fig. 2/11, Fig. 2/16 and Fig. 2/1, 2/3, 2/5, Vol. 3A.)

The operation of depressing the 'Start M/A' button shorts together DE, DF on the computer and terminals 58, 59 on the power cubicle. This results in the operation of the line contactor in the star-delta starter and the application of power to the motor of the motor-alternator set. The motor is started as a star connected machine and is changed to delta connection after a period of 1½ minutes determined by a timing relay in the starter. The operation of the delta contactor closes a pair of contacts which short together terminals 39 and 40 on the power cubicle. The closing of these contacts will thus apply 220V. 50 c.p.s. across TR.6 and so light the 'Alternator Running' lamp on the power cubicle and the 'Alternator' neons on the computer monitor and engineers' panel. Terminals A3 and A4 will be shorted together when the control

amplifier is warmed up enabling the valve heaters to be switched on by the appropriate button.

3.3.4 Bias. (See Fig. 2/16, Fig. 2/11, Fig. 2/4, 2/6, Vol. 3A.)

The bias switch controls the main alternator supply to transformer TR.4. The rectified outputs from the secondary windings of TR.4 provide the bias supplies. A contact on the bias switch is in series with contact CR.4/3 thus preventing the energisation of the 150 c.p.s. alternator field when the bias is switched off.

3.3.5 Heaters On

Assuming that the 'Start Heaters' lamp is alight indicating that the motorised potentiometer is against the 'Lower' limit switch, the depression of the 'Heaters On' button operates contactor CR.1 which is held on through the contact of the external relay RL.9 and through its own contact CR.1/4.

CR.1/1, 2, 3, connect the supply to the fans and to TR.1. CR.1/6 operates the motorised potentiometer in the 'Raise' direction until it runs onto the 'Upper' limit switch, which disconnects contactor CR.3 and energises contactor CR.4.

CR.4/1, 2, changes the power input to the control amplifier and the two field regulators from the mains supply to the main alternator supply.

CR.4/4 energises the 'Heater Hour Meter' and the time delay switch.

The operation of the time delay switch closes RL.1. RL.1/2 holds the relay on and RL.1/1 disconnects the timer. RL.1/4 brings on the green 'Heaters On' indicator on the power cubicle.

RL.1/3 connects one phase of the main alternator to terminal 52 thus energising the 'Heaters Ready' lamp. CR.4/3 is in series with a contact on the bias switch and a switch on the computer desk. When these switches are closed, the D.C. supply derived from TR.1 and its associated rectifiers, is fed to the field of the 150 c.p.s. alternator.

3.3.6 Heaters Ready

When the 'Heaters Ready' lamp is illuminated the H.T. may be switched on by the appropriate button.

3.3.7 H.T. On

When the 'H.T. On' button is pressed, contactor CR.2 is energised and the H.T. hour meter commences recording.

Contact CR.2/4 holds on the contactor.

Contact CR.2/5 switches on the blue 'H.T. On' indicator lamp.

Contacts CR.2/1, 2, 3, connect the main alternator supply to transformer TR.5. The rectified output from this transformer provides the H.T. supplies.

One phase of the input to TR.5 is connected to terminal 53 which feeds the 'H.T. On' indicator lamp.

The H.T. supplies cannot be switched on unless the bias supply is switched on. (See Fig. 2/4.)

3.4 Computing Store Parity Failure Table

The following procedure should enable the engineer to locate quickly faults of this nature.

3.4.1 To determine the type of parity failure.

(1) Put switch 'B' to position "Test 2"..

(2) Put switch 'A' to position "N.O." If the level of the waveform appearing on the display is positive an N-parity failure is indicated.

(3) Put switch 'A' to position "X.7." If the waveform level is positive an X-parity failure is indicated.

(4) Check which 'Next Order' neon is ignited, 'A' or 'B'.

(5) Read the order number from the 'Order Number Register' display. Suppose the order number is m.n. Failures will have occurred during the beats as detailed in the following table.

Next Order	N-parity failure	X-parity failure
A	Case 1 Failure could have occurred during (i) B-beat of m.[n-1] (excepting in jump orders) (ii) C-beat of m.n, if on a single shot operation, or a parity failure accompanied by an optional stop.	Case 3 Failure occurred during B-beat of m.[n-1].
B	Case 2 Failure occurred during (i) C-beat of m.n. (ii) A-beat of m.n.	Case 4 Failure occurred during A-beat of m.n.

3.4.2

Case 1

(i) Monitor address m.[n-1]. Determine the function of the B-order and then the N-address involved by taking into account any modification. Suppose address is Nm, see development of Case 1 (i).

Case 1

(ii) Monitor address m.n. Determine if m.n has incorrect parity.

Case 2

(i) Monitor address m.n. Determine if m.n has incorrect parity.

Case 2

(ii) Monitor address m.n. Determine the function of the A-order and then the N-address involved by taking into account any modification. Suppose it is Nm, see development of Case 2 (ii).

Case 3

Monitor the X-address specified in the B-order of m.[n-1] and check for incorrect parity. If the X-address is correct the fault may be in the gating circuits concerned with the X-bus.

Case 4

Monitor the X-address specified in the A-order of m.n and check for incorrect parity. If the X-address is correct the fault may be in the gating circuits concerned with the X-bus.

Development of Case 1 (i) and Case 2 (ii) N-parity failures	
Functions	Failure
00 to 06 10 to 16 40 to 46 60 to 66 23, 74, 75, 76, 77	Nm -
20 to 22 24 to 26	Nm X on to N-bus
50 to 56	Nm X on to N-bus
70 to 71	Nm = Bm (Modulo 8) X1 on to N-bus
73	Nm X.0, X.1, to X.7

3.4.3 N-parity stop

Y161 is sensed at P41. Assuming the N-parity staticiser to be able to circulate, then (except during beat E) it can be set by a register giving an incorrect parity output on to the N-bus. This means that the N-parity staticiser can be set during beat D in normal length instructions, that is, during CD, AD, BD.

In multilength instructions the N-parity staticiser can be set during beats CD, D, [D+1] etcetera, K, L, where L is distinct from E.

Considering the N-decoding in order to determine the registers that give an output on to the N-bus during the relevant periods, we have:

During CD, for both normal and multilength instructions the N-decoding is set by the order number and so incorrect parity of the register corresponding to the order number will set the parity staticiser.

Normal Length Instructions. (Groups 0,1,4,6)

For normal length instructions the N-decoding is set by the N-digits of the instruction during C.D. and so failure of the relevant registers will set the parity staticiser.

Multilength Instructions

Group 2 excepting 23, Group 5, Group 7, (Instruction 70-74) Shifts (Group 5).

During C.D the N-decoding corresponds to the N-address in the shift instruction, that is, the number of shifts.

During D + 1, D + 2 etcetera to K, the N-decoding corresponds to the accumulator whose contents are being shifted.

Therefore an N-parity failure on a shift instruction indicates a faulty N-register or a fault in the gating of the X register onto the N-bus.

If the accumulator is at fault there should also be an X-parity failure.

Instructions in Group 2 (excepting 23).

During C.D the N-decoding corresponds to the N-address (multiplicand/divisor).

During [D + L], N-decoding corresponds to the X-address (multiplier/dividend).

During [D + 2], [D + 3] etcetera, K and L in a 22 instruction, the N-decoding is controlled by the N-address.

In multiplication/division instructions therefore, an N-parity failure can be due to the N-address or X-address (in the gating on to the N-bus). If the accumulator is at fault then both N and X-parity failures occur. In a 23 instruction, during C.D. the N-decoding corresponds to the N-address, and so an N-parity failure on this instruction indicates a faulty N-register.

Group 7

70 and 71 instructions (Single-word transfers).

During C.D., N-decoding corresponds to the N-address which indicates the block on the drum concerned with the instruction.

During subsequent beats the N-decoding refers to accumulator 1.

An N-parity failure in instructions 70 and 71 therefore indicates a fault in the N-address or accumulator 1.

72 instructions

Incorrect parity indication is inhibited in '72' instructions by the use of waveform X34 on the parity staticiser.

73 instructions

During C.D., N-decoding corresponds to the N-address of the instruction. During subsequent beats N-decoding is governed by the X-digits.

If in the order Nm X 73 a parity failure occurs, then the faulty line may be Nm, X.0, X.1 to X.7.

74, 75, 76, 77 instructions

In these instructions N-decoding corresponds to the N-address.

3.5 Drum Parity Failure

In this section the possible causes of drum parity failures are listed and methods of diagnosing them are suggested.

3.5.1 A drum parity failure occurring during or immediately following a drum read order indicates either a fault in the circuitry concerned with reading (see 3.5.4) or that the information track concerned with the drum read order has been written with incorrect parity. In the latter case the fault could lie in any part of the circuitry concerned with writing.

A drum parity failure occurring during any instruction other than a drum read order, indicates an address track fault.

3.5.2 The track selection neons indicate which information track is being decoded.

3.5.3 If the track number lies in the range 0-31 inclusive, a drum parity failure can be caused by a failure in writing or reading and the circuitry associated with these functions.

If the track number lies in the range 40-63 inclusive, the failure could be due to a programming error, a tape error, or a tape reading error. If the fault occurs consistently when the operations are repeated the tape reader should be tested in the usual manner. (See 5.2.) If the tape reader test is satisfactory the fault is due to a programming or tape error, or a computer fault.

If the fault does not occur consistently, the tape reading facility is likely to be at fault, this involves the tape reader, associated

logic and the data processing facilities utilised in the programme whilst reading the tape.

3.5.4 If the track number is in the isolated store, i.e., tracks 32-39, then the fault can only lie in reading which involves:-

(1) The Drum surface

(2) The Heads

(3) The Read/Write switches

(4) Track Selection

(5) Read Amplifier

(6) Read Strobe

It should be possible by monitoring "Selected Track", to see the intermittent or faulty digits that cause the parity failure. By switching to "Drum Trigger" and selecting the appropriate drum address keys, the faulty word-address should be found.

(i) In the case of a single digit failure, it is possible that the ambient temperature has risen sufficiently to cause a change in head positions, resulting in an alteration of digit timing. This may occur if, for example, the vent fan in Bay 1 ceases to function, any evidence of over-heating therefore should be thoroughly investigated. The correct setting for the thermal overload trips is given in 5.7. The drum heads are set correctly during manufacture and should not require adjustment in service. Assuming that the fan is functioning and that the unit is not overheated, the fault may lie in the Write/Read switch (Package type 16).

(ii) If the fault is due to intermittent digits which are all odd or all even, the drum parity staticiser should be inhibited and manual transfers carried out from other columns. If all other columns show failures the fault is probably in the appropriate Read amplifier or Read Strobe package. If none of these other columns show failures the Write/Read switch should be checked by substitution. If the fault still persists it is probably due to a dry joint in the back wiring.

3.6 Low Level Test Points

3.6.1 General

The voltage levels of waveforms in the computer are referred to by

Greek letters: the standard level is α; a cathode follower reduces this to β and a further cathode follower to γ; the effect of a mix operation is to add a 'minus' to the symbol, so that the minimum permissible level is γ-.

The levels should not be less than 13 volts for α, 8 volts for β and 3 volts for γ levels, less 2 volts for each minus. These figures are the minimum to be expected in the worst possible conditions.

3.6.2 Table of Low Level Test Points

Beta (--)	Gamma	Gamma (-)	Beta (--)	Gamma	Gamma (-)
V2	M3	V13		X240	
W66	M6	V21		X242	
	$Q2_0$	$V25_1$		X244	
	$Q2_1$	V28		X246	
	T5	V41		X256	
	T50	V50		X258	
	U2	V65		X260	
	$U4_1$	W4		X262	
	$U4_2$	W12		X272	
	U54	$W14_1$		X274	
	V20	W17		X276	
	V21	W22		X278	
	X4	W23		X288	
	X7	W27		X290	
	X16	W68		X292	
	X53	X107		X294	
	X56	X129		X335	
	$X65_1$	$X231_1$		X341	
	X91	Y9		X354	
	X96	Y60		X452	
	X100	Y76		Y11	
	X102	Y80		Y44	
	X130	Y162		W2	
	X202				
	$X205_1$				
	$X206_1$				
	$X207_1$				
	$X208_1$				
	X223				

3.7 Waveform Nomenclature

3.7.1

The computer waveforms are referred to by code letters according to their purpose. The table given shows the code letters corresponding to the various types of waveforms.

Code Letter	Type of Waveform
A, B, C, D, E.	Beat Waveforms.
F	Function decoding staticiser outputs.
G	Combined 'F' waveforms.
H	Strobed drum outputs.
I	Order register tappings.
J	'Jump' action waveforms.
K, L.	Special beat waveforms in multiplication and division operations.
M	Multiplication action waveforms.
N	Partial register decoding.
P	'p' pulses.
Q	Division action waveforms.
R	Drum column and row decoding.
S	Track, punch, and partial register decoding.
T	Combinations of 'p' pulses.
U	Combinations of beats.
V	'Mix' of 'X' waveforms.
W	'Mix' of 'Y' waveforms.
X	Action waveforms.
Y	Operands.
Z	Leads from handkeys and monitor switches.

3.8 List of Waveforms

The following tables of waveforms with their logical diagram reference, package type and element position should be helpful when studying the logical diagrams. The elements used with any particular waveform can be traced by the tables given and likewise the waveforms associated with any particular element.

The position of the load resistor of a mix waveform is indicated by an asterisk.

In this list Package type 6 is a 42 digit nickel line
Package type 6* is a 35 digit nickel line

3.8.1 p-Pulses

Waveform	Element Position	Package Type	Logical Diagram Reference
$p0_0$	23M3	2	5/G8
$\sim 0_0$	23L3	3	5/H8
0_1	23J5	8	5/G8
$\sim 0_1$	30G5	8	1/E7
0_2	25R3	8	6/E2
$\sim 0_2$	25R1	8	6/E5
0_3	12K1	8	4/H8
$\sim 0_3$	25R2	8	6/F2
0_4	12K2	8	8/A9
1_0	23M2	2	5/G9
$\sim 1_0$	23L1	3	5/H9
1_1	23P4	8	5/H0
$\sim 1_1$	31G5	8	1/E9
1_2	32C5	8	1/J3
1_3	12F6	8	8/C9
1_4	13Q2	8	8/H3

3.8.1 p-Pulses (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
2_0	23M1	2	5/H1
~ 2_0	22D3	3	5/J1
2_1	23P1	8	5/H2
2_2	12F1	8	8/B4
3_0	23Q1	2	5/H2
~ 3_0	23U2	3	5/J3
3_1	23P2	8	5/D3
~ 3_1	11V4	7	8/D4
3_2	11V1	7	8/F8
4_0	23Q2	2	5/H3
4_1	23P3	8	5/H4
5_0	23Q3	2	5/H4
5_1	12F2	8	8/E9
6_0	23R3	2	5/H5
6_1	13S3	7	8/K4
7_0	23R2	2	5/H6
7_1	13S4	7	8/J4
8_0	23R1	2	5/H6
8_1	23D4	7	8/J4
9_0	23S1	2	5/H7
9_1	13S6	7	8/J4

3.8.1 p-Pulses (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
10_0	23S2	2	5/H8
10_1	13U4	8	8/F4
11_0	23S3	2	5/H8
$\sim 11_0$	23U1	3	5/J9
11_1	13R1	7	8/F4
$\sim 11_1$	22Q6	8	4/J1
12_0	12W3	2	5/H9
$\sim 12_0$	12Y3	3	5/J9
12_1	13R3	7	8/F4
$\sim 12_1$	11R1	4	8/D9
17_0	12W2	2	5/F0
18_0	24C1	2	5/F0
18_1	24D1	7	5/F1
18_2	24D6	7	8/K4
19_0	24C2	2	5/F2
19_1	24D3	7	5/F2
20_0	24C3	2	5/F3
20_1	24D4	7	8/J3
21_0	24E3	2	5/F4
22_0	24E2	2	5/F4

3.8.1 p-Pulses (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
23_0	24E1	2	5/F5
24_0	24F1	2	5/F6
24_1	24G1	7	5/F6
25_0	24F2	2	5/F7
25_1	24G3	7	5/F8
26_0	24F3	2	5/F8
26_1	24G4	7	5/F9
26_2	13Q3	8	8/H3
27_0	24H3	2	5/F0
$\sim 27_0$	22D2	3	5/G1
27_1	24L1	8	5/F1
28_0	24H2	2	5/F2
28_1	24G6	7	5/F2
28_2	25S2	8	6/G3
29_0	24H1	2	5/F3
$\sim 29_0$	23K3	3	5/G3
29_1	32D3	8	1/E3
29_2	13R6	7	8/H3
30_0	23C3	2	5/F4
31_0	23C2	2	5/F4

3.8.1 p-Pulses (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
31_1	23D3	7	5/F5
32_0	23C1	2	5/F6
32_1	23D1	7	5/F6
33_0	23E1	2	5/F7
34_0	23E2	2	5/F8
34_2	13T1	7	8/G4
35_0	23E3	2	5/F8
35_1	13T3	7	8/H4
36_0	23F3	2	5/F9
$\sim 36_0$	26P1	3	5/G9
36_1	23G6	7	5/G0
36_2	13Q4	8	8/H4
37_0	23F2	2	5/G1
$\sim 37_0$	33C3	3	5/H1
37_1	23G4	7	5/G2
37_2	23J4	8	2/D3
37_3	13T4	7	8/H4
38_0	23F1	2	5/G2
38_1	23G3	7	5/G3
38_2	31G4	8	1/E1
38_3	13T6	7	8/J4

3.8.1 p-Pulses (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
39_0	23H1	2	5/G4
~ 39_0	23K1	3	5/H4
39_1	23G1	7	5/G4
~ 39_1	31R1	8	1/H7
39_2	13V1	8	4/H8
~ 39_2	34X2	8	2/G9
39_3	20Q5	8	5/B1
39_4	23J1	8	4/E8
39_5	32C6	8	1/F0
39_6	13U3	8	8/J4
40_0	23H2	2	5/G5
~ 40_0	23K2	3	5/H5
40_1	23J2	8	5/G6
~ 40_1	30R2	8	1/E1
40_2	34P3	8	2/G3
~ 40_2	24U2	8	6/H0
40_3	34M3	8	2/G5
~ 40_3	34E2	8	2/G7
40_4	34M2	8	2/G2
~ 40_4	34M1	8	2/G2
40_5	22P5	8	4/J0
~ 40_5	34P2	8	2/F4

3.8.1 p-Pulses (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
40_6	31E1	2	1/G0
40_7	11V6	7	8/C3
41_0	23H3	2	5/G6
$\sim 41_0$	23L2	3	5/H7
41_1	23J3	8	5/G7
$\sim 41_1$	30R3	8	1/E1
41_2	35D1	8	4/K3
$\sim 41_2$	25S1	8	6/G2
41_4	13V4	8	8/K4

3.8.2 Basic Rythmic Waveforms

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
A_0		24M1	1	6/E0
A_1		24Q2	8	6/D1
B_0		24M2	1	6/E1
B_1		24Q4	8	6/E2
C_0		24P2	3	6/E1
$\sim C_0$		M 24M1	1	6/E0
$\sim C_0$		M*24M2	1	6/E1
C_1		24Q3	8	6/A2
$\sim C_1$		24L3	8	6/D0

3.8.2 Basic Rythmic Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
C_2		13Q1	8	8/J3
$\sim C_2$		24P3	3	2/J0
$\sim C_3$		12C2	3	8/J2
D_0	[41 - 40]	24T1	1	6/H0
$\sim D_0$		31J1	3	1/F0
D_1		31G2	8	1/F1
$\sim D_1$		31G1	8	1/F0
D_2		32D1	8	1/E5
$\sim D_2$		24R3	3	4/C3
D_3		22P4	8	6/J1
$\sim D_3$		35Y2	8	1/F0
D_4		22P3	8	6/F1
D_5		24L2	8	6/A2
D_7		32D2	8	1/G1
E_1	[41 - 40]	31R5	8	1/F1
E_0		24V1	1	6/H1
$\sim E_0$		24W2	3	6/H2
$\sim E_1$		31G6	8	1/D0
E_2		24U4	8	6/J1
$\sim E_2$		31G3	8	1/F1
E_3		24U3	8	6/B1
$\sim E_3$		24U5	8	6/H1

3.8.2 Basic Rythmic Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
E_4		24L5	8	8/G4
$\sim E_4$		26U3	8	2/G0
$\sim E_5$		20D4	8	5/C4
$\sim E_6$		13U1	8	8/J6

3.8.3 F-waveforms:- Set at p41 (i.e., Beginning) of AD & DB, operative from p0 of D to p39 of E.

Waveform	Element Position	Package Type	Logical Diagram Reference
$F0_0$	23V2	1	4/A0
$\sim F0_0$	23W3	3	4/A1
$F0_1$	22Q5	8	4/A1
$\sim F0_1$	22U1	8	4/A1
$F1_0$	23X2	1	4/B0
$\sim F1_0$	23W2	3	4/B1
$F1_1$	22U2	8	4/B1
$\sim F1_1$	22U3	8	4/B1
$F2_0$	23X1	1	4/C0
$\sim F2_0$	23W1	3	4/C1
$F2_1$	23T2	8	4/C1
$\sim F2_1$	22U5	8	4/C1
$F3_0$	20W2	1	4/D0
$\sim F3_0$	10V3	3	4/D0

3.8.3 Function Decoding Staticiser Outputs (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
$F3_1$	20U1	8	4/D0
$\sim F3_1$	20U2	8	4/E1
$F3_2$	21K4	8	4/D1
$\sim F3_2$	21K2	8	4/A5
$F4_0$	20X2	1	4/E0
$\sim F4_0$	20V2	3	4/E1
$F4_1$	20U3	8	4/E0
$\sim F4_1$	20U4	8	4/F1
$F4_2$	21K3	8	4/E1
$F5_0$	20X1	1	4/F0
$\sim F5_0$	20V1	3	4/F1
$F5_1$	20U5	8	4/F0
$\sim F5_1$	20U6	8	4/F1
$F5_2$	20Q1	8	5/A3
$\sim F5_2$	20Q2	8	5/A4
$F5_3$	32D4	8	1/C0

3.8.4 Combined F-Waveforms G-Waveforms:- Significant 1 digit time later than F-Waveforms, i.e., D1 to E40

Waveform	Element Position	Package Type	Logical Diagram Reference
G00	22T1	2	4/A2
$G01_0$	22T2	2	4/A2
$G01_1$	22Q1	8	4/A2
$G02_0$	22T3	2	4/B2
$G02_1$	22Q2	8	4/H7
G03	22S3	2	4/B2
G04	22S2	2	4/B2
$G05_0$	22S1	2	4/C2
$G05_1$	22Q3	8	4/C2
~ $G05_1$	21V3	3	4/J2
$G05_2$	32C4	8	1/G1
$G06_0$	22R1	2	4/C2
$G07_0$	22R2	2	4/C2
~ G07	22W3	3	4/G7
$G07_1$	20Q3	8	5/C2
G10	20T1	2	4/D2
G11	20T2	2	4/D2
G12	20T3	2	4/E2
G13	20S3	2	4/E2
$G13_1$	22P2	8	4/E2
$G14_0$	20S2	2	4/E2

3.8.4 Combined F - Waveforms (Contd)

Waveform	Element Position	Package Type	Logical Diagram Reference
$G14_1$	32C3	8	1/H1
$G15_0$	20S1	2	4/F2
$G15_1$	32C2	8	1/C0
$G16_0$	20R2	2	4/F2
$\sim G16_0$	21Q3	3	4/C9
$G16_1$	21K1	8	4/J2
$G16_2$	32C1	8	1/D1
G17	20R1	2	4/F2

3.8.5 Outputs of Drum 'Read' Amplifiers

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
H6	Address Track Signal	27G1	15	7/F9
H7		27G2	15	7/J9
H8		27F2	15	7/D9
H9		27F1	15	7/C9

3.8.6 Order Register Outputs

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
IO_0	Order Adder output	25T2	1	6/F6
IO_1		26U5	8	6/J6
IO_2		23D6	7	8/G5
I1		26R1	2	6/J6
$I2_0$		26R2	2	6/J6
~ I2		26P2	3	6/H3
I3		26R3	2	6/J7
$I4_0$		26S3	2	6/J7
$I4_1$		25R6	8	6/B7
I5		26S2	2	6/J8
I6		26S1	2	6/J8
I7		26V1	2	6/J6
I8		26V2	2	6/J6
I9		26V3	2	6/J7
~ I9		26W2	3	4/B7
I10		26X2	2	6/J7
I11		23Y3	2	6/J8
I12		23Y2	2	6/J8
I13		23Y1	2	6/K6
I14		20Y3	2	6/K6
I15		20Y2	2	6/K7
I16		20Y1	2	6/K7
I17		25M3	2	6/K8

3.8.7 'Jump' Action Waveforms

Waveform	Element Position	Package Type	Logical Diagram Reference
J	21W1	1	4/A7
~ J	24W1	3	4/A8

3.8.8 Multiplier - Divider Rythmic Waveforms

Waveform	Element Position	Package Type	Logical Diagram Reference
K_0	31T2	1	1/J1
K_1	31R2	8	1/K1
~ K	31X2	3	1/J2
L_0	32T2	1	1/J2
~ L	31C3	3	1/J3

3.8.9 Multiplication Action Waveforms

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
M1	20,21,22 [D.1 to L.40]	31D1	1	1/H0
M2	G02 & G12 [Mult. & Add]	32M1	4	1/H0
~ M2		32L3	3	6/F1
M3	M1 & D1	31M1	4	1/J0
M4	Three Right Shifts in 6 & 7. [M1 & $\sim D_0$]	31M2	4	1/J0
M5	Normal circulation in 7. [M1 & $\sim D_0$]	31C2	3	1/J0
M6	M1 & $\sim E_1$	31F3	4	1/K0
M7	Set Stats	31Q2	2	1/K0
M8	Most Sig.	30Q1	1	1/D9
M9	3 multipliers in 7	30L2	1	1/D8
M10	Least Sig.	30L1	1	1/D7

3.8.10 Gating Waveforms [Combinations of S1-S7]

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Gating for Accumulators				
N00		35V1	2	2/K4
$N00_1$		35D4	8	6/C9
Gating for Special Register Blocks				
N01	8-15	35V2	2	2/K4
N02	16-23	35V3	2	2/K4
N04	32-39 [constants]	35U4	4	2/J4
Gating for Ordinary Register Blocks				
$N10_0$		35X1	2	2/K3
$N10_1$		35Y3	8	3/E3
$N11_0$		35W1	2	2/K3
$N11_1$		35Y4	8	3/E3
$N12_0$		35X3	2	2/K3
$N12_1$		35Y5	8	3/E3
$N13_0$		35W3	2	2/K3
$N13_1$		35Y1	8	3/E4
N14		35X2	2	2/K2
N15		35W2	2	2/K2
Gating Within Blocks				
N20		35R3	2	2/K7
N21		35R2	2	2/K6
N22		35Q1	2	2/K6
N23		35Q2	2	2/K6
N24		35Q3	2	2/K6
N25		35P3	2	2/K5
N26		35P2	2	2/K5
N27		35P1	2	2/K5

3.8.11 Overflow Setting

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
OVR_0		21S1	1	4/D8
OVR_1		32D6	8	4/C8

3.8.12 Division Action Waveforms

$Q1_0$	Gate Divisor to add-sub., justify, gate X to 7 [D],	30V3	2	1/C0
$Q1_1$	normal circulation in 6 [K], gate digits to half add-sub. R shift in 6 [E]	31R4	8	1/D0
$Q1_2$		31R3	8	1/D0
$Q2_0$	$Q1_2$ & ~ E1, & ~ K. Left shift in 7.	31M3	4	1/E0
$Q2_1$	$Q1_2$ & ~ E1, & ~ K. Left shift in 6.	31U2	4	1/E0
Q4	*Add*, Add in full add-sub., Sub in half add-sub.	30X2	2	1/J4
Q5	*Sub*. Sub in full add-sub., Add in half add-sub.	30Y3	3	1/J4

3.8.13 Track Selection Decoding

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Column Decoding				
$R00_0$		26C1	2	7/C0
$R00_1$		27L1	8	7/D0
$R01_0$		26C2	2	7/C1
$R01_1$		27L2	8	7/D1
$R02_0$		26C3	2	7/C1
$R02_1$		27L3	8	7/D1
$R03_0$		27K1	2	7/C1
$R03_1$		27L4	8	7/D1
$R04_0$		27K2	2	7/C2
$R04_1$		27L5	8	7/D2
Within Column Decoding				
R10		26J1	3	7/C3
R11		26J2	3	7/C4
R12		26J3	3	7/C4
R13		26H3	3	7/C4
R14		26H2	3	7/C5
R15		26H1	3	7/C5
R16		26G1	3	7/C6
R17		26G2	3	7/C6

3.8.14 Decoding/Selection Staticiser Outputs

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
N-decoding				
S1		34Q2	1	2/H2
~ S1		35M3	3	2/H2
S2		34Q1	1	2/H3
~ S2		35T3	3	2/H3
S3		34S1	1	2/H4
~ S3		35T1	3	2/H4
S4		34S2	1	2/H4
~ S4		35T2	3	2/H4
$S5_0$		34K2	1	2/H5
~ S5		34J3	3	2/H5
$S5_1$		35L3	8	2/H5
$S6_0$		34L1	1	2/H6
$S6_1$		35L2	8	2/H6
~ S6		35M2	3	2/H6
$S7_0$		34L2	1	2/H6
$S7_1$		35L1	8	2/H6
~ S7		35M1	3	2/H6
X/M Decoding				
S8		34V1	2	2/H8
~ S8		34W2	3	2/H8
S9		34V2	2	2/H8
~ S9		34W3	3	2/H8

3.8.14 Decoding/Selection Staticiser Outputs

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
$S10_0$		34Y2	1	2/H9
~ $S10_0$		34W1	3	2/H9
$S10_1$		34X6	8	2/H9
~ $S10_1$		34E3	8	2/J9
Track Selection				
S21		26E2	1	7/A2
~ S21		26D3	3	7/B2
S22		26F2	1	7/A3
~ S22		26D2	3	7/B3
S23		26F1	1	7/A3
~ S23		26D1	3	7/B3
S24		M 26L1	1	7/A4
~ S24		26K1	3	7/B2
S25		M 26L2	1	7/A4
~ S25		26K2	3	7/B5
S26		M 26M2	1	7/A5
~ S26		26K3	3	7/B5
Punch-Selection				
S27		11E1	1	8/C7
[S27]		11K1	10	8/C6
S28		11F1	1	8/D7
[S28]		11K2	10	8/D6

3.8.14 Decoding/Selection Staticiser Outputs (Contd).

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
S29		11F2	1	8/E7
[S29]		11K3	10	8/E6
S30		11G2	1	8/E7
[S30]		11L3	10	8/E6
S31		11G1	1	8/F7
[S31]		11L2	10	8/F6

3.8.15 HOOT ON STOP Waveform

HOOT ON STOP		13X3	9	8/F2

3.8.16 p-Pulse Combinations

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
T1	P2,9,16,23,30,37	12W1	2	5/B6
T2	P1,4,7,P10-P40	12S1	1	5/D6
$T3_0$	Odd p-pulses	12S2	1	5/E6
$T3_1$	Odd p-pulses	22P6	8	3/C2
$T4_0$	Even p-pulses	12T3	3	5/E6
$T4_1$	Even p-pulses	20D3	8	3/C2
$T4_2$	Even p-pulses	12K3	8	5/D6
T5		13Q6	8	8/H0

3.8.16 p-Pulse Combinations (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
$T6_0$	p6-p12 D^{19}	12X2	1	5/A2
$T6_1$	"	13S1	7	5/B2
$T23_0$	Address Track	20E2	1	5/A1
$T23_1$		23T1	8	8/H2
T32	p41-p37	24X2	2	2/A2
T33	p41-p38	23T6	8	2/A2
T35	p31-p36	25X1	1	6/A1
T36	p32-p41	25X2	1	6/K4
T37	p1-p38	26T1	4	6/E4
T38	p1-p39	25L1	3	4/H3
~ T38		27L6	8	4/H3
T39	Start Order Pair	M 23R1	2	5/H6
		M 23S1	2	5/H7
		M 24C2	2	5/F2
		M 24F1	2	5/F6
		M*24F3	2	5/F8
		M 24H2	2	5/F2
		M 24H3	2	5/F0
		M 25S4	8	5/H7
T41	p30-p32	23J6	8	4/C5
T42	p5-p29	21U2	1	4/D5

3.8.16 p-Pulse Combinations (Contd).

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
T43	p3-p27	22F2	1	4/D3
T50	p38-p40	31R6	8	1/A0
T51	p39-p41	30M3	2	1/A0
T52	p41-p37	30U3	3	1/B0
T53	p1-p40	30V1	2	1/B0
T54	p1-p37	30W1	4	1/B0
T70		23V1	1	4/H5
T71	23 $_{v}$ 40	24Q6	8	8/B2
T72	24 $_{v}$ 41	11W3	2	8/B2
T73	25 $_{v}$ 0	11W2	2	8/C2
T74	26 $_{v}$ 1	11W1	2	8/C2
T75	27 $_{v}$ 2	11U1	2	8/D2
T76	~ T42	11T3	3	8/E3
T77	M3 [30-41]	32U2	1	1/F3
T80	From Comm. 1 in 7	12X1	1	5/B6
T81	„ „ „	12V1	2	5/B7
T82	„ „ „	12V2	2	5/B7
T83	„ „ „	12V3	2	5/B8
T84	„ „ „	12U2	2	5/B8
T85	„ „ 1 „ 42 [or 43]	12U3	2	5/C8
T86	„ „ 1 in 3	12U1	2	5/D6

3.8.16 p-Pulse Combinations (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
T87	From Comm. 6 in 7	M 12U2	2	5/B8
		M 12V1	2	5/B7
		M*12V2	2	5/B7
		M 12W1	2	5/B6
		M 12X1	1	5/B6
T88	From Comm. 2 in 3	M*12S1	1	5/D6
		M*12U1	2	5/D6
T89	From Comm. 1 in 7	12Y1	3	5/B6
T90		12T1	3	5/C6
T91	~ T85	12T2	3	5/C8
T92	T36 & "Hoot on Stops"	13W1	4	8/F1

3.8.17 Rythmic Waveform Combinations

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
U1	D.p2 - D.p11	22M2	1	4/J2
$U2_0$	D ~ C	24S1	4	2/H0
$U2_1$		35D3	8	2/H0
U3	[C.D. $_V$ (A.E ~ J)] delayed one digit time	24V2	1	2/F8
$U4_0$	~ C.D. P41	24Y4	4	2/G7
$U4_1$		23P6	8	4/C0
$U4_2$		23P5	8	4/D0
U15	[C.D.] delayed one digit time	25M1	2	6/A3
U16	~ U15	25L2	3	6/A4
U50	D_1 delayed one digit time	32S3	2	1/A1
U51	~ D. ~ E.	31F2	4	1/A1
U52	~ [E & p37]	32Q3	3	1/B1
U53	D $_V$ [~ p3]	30U1	3	1/B1
U54	E ~ [p38-40] = ~ E.p41-37	31U1	4	1/B1
U55	~ L p39-41	31F1	4	1/C1
U56	~ D. ~ L. ~ p0	31Q1	2	1/C1
U70	~ [E_0 & 39_4] Resets F-Stats	24W3	3	4/B0
U74	~ [E & Read or Write]	20C3	3	5/A3
U75	~ [F4 & F5]	21J3	3	1/A2
U77	E 'remembered' to D	24T2	1	6/C1

3.8.18 'Mix' of X-Waveforms

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
V1	Inhibit Normal circulation in 0 reg. [Man]	M 25D1	1	6/C3
		M*25D2	1	6/F4
	X19 $_{V}$ X20 $_{V}$ X121 inverted to form X21.	M 25G2	2	6/C3
V2	Gate modifier digits to Order Register,	M 26T2	4	6/G4
	13 digits for 70 and 71 instructions,	M 26T3	4	6/H4
	10 digits for 72 and 73 instructions.	M*26Q3	2	6/H4
$V3_0$	Set E	M 20K1	1	5/D4
		M 20R3	2	5/D0
		M 22C2	1	4/H7
		M 22U4	8	1/K2
		M 22V1	1	6/G1
		M*22Y2	4	4/B9
		M 24X1	1	6/G1
$V3_1$		24U1	8	6/H1
V4	Carry Suppress in Mill [p1 or Unit count or not equivalent]	21E2	1	4/J3
		M*23M2	2	5/G9
V5	C or E 'remembered' to D	M*24P2	3	6/E1
		24T2	1	6/C1
V6	Set K for 56 instruction.	M*25Y1	1	4/B9
		M 32K1	1	1/H1
V7	Reset X123, on "input busy" ~ P12 $_{V}$ X122	M*11H5	8	8/B0
		M 12Y3	3	3/J9

3.8.18 'Mix' of X-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
V8		M*12D2	1	8/H6
		M 13K1	1	8/G6
V9	Input busy to neon indicator X122 $_{V}$ X123	M 11Q1	1	8/B1
		M*11Q2	1	8/B0
V10		M*26T4	4	2/G1
		M 26X3	2	2/F1
V11	Inhibit setting of drum parity during E except during read orders. ~ E $_{V}$ X34	M*20D4	8	5/C4
		M 20L2	2	5/B4
V12	Inhibit coincidence until after 3rd character has been set up for block address punching.	M 12H2	1	8/B7
		M*12K4	8	8/B7
		M 12K5	8	8/B7
		M 20F1	1	5/B2
V13	Set K [Block Write, Normalise]	M 20L1	2	5/D4
		M*31U3	4	1/H2
		M 31U4	4	1/H2
V15$_{0}$	Internal Stops [for hoot on stops]	M 12P1	1	4/K6
		M 12Q1	1	4/K5
		M*12Q2	1	4/K7
		M 12R1	1	4/K6
		M 12R2	1	4/K7
		M 34C1	1	4/K4
		M 34C2	1	4/K4

3.8.18 'Mix' of X-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
$V15_1$		13V5	8	4/K7
V16	Unallocated functions	M 22C1	1	4/H6
		*22C2	1	4/H7
V17	Address track, or beat number for multi-beat triggers.	M 11R3	4	8/J1
		M*13H2	4	8/H2
V18	[D $_V$ L] delayed one digit time.	M 32S3	2	1/A1
		M*32T2	1	1/J2
V20	Part of normal circulation in x7 [X60]	M 31H2	1	1/C2
	X52 $_V$ X55 $_V$ Q2	M 31K2	1	1/B2
		M*31M3	4	1/E0
V21	Multiply or divide or Shifts & ~ E.	M*30C2	4	1/B2
	[for normal circulation in x]	M 31F3	4	1/K0
		M 31F4	4	1/C2
		M 31R4	8	1/D0
V22	p18 or A-order from H/Sws	M*24C1	2	5/F0
		25M2	2	2/D1
V24	Stop Signal [to Beat Trigger] Inhibits generation of X80.	M 12P2	1	4/K8
		M*13V5	8	4/K7
		M 26X1	2	4/K8
$V25_0$	Monitor 'Beat Trigger'.	M 13J2	4	8/G7
		M*13J3	4	8/G7
		M 13J4	4	8/H7

3.8.18 'Mix' of X-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
$V25_1$		13R4	7	8/G7
V26		M 10Y2	1	8/K7
		M*13C3	2	8/J8
		M 13H3	4	8/K8
V28		M*13R5	7	8/F5
~ V28		13L2	3	8/F5
V30		M 13M1	1	8/G5
		M*13M2	1	8/G5
~ V30		13L1	3	8/G6
V40		M 35D4	8	6/C9
		M*36G3	2	6/C9
~ V40		36F1	3	6/D8
V41	Inject Parity Digit	M 33Q4	8	1/D4
	Storage locations on which there is no parity check, decoded.	M 33Q5	8	1/D5
		M 35E2	4	6/C8
		M*35E3	4	6/D8
		M 35E4	4	6/D8
V43		M*20D5	8	2/A3
V50	X203 or X202 Delayed to form X38	M*22Y3	4	2/B2
		M 22Y4	4	2/B2

3.8.18 'Mix' of X-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
V51		M*34H3	2	2/G6
		M 34K1	1	2/F5
V52	3 1s. N-digits to S-stats [S5-S7]	M*34F1	1	2/G5
		M 34H1	2	2/F5
V53		M*21G2	4	4/F5
		M 21G3	4	4/F5
V54		M 21K5	8	4/F7
		M*21X1	3	4/E7
V55		M 21S2	1	4/C6
		21T1	1	4/B6
		M 21T2	1	4/D6
V56		M 21T1	1	4/B6
		M 21U1	1	4/A6
V57	Tape Parity circuit	M 11S2	1	8/D3
		M*11U2	2	8/B3
V58	Reader busy circuit	M*11D2	4	8/A1
		M 11P2	3	8/A1
V59	Punch control circuit	M 11J1	1	8/B5
		M*11P1	3	8/B4
V61	'a' or 'b' in Drum coincidence	M 20E2	1	5/A2
V62		20H3	2	5/C3
		M*20J2	1	5/C3

3.8.18 'Mix' of X-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
V63	~ W7 or [Y36 & Y37]	M 32L2	3	1/C3
		M*32M3	4	1/C3
V64	Mask for Zero Rem.test [in Divide]	M*32U1	1	1/F3
		M 32U2	1	1/F3
V65		M*30W4	4	1/H3
		M 31W1	1	1/H4
V66	Inhibit +1 to Order No.	M*25C1	1	6/F3
		M 25G1	2	6/G3
V68	Part of Gate to Coincidence	M 20H1	2	5/B0
		M*20J1	1	5/B0

3.8.19 'Mix' of Y-Waveforms

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
$W1_0$	Order adder input Tapping point for M digits.	M*25E2	1	2/E1
		M 25G3	2	6/D5
		M 25J1	1	6/C5
		M 25J2	1	6/C5
$W1_1$		25S5	8	6/E6
$W1_2$		26U4	8	2/F8
W2	Acc. 1 output to X/M Bus.	*33D4	4	2/D9
		33F4	4	2/D9
W3		M 20E2	1	5/A1
		M*20H2	2	5/B1
W4	Set OVR [shifts]	M*21S1	1	4/D8
		M 32M2	4	1/D3
		M 32M4	4	1/H1
W5	Modifier Control	M*26P2	3	6/H3
		M 26P3	3	6/H3
W6	$14_V \sim$ P34	M*24K3	3	6/J3
W7	$Y36_V$ $Y37_V \sim$ P37	M 33C3	3	5/H1
	Part of equivalence test for division out of range.	M 32P2	2	1/C8
		M*32P3	2	1/C7
W8	Part of Zero Residue test in divide.	M 30E1	1	1/G7
		M*30S1	1	1/G3
W9	Input to Acc.7 half adder.	M 31V2	2	1/E0
		M*31W2	1	1/A9

3.8.19 'Mix' of Y-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
$W1O_0$	Normal circulation in x6	M 31S1	1	1/J7
		M*31S2	1	1/J7
		M 31T1	1	1/K7
		M 31V3	2	1/K0
$W1O_1$		34X1	8	1/J6
W11	Busy Stop	M 25R5	8	6/H7
	$W1_V$ Io_V $I2_V$ I9	M 26U4	8	2/F8
	Part of test for 16 or 17 address instruction in presence of input/output busy	M 26U5	8	6/J6
		M*26V3	2	6/J7
~ W11		26W1	3	4/J8
W12	Acc. 6 or Acc. 7 to X/M bus.	M*33V2	4	1/K5
		M 33V3	4	1/K5
		M 33V4	4	1/C5
		M 33Y2	4	1/C5
W13	Test point for divisor or residue equal to zero in l.s. half. Digit from Acc.7 to Acc.6 during division.	M*31L1	1	1/B7
		M 31L2	1	1/A7
$W14_0$	Multiplicand/Divisor; sign repeated three times.	M*30M2	2	1/E6
		M 30R4	8	1/E6
$W14_1$		30R1	8	1/D7
W16	One digit per left shift or Multiplication from X-bus.	M*31K1	1	1/A6
		M 31Q3	2	1/A6

3.8.19 'Mix' of Y-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
W17		M 33Y3	4	1/B5
		M*33Y4	4	1/B5
W19	Accumulators and special registers to N-bus.	M 11S1	1	8/E3
		M 33P1	1	2/E4
		M*33P2	1	2/E6
		M 33W2	1	1/D4
		M 34D2	2	2/E9
		M 35F2	2	6/B8
		M 35C2	2	2/E3
		M 35S1	1	2/E3
		M 35S2	1	2/E3
W20	Blocks 0-2	M*37G1	1	3/C5
		M 37G2	1	3/C6
		M 38C1	1	3/C7
		M 38C2	1	3/C8
		M 38G1	1	3/E7
		M 38G2	1	3/E8
		M 39G1	1	3/E5
		M 39G2	1	3/E6
		M 39P1	1	3/H7
		M 39P2	1	3/H8
		M 39V1	1	3/H5
		M 39V2	1	3/H6

3.8.19 'Mix' of Y-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
W21	Blocks 3 - 5 to M-bus.	M 36P1	1	3/K2
		M 36P2	1	3/K3
		M 36V2	1	3/K1
		M 37V1	1	3/H0
		M 37V2	1	3/H1
		M 37P2	1	3/H3
		M 37P1	1	3/H2
		M 38P1	1	3/K7
		M 38P2	1	3/K8
		M*38V1	1	3/K5
		M 38V2	1	3/K6
W22	Accs. 2 & 3 to X/M bus	M 33J2	4	2/D7
		M 33J3	4	2/D8
		M*33M3	4	2/D6
		M 33M4	4	2/D7
W23	Accs. 4 & 5 to X/M bus.	M 33M2	4	2/D6
		M 33T2	4	2/D5
		M*33T3	4	2/D4
		M 33T4	4	2/D5
W24	'Locking Signal' [Drum to Comm.]	12F5	8	5/B4
		20P4	4	5/B5

3.8.19 'Mix' of Y-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
W25		M 13T2	7	8/H4
		M*13T5	7	8/J4
W27		M 13R2	7	8/H5
		M 13S2	7	8/K5
		M*13S5	7	8/J5
W40		M 32W2	1	4/H1
		M*33F2	4	4/G1
~ W40		33X2	3	4/H1
W50		M*32D5	8	4/G2
		M 32K2	1	4/H2
W52	Mill add. sub. 'b' input	M*22F1	1	4/E4
		M 22G1	1	4/C4
		M 22G2	1	4/D4
		M 22H1	1	4/B4
		M 22H2	1	4/C4
W53	Mill add. sub. 'a' input	M*21D1	1	4/G7
		M 21D2	1	4/H7
		M 22E1	1	4/F4
		M 22E2	1	4/G4
W54		M*22M1	1	4/F3
		M 22R3	2	4/E3
W56		22K1	1	4/G3
W57		22K2	1	4/G3

3.8.19 'Mix' of Y-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
W58		M*21M2	2	4/F7
		M 21P2	2	4/F8
W60		M 12D1	1	8/E8
		M*12F4	8	8/C8
		M 12G2	4	8/C9
		M 12G3	4	8/C8
W62	Input to 1st. adder x6	M 30S2	1	1/J5
		M*30Q2	1	1/H5
$W63_0$	Carry in x6 1st adder.	M*30K1	1	1/F6
		M 30P1	1	1/F5
$W63_1$		30G1	8	1/F5
$W64_0$	Carry in x6 2nd adder.	M*30H2	1	1/F7
		M 30K2	1	1/F6
$W64_1$		30G2	8	1/F7
$W65_0$	Carry in x6 3rd adder.	M 30E2	1	1/F9
		M*30M1	2	1/F8
$W65_1$		30G6	8	1/F8
W66		M 30W2	4	1/G5
		M*30W3	4	1/G5
$W67_0$	Acc. 6, 1st. to 2nd. Adder	M*30H1	1	1/G6
		M 30P2	1	1/H6
$W67_1$	Acc. 6, 1st. to 2nd. Adder	30G3	8	1/H7

3.8.19 'Mix' of Y-Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
W68	3 right shifts in Multiplication	M 31M4	4	1/J9
		M*31P2	1	1/H9
W69	Order adder 'c' input	M*25V1	1	6/H5
		M 25V2	1	6/F5

3.8.20 Action Waveforms

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X1	G05 & G11 [Right Shift]	22J2	4	4/C3
$X2_0$	Reset Ext.Cond. Stats. [X17 v X104]	33C1	3	5/D1
$X2_1$		35L4	8	3/A3
X3	Normal	25C2	1	6/E3
X4	Functions. 2 or 3 all groups ~ F3, F4	21R4	4	4/C5
X5		M23T4	8	4/G3
		M23T5	8	4/H3
X6	Not logical Shifts [functions 52, 53] ~ [X4.G05]	21X1	3	4/E7
X7	Gate condition satisfied signal to J Stat. E.G06.P2.	21R3	4	4/E7
X8	Reset OVR. Stat. for 64, 65 ~ [E.G06.P2.X26]	21Q1	3	4/E7
X9	Hoot on stops [to L.S. drive]	13W4	4	8/F2

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X10	Mill Subtract. Grs. 0,1,4,5, functions 2-7 [F4. ~ F1] $_{V}$ [F3. ~ F1.] delayed one digit time.	21E1	1	4/J3
X11	Mill Add.G. 2,3,6,7, Functions 0,1. ~ X10	21F1	3	4/J4
X14	Carry Suppression ~ [67.P28 $_{V}$ 06,16,46, $_{V}$ P1]	21F3	3	4/J4
X15	Gate to O.R. [erase A-order to jump to B.]	25K1	1	6/B4
X16	Normal P1-P38 X. T37	25H2	4	6/E4
X17	"Start" P12-P11	25E1	1	6/D3
$X18_0$	"Not Start" ~ X17	25F1	3	6/D4
$X18_1$		24Q5	8	6/C1
X19	Gate short Circulation of B-order AE. ~ J. P20-P0.	25D1	1	6/C3
X20	Gate in O.N. & +1 BE ~ J	25G2	2	6/C3
X21	Inhibit normal circulation in O.R.	25H1	4	6/C4
X22	Gate mod. digits delayed six digit times into O.R.	26M1	1	6/J4
X23	Comp. Store parity failure	35L6	8	4/K4
$X24_0$	Manual	25C1	1	6/F3
$X24_1$		25R4	8	6/F3
X25	Start or X104	35Y6	8	5/C1

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X26	Functions 4 & 5 all groups. F3 ~ F4	22Y1	4	4/B5
X28	Inhibit + [-1] to shift count, OVR. sense after shift.	22X1	3	4/B9
X29	Clear OVR. or Justify ~ [D.P40.23]	22W1	3	6/G2
$X30_0$	Control circuit Drum Transfer Functions.	20M2	2	5/C2
$X30_1$		23T3	8	2/E1
X31	Decodes as Acc.1	26X3	2	2/E1
X33	Write functions, Gate Mill Delay F5.X30	21G1	4	5/D2
$X34_0$	Read Action	20L2	2	5/B4
$X34_1$		24L4	8	7/B2
~ X34		20C2	3	5/B5
X35	Write Action	20L3	2	5/B4
X36	Write Suppression	24K1	3	5/E2
X37	Block T.A. W.F. [Gate half adder]	20E1	1	5/C4
$X38_0$	'Erase' [X203 or X202] & +1	34D3	2	3/D0
$X38_1$		34D4	8	3/E0
$X38_2$		34M5	8	3/E1
$X38_3$		34M4	8	3/E1
X39	From half adder [count = 7]	34G4	4	2/G7

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X40	Drum Transfers & ~ E [X30 ~ E] delayed one digit time.	26Y2	2	2/G1
X41	~ [Drum Transfers & ~ E]	34J2	3	2/G1
X42	Decode as N-address ~ X43	33C2	3	2/H1
X43	Decode as X-address [Neg. for Group.7]	22V2	1	2/H1
X44	S1 & S2 [Addresses 4.0 -7.7]	35U1	4	2/J2
X45	S1 & ~ S2 [Addresses 0.0 - 3.7]	35U2	4	2/J3
X47	~ S1 & ~ S2 [Addresses 0-31]	35U3	4	2/J4
X50	Group 2 excluding 23 and 27.	21G4	4	1/A2
X51	Gate Multiplicand or Divisor X50 delayed one digit time.	30V2	2	1/A2
X52	Right Shifts [Double length] [~ E55 $_{V}$ K56] delayed one digit time.	31K2	1	1/B2
X53	Gate Right shift in 6. ~ D. ~ E. X52	30C2	4	1/B2
X54	Gate Right shift in 7. Shunt l.s. digit 6 to 7.	31E2	2	1/B2
X55	Left Shifts	31H2	1	1/C2
X56	Gate Left Shift in 6.	31F4	4	1/C2
X57	Gate Left Shift in 7. Shunt m.s. digit 7 to 6	31E3	2	1/D1
X58	Circulation in 6, 7 & Multi. Div. Register.	30U2	3	1/D2
X59	Normal circulation in 6.	31X1	3	1/D1

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X60	Normal circulation in 7.	31J3	3	1/D2
X61	Repeat sign in 6.	31D2	1	1/E2
X62	"Not Shifts". Delete m.s. digit in 7.	31J2	3	1/E2
$X65_0$	N-decoding x6. N00. N26.	33V1	4	1/K6
$X65_1$		33Q4	8	1/D4
X70	Part of 'Switch Stop	12L3	3	4/K9
X71	Programmed stop stat. output 77 stop.	12Q1	1	4/K5
X72	S/G digit stop stat. output	12P1	1	4/K6
X73	OVR on Write	12R1	1	4/K6
X74	Drum parity failure stop staticised.	M 26E1	1	7/C3
		M 12Q2	1	4/K7
X75	Unallocated functions stop staticised.	12R2	1	4/K7
X77	Inverse drum parity failure. ~ X74	23U3	3	2/E4
X78	Key-stop stat. [Inhibit Hooter Drive]	12P2	1	4/K8
X79	Gate 'Hoot' [~ X78]	12Y2	3	8/F1
$X80_0$	"Beat Trigger"	24S2	4	6/C0
$X80_1$		24Q1	8	6/D1
$X80_2$		13U2	8	8/H6
X82	Drum Transfers-set K. Beat timing control output [42 digit line].	32X	6	1/G2

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X90	~ Drum T.A. Wf. [Reset waiting period]	20G2	3	5/C3
X91	Tape, 17 or 16, X92 $_{v}$ X93	24U6	8	8/A3
X92	Address 16.	33D2	4	8/A3
X93	Address 17.	33D3	4	8/A3
X95	'Busy' ~ [X122 $_{v}$ X123 $_{v}$ X125]	11H6	8	8/C5
~ X95		12C3	3	5/B0
X96	Groups 0, 1, 2, [3] ~ [10 $_{v}$ 12] & D.	11R4	4	8/A0
X99$_{0}$	Set S-stats. [21-23] [Track Selection]	20M3	2	7/A0
X99$_{1}$		20Q4	8	7/B0
X99$_{2}$		26U2	8	7/A1
~ X99$_{0}$		24K2	3	7/B1
~ X99$_{1}$		26U1	8	7/B1
X100	G06 & D4 Jumps	22J3	4	4/D3
X101		22P1	8	4/A4
X102	G05 & G06 [Normalize]	22J4	4	4/B3
X104$_{0}$	Set ext. cond. stats. [lasts two drum revs.]	20W1	1	5/C0
X104$_{1}$		35L5	8	3/A4
X104$_{2}$		35D2	8	3/B4
X105		13E1	3	8/H9
X106	~ X111	13E3	3	8/H8
X107	Y shift Up L.H.	13G4	4	8/J9

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X108	Y shift Down	13C1	2	8/J9
X109	Stop scan L.H.	13G1	4	8/K8
X110		13D1	1	8/G9
X111		13D2	1	8/H9
X116	Scale [L.H.S.] D^{19}	13P2	1	8/K0
X117	Start scan R.H.	13K2	1	8/J8
X118	Stop scan R.H.	M 13C1	2	8/J9
		M 13C2	2	8/J8
X120	Inhibit +1 to Order No. on Manual	25U3	3	6/G4
X121	Manual, gate H/S order	25D2	1	6/F4
$X122_0$	Tape Reader Busy	11Q2	1	8/B0
$X122_1$		11H5	8	8/B0
X123	Tape Reader Busy	11Q1	1	8/B1
$X124_0$	Prime Selector Stats. [Punch]	11E2	1	8/D8
$X124_1$		11H1	8	8/B5
$X125_0$	Hold [Punch] Stats. [Punch Busy]	11J2	1	8/B5
$X125_1$		11H3	8	8/C5
$X125_2$		11H2	8	8/C5
$X125_3$		11H4	8	8/B5
X127		12E3	2	8/H7
		*13F1	1	8/J7
		13F2	1	8/J7

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X128	Monitor Scale [R.H.S.] D^{14}	13P1	1	8/K0
X129	Y shift up R.H.	13G3	4	8/J9
X130	G05 & ~ E2. Gate addition of -1 to N digits.	30C3	4	1/A2
X200	~ 54 $_{V}$ 55	22X3	3	2/B1
X201	~ G02 $_{V}$ [G02 & G13].	22X2	3	2/A1
X202	Groups [0,1,3,4,6, $_{V}$ 23, 50-53, 56,57] & E	22Y4	4	2/B2
X203	Erase for 72, G12 parity fail Read T.A. W.f.	22Y3	4	2/B2
X204	Acc. 5 decoded.	33T1	4	2/A4
$X204_1$	Acc. 5 decoded.	33Q1	8	2/B4
$X205_0$	Acc. 4 decoded.	33M1	4	2/A5
$X205_1$	Acc. 4 decoded.	33Q2	8	2/B5
$X206_0$	Acc. 3 decoded.	33J4	4	2/A6
$X206_1$	Acc. 3 decoded.	33Q6	8	2/B6
$X207_0$	Acc. 2 decoded.	33J1	4	2/A7
$X207_1$	Acc. 2 decoded.	33Q3	8	1/B7
$X208_0$	Acc. 1 decoded.	33F1	4	2/A9
$X208_1$	Acc. 1 decoded.	34E1	8	2/B9
X209	Acc. 5 Erase	33R1	3	2/B4
X210	Acc. 4 Erase	33R2	3	2/B4
X211	Acc. 3 Erase	33R3	3	2/B6
X212	Acc. 2 Erase	33H1	3	2/B7

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X213	Acc. 1 Erase	33H3	3	2/B9
X217	~ [G02 & G13]	22W2	3	2/H0
X218	$J_V 10_V X40_V$ X20. Trig. to S1	34E6	8	2/F2
X219	Not Acc. Transfers.	26W3	3	2/F2
$X219_1$		34P1	8	2/G3
X220	Trigger S2 [& p40 & X219]	34F2	1	2/F3
X221	Trigger S3 [& p40 & X219]	34R1	2	2/G3
X222	Trigger S4 [& p40 & X219]	34R2	2	2/G4
X223	Part trigger to S1 [M-address]	34G1	4	2/G2
X224	W/f. in half adder to increase on Block transfer.	34J1	3	2/F5
X225	Set S6 for transfers	34H2	3	2/G5
X226	Part S7 set, part Count 7 for transfers.	34H3	2	2/G6
X227	Part of half adder increasing N in a block transfer.	34K1	1	2/F5
X228	X/M digits to S8	26Y1	1	2/F8
X229	X/M digits to S9	34T1	2	2/G8
X230	X/M digits to S10	34T2	2	2/G9
X231	[Set S - stats] [S8]	M*24Y3	4	2/G7
X231	[Set S - stats] [S8]	M24Y4	4	2/G7
$X231_1$		34X3	8	2/G8
X232	0.0. decoded	38D4	4	3/A9
X233	0.0. decoded Erase.	39C		3/A9

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X234	0.1 decoded	38D3	4	3/A8
X235	0.1 Erase	39D		3/A8
X236	0.2 decoded	38D2	4	3/A8
X237	0.2 Erase	37C		3/A8
X238	0.3 decoded	38D1	4	3/A7
X239	0.3 Erase	37D		3/A7
X240	0.4 decoded	37H4	4	3/A7
X241	0.4 Erase	37E		3/A7
X242	0.5	37H3	4	3/A6
X244	0.6	37H2	4	3/A6
X246	0.7	37H1	4	3/A5
X248		38H4	4	3/C9
X250		38H3	4	3/C8
X252		38H2	4	3/C8
X254		38H1	4	3/C7
X256		39H4	4	3/C7
X258		39H3	4	3/C6
X260		39H2	4	3/C6
X262		39H1	4	3/C5
X264		39Q4	4	3/F9
X266		39Q3	4	3/F8
X268		39Q2	4	3/F8
X270		39Q1	4	3/F7

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X272		39W4	4	3/F7
X274		39W3	4	3/F6
X276		39W2	4	3/F6
X278		39W1	4	3/F5
X280		39Q4	4	3/H9
X282		38Q3	4	3/H8
X284		38Q2	4	3/H8
X286		38Q1	4	3/H6
X288		38W4	4	3/H7
X290		38W3	4	3/H6
X292		38W2	4	3/H6
X294		38W1	4	3/H5
X296		37Q4	4	3/F4
X298		37Q3	4	3/F3
X300		37Q2	4	3/F3
X302		37Q1	4	3/F2
X304		37W4	4	3/F2
X306		37W3	4	3/F1
X308		37W2	4	3/F1
X310		37W1	4	3/F0
X312		36Q4	4	3/H4
X314		36Q3	4	3/H3

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X316		36Q2	4	3/H3
X318		36Q1	4	3/H2
X320		36W4	4	3/H2
X322		36W3	4	3/H1
X324		36W2	4	3/H1
X326		36W1	4	3/H0
X328		36H1	2	3/D3
$X329_0$		24S3	4	4/C0
$X329_1$		20Q6	8	4/C0
X330		21K6	8	4/D5
X331		21H1	1	4/E5
X332		21J1	3	4/E5
X333		21J2	3	4/F5
X335		21R1	4	4/D7
X336		21Q2	3	4/E8
X337		21R2	4	4/E8
X338		21V1	3	4/A7
X339		25Y2	1	4/B8
X340		25Y1	1	4/B9
$X340_1$		25S3	8	4/A9
X341		22J1	4	4/G7
X342		25H3	4	4/J6

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X343		12M2	1	4/K9
X344		12M1	1	4/K9
X345		11T2	3	8/C3
X346		11S2	1	8/D3
X347	Tape Read	21F2	3	8/A0
X348	Tape Location	11D2	4	8/A1
X349	Tape Brake	21U1	1	4/A6
X350		11P3	3	8/C0
X351		11C1	4	8/B5
X352		11J1	1	8/B5
X353		21P1	2	8/B6
X354		12G4	4	8/B7
X355		12L1	3	8/A7
X356		12L2	3	8/A7
X357		12H2	1	8/B7
X358		12J1	1	8/B8
X359		12J2	1	8/B8
X360		12H1	1	8/B9
X361		12E2	2	8/C9
X362		12K6	8	8/C9
X363		12C1	3	8/E8
X364		12E1	2	8/E8
X365	Parity digit to output Punch	21W2	1	2/C3

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X367		20H2	2	5/B1
X368		20G1	3	5/B1
X369		20F1	1	5/B2
X370	Coincidence	20G3	3	5/B2
X371		20F2	1	5/B3
X372		20H3	2	5/C3
X373	[~ X73]	20C1	3	5/A4
X378		31C1	3	1/G0
X379		30S1	1	1/G3
X380		30X1	1	1/G4
X381		30Y2	3	1/G4
X382		30R6	8	1/G3
X384		32L1	3	1/G1
X385		31X3	3	1/A8
$X386_0$		33Y1	4	1/D5
$X386_1$		33Q5	8	1/D5
X387		33X3	3	1/C5
X388		30J1	3	1/G6
X390		30F3	3	1/G9
X391		30J2	3	1/H6
X392		30F1	3	1/H7
X393		30F2	3	1/H9

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X394		33X1	3	1/K6
X395		25K2	1	6/B3
X396		25L3	3	6/B3
X397		24S4	4	6/C3
X398		25F2	3	6/C4
X399		25F3	3	6/E3
X400		24R1	3	6/C0
X401		24P1	3	6/D0
X402		22U6	8	6/F0
X403		22V1	1	6/G1
X404		25G1	2	6/G3
X405		26Q1	2	6/G3
X406		26Q2	2	6/H3
X407		25U1	3	6/E6
X408		25U2	3	6/G6
X409		20H1	2	5/B0
X410		20K2	1	5/A2
X411		21X2	3	4/E8
X412		30Y1	3	1/A5
X413	Gate justification of X and Q for double length division [D ~ F4] delayed one digit time.	34D1	2	1/A5
X414		22D1	3	4/H6

3.8.20 Action Waveforms (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
X420		34C2	1	4/K4
X421		34C1	1	4/K4
X425	Gate setting pulse to drum parity staticised p39 and "Drum clock"	13G2	4	5/A5
X450	A ~ J	25H4	4	2/E8
X451	B_V J	24L6	8	6/B0
X452	Gate inputs to order Register, trigger [B_V J] ~ p40. E.Z200	13H4	4	8/G5
X453		24R2	3	6/C0
X455		13J1	4	8/J6
X456		13H1	4	8/J6
X457		13M1	1	8/G5
X458		13M2	1	8/G5
X459	Coincidence output for Order number and Drum address trigger	13K1	1	8/G6
X460	D^{19}	11X	6	8/J2
X461	D^{21}	11R3	4	8/J1
X462	D^{14}	11Y1	1	8/K2
X463	D^{9}	11T1	3	8/J2
X470		34M6	8	2/G7

3.8.21 Operands

Waveform	Type of Waveform	Element Position	Package Type	Logical Liagram Reference
Y1	Output of Mill delay line, [write to drum]	21L	6*	4/F6
Y2	Output of Mill	21M3	2	4/F7
Y3		34P6	8	6/B8
Y4	N-bus and D ~ C sign repeated	22L1	1	4/K1
Y5	X-bus and D ~ C sign repeated	22L2	1	4/G1
Y6		32R1	1	1/C6
Y7	M-bus	35F1	2	4/H1
Y8	X-bus	34G3	4	4/G1
Y9	N-bus to multiplicand/divisor register, and optional stop.	24Y1	4	6/A9
~ Y9	Sign repeater	21V2	3	4/J6
Y10	Sign of Acc. 7 staticised.	24Y2	4	6/A9
Y10		32T1	1	1/A8
Y11		34G2	4	2/D2
Y12	Output of 2nd adder Acc.6 [used in add/subtract operation in division].	30E1	1	1/G7
$Y12_1$		30G4	8	1/H8
Y13	Output of Acc.6 nickel line. Last digit to Acc.7 for double length shifts down.	30D	6*	1/G9
Y14	Shuffle digits from Acc.6 to Acc.7 for multiplication.	32S2	2	1/J9
Y15	M-bus delayed 3 places [i.e. total delay 6 places]	25W3	2	4/J1

3.8.21 Operands (Contd)

Waveforms	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Y16	Acc. 6 contents to mill for 21 and 22 instructions.	32S1	2	1/J8
Y17	Used in not equivalent operations for 54 and 56 instructions.	33W1	1	1/J5
Y18		30R5	8	1/H5
Y19	External conditioning relay tape reader digit 4	11C2	4	8/D1
Y20	External conditioning relay tape reader digit 3	11C3	4	8/D1
Y21	External conditioning relay tape reader digit 2	11C4	4	8/C1
Y22	External conditioning relay tape reader digit 1	11D4	4	8/C1
Y23	External conditioning relay tape reader digit 0	11D3	4	8/B1
Y30	Write waveform [even digits] to drum	36G2	2	3/C4
Y31		36G1	2	3/C4
Y32	Write waveform [odd digits] to drum	36H3	2	3/C4
Y33		36H2	2	3/D4
Y34	Drum read output.	M 20P2	4	5/D1
		M* 20P3	4	5/D1
$Y35_0$	Input bus.	21Y1	1	2/B3
		21Y2	1	2/B3

3.8.21 Operands (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
$Y35_1$	Input bus.	34E5	8	3/E2
$Y35_2$		34X4	8	3/E2
$Y35_3$		34X5	8	3/E2
$Y35_4$		34P5	8	3/E3
$Y35_5$		34P4	8	2/A3
$Y35_6$		33F3	4	2/A3
$Y35_7$		20D5	8	2/A3
Y36	Test points for out of range division.	32P2	2	1/C8
Y37		32P3	2	1/C7
Y38	Digits from Acc.7 to Acc.6 for instruction 22.	31P1	1	1/B5
Y39	Input to Mill from Acc.6 in instruction 22. Adjusts contents of N in instruction 23.	32W1	1	1/B3
Y40	Order Number Register output.	25P	6	6/A5
Y41		M 13W3	4	8/H0
		M_*13W2	4	8/H0
Y42	Order Register output.	25Q	6*	6/A6
Y43		20M1	2	2/B3
Y44		33D1	4	1/B4
Y45		11U2	2	8/B3
Y46		24J2	2	6/B5

3.8.21 Operands (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Y47		24J1	2	6/B5
Y51	Accumulator x1	33E	6	2/C9
Y52	„ x2	33K	6	2/C7
Y53	„ x3	33L	6	2/C6
Y54	„ x4	33S	6	2/C5
Y55	„ x5	33U	6	2/C4
Y59		21H2	1	4/F5
Y60	N. - bus to Order Register and via Mill to drum and to buffer store.	24Y2		6/A9
Y61		36E2	1	3/D2
Y62		36F3	3	3/C3
Y63		36E1	1	3/C2
Y64		36F2	3	3/C3
Y65	X - M bus	M 34U1	1	4/G0
		M 34U2	1	4/G0
Y66		34T3	2	4/H0
Y67		34R3	2	4/H1
Y68		25W1	2	4/J0
Y69		25W2	2	4/J1
Y70		21M2	2	4/F7
Y71		21P2	2	4/F8
Y72		21P3	2	4/F9

3.8.21 Operands (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Y73		21C1	2	4/G9
Y74		21C2	2	4/G9
Y75		M*21C3	2	4/F9
		M 21P3	2	4/F9
Y76		M 23D2	7	2/C2
		M 24G5	7	2/D1
		M 24G2	7	2/D1
		M 23D5	7	2/C2
		M 23G2	7	2/C1
		M 23G5	7	2/C1
		M 24D2	7	2/D2
		M 23D5	7	2/D2
Y77		25M2	2	2/D1
Y78		24J3	2	2/E1
Y80		M*11V2	7	8/B2
		M 11V5	7	8/D2
Y81		M*11R2	4	8/D3
		M 11U3	2	8/E3
Y82		32V1	1	1/A3
Y83		32V2	1	1/B3
Y84		32Q1	3	1/A4
Y85		32R2	1	1/B4
Y86		32K1	1	1/H1

3.8.21 Operands (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Y87		31V1	2	1/B8
Y88		31Y	6*	1/B9
Y89		32P1	2	1/C8
Y90		30T	6	1/E5
Y91		30P1	1	1/F5
Y92		30K2	1	1/F6
Y93		30M1	2	1/F8
Y94		30K1	1	1/F6
Y95		30H2	1	1/F7
Y96		30E2	1	1/F9
Y97		30P2	1	1/H6
Y98		31H1	1	1/H9
Y99		25T1	1	6/E6
Y100	Register 0.0	39C	6	3/B9
Y101	Register 0.1	39D	6	3/B8
Y102	Register 0.2	37C	6	3/B8
Y103	Register 0.3	37D	6	3/B7
Y104	Register 0.4	37E	6	3/B7
Y105	Register 0.5	37F	6	3/B6
Y106	Register 0.6	37J	6	3/B6
Y107	Register 0.7	37K	6	3/B5
Y110	Register 1.0	38E	6	3/D9
Y111	Register 1.1	38F	6	3/D8

3.8.21 Operands (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Y112	Register 1.2	38J	6	3/D8
Y113	Register 1.3	38K	6	3/D7
Y114	Register 1.4	39E	6	3/D7
Y115	Register 1.5	39F	6	3/D6
Y116	Register 1.6	39J	6	3/D6
Y117	Register 1.7	39K	6	3/D5
Y120	Register 2.0	39L	6	3/G9
Y121	Register 2.1	39M	6	3/G8
Y122	Register 2.2	39R	6	3/G8
Y123	Register 2.3	39S	6	3/G7
Y124	Register 2.4	39T	6	3/G7
Y125	Register 2.5	39U	6	3/G6
Y126	Register 2.6	39X	6	3/G6
Y127	Register 2.7	39Y	6	3/G5
Y130	Register 3.0	38L	6	3/J9
Y131	Register 3.1	38M	6	3/J8
Y132	Register 3.2	38R	6	3/J8
Y133	Register 3.3	38S	6	3/J7
Y134	Register 3.4	38T	6	3/J7
Y135	Register 3.5	38U	6	3/J6
Y136	Register 3.6	38X	6	3/J6
Y137	Register 3.7	38Y	6	3/J6

3.8.21 Operands (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Y140	Register 4.0	37L	6	3/G4
Y141	Register 4.1	37M	6	3/G3
Y142	Register 4.2	37R	6	3/G3
Y143	Register 4.3	37S	6	3/G2
Y144	Register 4.4	37T	6	3/G2
Y145	Register 4.5	37U	6	3/G1
Y146	Register 4.6	37X	6	3/G1
Y147	Register 4.7	37Y	6	3/G0
Y150	Register 5.0	36L	6	3/J4
Y151	Register 5.1	36M	6	3/J3
Y152	Register 5.2	36R	6	3/J3
Y153	Register 5.3	36S	6	3/J2
Y154	Register 5.4	36T	6	3/J2
Y155	Register 5.5	36U	6	3/J1
Y156	Register 5.6	36X	6	3/J1
Y157	Register 5.7	36Y	6	3/J0
Y160		33H2	3	6/A9
Y161	N-bus parity count.	35C1	1	6/B9
Y162		35D6	8	6/B8
Y163		35F3	2	6/C8
Y164	X-bus parity count.	32K2	1	4/H2
Y200		25S6	8	6/D6

3.8.21 Operands (Contd)

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Y215	Input bus parity count.	20P1	4	2/C4
Y216		20M1	2	2/B3
Y217		20D6	8	2/C3
Y218		21X3	3	2/C3
Y383		32Q2	3	1/H2

3.8.22 Waveforms from Output Plates

Waveform	Type of Waveform	Element Position	Package Type	Logical Diagram Reference
Lamp controls				
[L] L1	Engineers' Panel	35G5	9	7/A6
[L] L2		35H5	9	7/A6
[L] L3		35J5	9	7/A7
[L] L4		35K5	9	7/A7
[L] L5		35G6	9	7/A8
[L] L6		35H6	9	7/A8
[P] L1	Programmers Panel	35K6	9	3/C0
[P] L2		35J6	9	3/C0
[P] L3		13Y1	9	8/G2
[P] L4		13Y2	9	8/G0
[P] L5		13X1	9	8/G0
[P] L6		35K2	9	3/C0
[P] L7		13Y4	9	8/G1
[P] L8		13X2	9	8/G2
[P] L9		13Y3	9	8/G1
[P] L10		13Y5	9	8/C0
[P] L11		13Y6	9	8/C6

3.8.22 Waveforms from Output Plates (Contd)

Function	Element Position	Package Type	Logical Diagram Reference
Loudspeaker Control			
L.S. [Loudspeaker]	13X5 13X6	9 9	8/F2 8/F3
N.P. [Noise Probe]	13X4	9	8/E2
Tape [Reader] Control			
Clutch [input $X122_1$]	11M3	10	8/C0
Brake 1 [input X350]	11M2	10	8/C0
Brake 2 [input X350]	11M1	10	8/C0
Tape Punch			
Clutch [input X352]	11L1	10	8/C5

3.9 Leads for Handswitches and Monitor Switches

Leads' Nos.	Programmers' Handswitch Nos.
Z0	40
Z1	39
Z2	38
Z3	37
Z4	36
Z5	35
Z6	34
Z7	33
Z8	32
Z9	31
Z10	30
Z11	29
Z12	28
Z13	27
Z14	26
Z15	25
Z16	24
Z17	23
Z18	22
Z19	21
Z20	20
Z21	19

3.9 Leads for Handswitches and Monitor Switches (Contd)

Nos.	Destination
Z53	Order No. Register to Monitor 2.
Z63	Order Register to Monitor 2.
Z64	Trigger H/Sw. 'Block 2' in inhibit position
Z65	Trigger H/Sw. 'Block 4' in inhibit position
Z66	Trigger H/Sw. 'Block 8' in inhibit position
Z70	Trigger H/Sw. 'Position 1'
Z71	Trigger H/Sw. 'Position 2'
Z72	Trigger H/Sw. 'Position 4'
Z73	Trigger H/Sw. 'Block 1'
Z74	Trigger H/Sw. 'Block 2'
Z75	Trigger H/Sw. 'Block 4'
Z76	Trigger H/Sw. 'Block 8'

3.9 Leads for Handswitches and Monitor Switches (Contd)

Nos.	Destination	Element Position	Package Type	Logical Diagram Reference
[Z155]	'Scale' switch L.H.S. [X116]	13P2	1	8/K0
[Z156]	'Scale' switch R.H.S. [X128]	13P1	1	8/K0
Z158	Drum Address	SW4a; 9, 10, 11.		
Z159	Multi-Beat	SW4a; 7.		
Z160	Repetitive	SW4a; 12.		
Z161	CD	SW4a; 1.		
Z162	AD	SW4a; 2.		
Z163	AE	SW4a; 3.		
Z167	BD	SW4a; 4.		
Z168	Drum Address or multi-beat or one-third word time triggers.	SW4b; 7, 9, 10, 11.		
Z169	BE	SW4a; 5.		
Z170	One-third word time trigger p27	SW4d; 9.		
Z171	One-third word time trigger p13	SW4d; 10.		
Z178	Half Word Scan	SW3c; 1.		
Z179	Not one-third word time triggers.			
Z200	Order Number Trigger			
Z205		35J3 35J4	9 9	3/A1 3/A1

3.9 Leads for Handswitches and Monitor Switches (Contd)

Nos.	Destination	Element Position	Package Type	Logical Diagram Reference
Z206		35J1	9	3/A1
		35J2	9	3/A1
Z208		35H1	9	3/A2
		35H2	9	3/A2
Z209		35H3	9	3/A2
		35H4	9	3/A2
Z224		35G3	9	3/A3
		35G4	9	3/A3
Z225		35G1	9	3/A3
		35G2	9	3/A3

3.10 Monitoring Points (Probe points on packages)

Section	Monitoring Point	
	Element	Probe Point
Order Register	25Q	D
Order Number Register	25P	D
Mill Output [delayed one digit time]	21M	D3
N-bus	34P	6

3.10 Monitoring Points (Probe points on packages) (Contd)

Section	Monitoring Point	
	Element	Probe Point
Registers		
0.0	39C	D
0.1	39D	D
0.2	37C	D
0.3	37D	D
0.4	37E	D
0.5	37F	D
0.6	37J	D
0.7	37K	D
1.0	38E	D
1.1	38F	D
1.2	38J	D
1.3	38K	D
1.4	39E	D
1.5	39F	D
1.6	39J	D
1.7	39K	D
2.0	39L	D
2.1	39M	D
2.2	39R	D
2.3	39S	D
2.4	39T	D
2.5	39U	D
2.6	39X	D
2.7	39Y	D

Section	Monitoring Point	
	Element	Probe Point
Registers		
3.0	38L	D
3.1	38M	D
3.2	38R	D
3.3	38S	D
3.4	38T	D
3.5	38U	D
3.6	38X	D
3.7	38Y	D
4.0	37L	D
4.1	37M	D
4.2	37R	D
4.3	37S	D
4.4	37T	D
4.5	37U	D
4.6	37X	D
4.7	37Y	D
5.0	36L	D
5.1	36M	D
5.2	36R	D
5.3	36S	D
5.4	36T	D
5.5	36U	D
5.6	36X	D
5.7	36Y	D

3.10 Monitoring Points (Probe points on packages) (Contd)

Section	Monitoring Point	
	Element	Probe Point
Accumulators		
X1	33E	D
X2	33K	D
X3	33L	D
X4	33S	D
X5	33U	D
X6 In Standard Timing*	31S	M1
X7	32R	D1
Trigger Points		
p41	23H	D4
CD	13J	A4
AD	13H	A3
AE	13H	A2
BD	13G	A2
BE	13G	A3
Multi-beat	13J	A2
Beats		
A	24M	D1
B	24M	D2
C	24P	I2
D	24T	D1
E	24V	D1
K	31T	D2
L	32T	D2
*For X6 and X7 nickel lines see 3.11.		

3.10 Monitoring Points (Probe points on packages) (Contd)

Section	Monitor Point			
	Staticiser		Inverter	
	Element	Probe Point	Element	Probe Point
N-Staticisers				
Most significant	34Q	D2	35M	I3
	34Q	D1	35T	I3
	34S	D1	35T	I1
	34S	D2	35T	I2
	34K	D2	34J	I3
	34L	D1	35M	I2
Least significant	34L	D2	35M	I1
X-Staticisers				
Most significant	34V	D1	34W	I2
	34V	D2	34W	I3
	34Y	D2	34W	I1
F-staticisers				
Most significant	23V	D2	23W	I3
	23X	D2	23W	I2
	23X	D1	23W	I1
	20W	D2	20V	I3
	20X	D2	20V	I2
Least significant	20X	D1	20V	I1

Miscellaneous Waveforms		Monitor Point	
		Element	Pin number
p Pulse	p0	23M	28
	C-Beat	24P	19
	W19	33W	18
	W20	37G	13
	W21	38V	13
Handswitches		25M	19
Tape Reader [Photo cell 0]		11V	20
Trigger Point		11Q	19

3.11 Special Monitoring Facilities

[*Note.* Panel engraving filled in black is significant when Switch B is in the 'Test 1' position.]

Waveform	Switch B Position	Switch A Position
Clock amplifier sine wave	Test 1	X0
Clock 1	„	X1
Clock 2	„	X2
Output of Mill 35 digit line	„	Mill
Reset line 1	„	N0
Reset line 2	„	N1
Reset line 3	„	N2
Reset line 4	„	N3
Reset line 5	„	N4
Reset line 6	„	N5
Reset line 7	„	N6
Reset line 8	„	N7
A Beat A1	Test 2	X2
B Beat B1	„	X3
C Beat C1	„	X4
D Beat D7	„	X5
E Beat E1	„	X6
X Parity	„	X7
N Parity	„	N0
X6 Nickel line.	„	N1
X7 Nickel line.	„	N2
Multiplier/Divisor Register.	„	N3
Multiplier timing register	„	N4
K1	„	N5
L1	„	N6
Input bus. $Y35_1$	„	N7
*Register 20	„	Selected Track
* Error Register	„	Hand Switches

*Computers with facilities for Magnetic Tape only.

3.12 Alarm and Fan Fuses. (Bay 1).

Fuse	Protective Circuitry Transformer Connection	Voltage	Power Cubicle Fuse	Transformer Loading	Loading
10	T2 [F1]	+300V	F62		Shelf 10
11		+300V	F62		Shelf 11
12		+300V	F62		Shelf 12
13		+300V	F62		Shelf 13
14		+300V	F62		Tape Readers, Engineers' Panel, Creed Punch. [T.B.550]
15		+300V	F62		Not used
10	T2 [E1]	+200V	F61		Shelf 10
11		+200V	F61		Shelf 11
12		+200V	F61		Shelf 12
13		+200V	F61		Shelf 13
14		+200V	F61		Not used.
15		+200V	F61		Monitor lamp panel.
16		+200V	F61		External conditioning relays engineers' panel [T.B.551]
17		+200V	F61		Not used.
10	T2 [D1]	-150V	F60		Shelf 10
11		-150V	F60		Shelf 11
12		-150V	F60		Shelf 12
13		-150V	F60		Shelf 13
14		-150V	F60		Engineers' panel, tape readers, interpreter. [T.B.552]
15		-150V	F60		Not used.
Drum +300V	T7 [E1]	Drum +300V			Shelf 27
Drum -150V	T7 [F1]	Drum -150V			Shelf 27
Bias +13V	T7 [B1]				
Bias -4V	T7 [A1]				

3.12 Alarm and Fan Fuses. (Bay 1). (Contd).

Fuse	Protective Circuitry Transformer Connection	Voltage	Power Cubicle Fuse	Transformer Loading	Loading
Bias -10V	T7 [C1]				
Bias -20V	T7 [D1]				
100	T2 [A1]	240V. 48.5 c.p.s. Ph. A	F16	H 10	Shelf 10
101		240V. 48.5 c.p.s. Ph. A	F16	H 11	Shelf 11
102	T2 [B1]	240V. 48.5 c.p.s. Ph. B	F17	H 13	Shelf 13
103		240V. 48.5 c.p.s. Ph. B	F17	H 14	Shelf 14
104	T2 [C1]	240V. 48.5 c.p.s. Ph. C	F18	H 12	Shelf 12
105		240V. 48.5 c.p.s. Ph. C	F18		Monitor
106		240V. 48.5 c.p.s. Ph. C	F18		Socket and Relay panel. [T.B. 555]
107	T2 [B1]	240V. 48.5 c.p.s. Ph. B	F17		Tape Reader 'B'
108	T2 [A1]	240V. 48.5 c.p.s. Ph. A	F16		Tape Reader 'A' [T.B. 553]
109	T2 [C1]	240V. 48.5 c.p.s. Ph. C	F18		T2. Auxiliary power panel.
110	T1 [A1]	440V. 50 c.p.s. Ph. A	F13		Creed punch auto transformer, Tape Spoolers A & B, Teleprinter.
111		440V. 50 c.p.s. Ph. A	F13		Fans
112	T1 [B1]	440V. 50 c.p.s.	F14		Teleprinter, Creed punch auto-transformer, Tape Spoolers A & B [T.B. 559]

3.12 Alarm and Fan Fuses. (Bay 1). (Contd).

Fuse	Protective Circuitry Transformer Connection	Voltage	Power Cubicle Fuse	Transformer Loading	Loading
113	T1 [B1]	440V. 50 c.p.s. PL. B.	F14		Not used.
114	T1 [C1]	440V. 50 c.p.s. Ph. C.	F15		Not used. [T.B.560]
115		440V. 50 c.p.s. Ph. C.	F15		Not used.

3.12 Alarm and Fan Fuses (Bay 2)

20	T4. [F1.]	+300V	F.62		Shelf 20
21		+300V	F.62		Shelf 21
22		+300V	F.62		Shelf 22
23		+300V	F.62		Shelf 23
24		+300V	F.62		Shelf 24
25		+300V	F.62		Shelf 25
26		+300V	F.62		Shelf 26
27		+300V	F.62		Shelf 27
28		+300V	F.62		Shelf 28
29		+300V	F.62		Shelf 29
20	T4. [F1.]	+200V	F.61		Shelf 20
21		+200V	F.61		Shelf 21
22		+200V	F.61		Shelf 22
23		+200V	F.61		Shelf 23
24		+200V	F.61		Shelf 24
25		+200V	F.61		Shelf 25
26		+200V	F.61		Shelf 26
27		+200V	F.61		Shelf 27
28		+200V	F.61		Shelf 28
29		+200V	F.61		Shelf 29
20	T4. [D1.]	-150V	F.60		Shelf 20
21		-150V	F.60		Shelf 21
22		-150V	F.60		Shelf 22
23		-150V	F.60		Shelf 23
24		-150V	F.60		Shelf 24
25		-150V	F.60		Shelf 25

3.12 Alarm and Fan Fuses (Bay 2) (Contd).

Fuse	Protective Circuitry Transformer Connection	Voltage	Power Cubicle Fuse	Transformer Loading	Loading
26	T4. [D1.]	-150V	F.60		Shelf 26
27		-150V	F.60		Shelf 27
28		-150V	F.60		Shelf 28
29		-150V	F.60		Shelf 29
200	T4. [A1.]	240V 48.5 c.p.s. Ph.A	F.16	H.20	Shelf 20
201		240V 48.5 c.p.s. Ph.A	F.16	H.21	Shelf 21
202		240V 48.5 c.p.s. Ph.A	F.16	H.22	Shelf 22
203		240V 48.5 c.p.s. Ph.A	F.16	H.23	Shelf 23
204	T4. [B1.]	240V 48.5 c.p.s. Ph.B	F.17	H.24	Shelf 24
205		240V 48.5 c.p.s. Ph.B	F.17	H.25	Shelf 25
206		240V 48.5 c.p.s. Ph.B	F.17	H.26	Shelf 26
207	T4. [C1.]	240V 48.5 c.p.s. Ph.C	F.18	H.27	Shelf 29
208		240V 48.5 c.p.s. Ph.C	F.18	H.28	Lower half Shelf 27. Upper half Shelf 28.
209		240V 48.5 c.p.s. Ph.C	F.18	H.29	Lower half Shelf 28.
210					Not used.
211					Not used.
212					Not used.
213	T3. [A1.]	440V 50 c.p.s. Ph.A	F.13		Not used.
214	T3. [B1.]	440V 50 c.p.s. Ph.B	F.14		Fans.
215	T3. [C1.]	440V 50 c.p.s. Ph.C	F.15		Not used.
216		+200V	F.61		Drum Packages.

3.12 Alarm and Fan Fuses (Bay 3)

Fuse	Protective Circuitry Transformer Connection	Voltage	Power Cubicle Fuse	Transformer Loading	loading
30	T6. [F1.]	+300V	F. 62		Shelf 30
31		+300V	F. 62		Shelf 31
32		+300V	F. 62		Shelf 32
33		+300V	F. 62		Shelf 33
34		+300V	F. 62		Shelf 34
35		+300V	F. 62		Shelf 35
36		+300V	F. 62		Shelf 36
37		+300V	F. 62		Shelf 37
38		+300V	F. 62		Shelf 38
39		+300V	F. 62		Shelf 39
30	T6. [E1.]	+200V	F. 61		Shelf 30
31		+200V	F. 61		Shelf 31
32		+200V	F. 61		Shelf 32
33		+200V	F. 61		Shelf 33
34		+200V	F. 61		Shelf 34
35		+200V	F. 61		Shelf 35
36		+200V	F. 61		Shelf 36
37		+200V	F. 61		Shelf 37
38		+200V	F. 61		Shelf 38
39		+200V	F. 61		Shelf 39
30	T6. [D1.]	-150V	F. 60		Shelf 30
31		-150V	F. 60		Shelf 31
32		-150V	F. 60		Shelf 32
33		-150V	F. 60		Shelf 33
34		-150V	F. 60		Shelf 34
35		-150V	F. 60		Shelf 35
36		-150V	F. 60		Shelf 36
37		-150V	F. 60		Shelf 37
38		-150V	F. 60		Shelf 38
39		-150V	F. 60		Shelf 39
300	T6. [A1.]	240V 48.5 c.p.s. Ph. A	F. 16	H. 30	Shelf 30
301		240V 48.5 c.p.s. Ph. A	F. 16	H. 31	Shelf 31
302		240V 48.5 c.p.s. Ph. A	F. 16	H. 32	Shelf 32

3.12 Alarm and Fan Fuses (Bay 3). (Contd)

Fuse	Protective Circuitry Transformer Connection	Voltage	Power Cubicle Fuse	Transformer Loading	Loading
303		240V 48.5 c.p.s. Ph.B	F.17	H.33	Shelf 33
304	T6.[B1.]	240V 48.5 c.p.s. Ph.B	F.17	H.33	Shelf 34
305		240V 48.5 c.p.s. Ph.B	F.17	H.33	Shelf 35
306		240V 48.5 c.p.s. Ph.C	F.18	H.36	Shelf 36
307	T6.[C1.]	240V 48.5 c.p.s. Ph.C	F.18	H.37	Shelf 37
308		240V 49.5 c.p.s. Ph.C	F.18	H.38	Shelf 38
309		240V 48.5 c.p.s. Ph.C	F.18	H.39	Shelf 39
310					Not used.
311					Not used.
312					Not used.
313	T5.[A1.]	440V.50 c.p.s. Ph.A			Not used.
314	T5.[B1.]	440V.50 c.p.s. Ph.B			Not used.
315	T5.[C1.]	440V.50 c.p.s. Ph.C			Fans.

3.13 Address Locations

Address	Register	Gating	Selection
0.0	39C	[38C[2]	38D [4]
0.1	39D	[	38D [3]
0.2	37C	[38C[1]	38D [2]
0.3	37D	[	38D [1]
0.4	37E	[37G[2]	37H [4]
0.5	37F	[	37H [3]
0.6	37J	[37G[1]	37H [2]
0.7	37K	[	37H [1]
1.0	38E	[38G[2]	38H [4]
1.1	38F	[	38H 3
1.2	38J	[38G[1]	38H 2
1.3	38K	[	38H 1
1.4	39E	[39G[2]	39H 4
1.5	39F	[	39H 3
1.6	39J	[39G[1]	39H 2
1.7	39K	[	39H 1
2.0	39L	[39P[2]	39Q 4
2.1	39M	[	39Q 3
2.2	39R	[39P[1]	39Q 2
2.3	39S	[	39Q 1
2.4	39T	[39V[2]	39W 4
2.5	39U	[	39W 3
2.6	39X	[39V[1]	39W 2
2.7	39Y	[	39W 1
3.0	38L	[38P[2]	38Q 4
3.1	38M	[	38Q 3
3.2	38R	[38P[1]	38Q 2
3.3	38S	[	38Q 1

3.13 Address Locations (Contd).

Address	Register	Gating	Selection
3.4	38T	38V[2]	38W 4
3.5	38U		38W 3
3.6	38X	38V[1]	38W 2
3.7	38Y		38W 1
4.0	37L	37P[2]	37Q 4
4.1	37M		37Q 3
4.2	37R	37P[1]	37Q 2
4.3	37S		37Q 1
4.4	37T	37V[2]	37W 4
4.5	37U		37W 3
4.6	37X	37V[1]	37W 2
4.7	37Y		37W 1
5.0	36L	36P[2]	36Q 4
5.1	36M		36Q 3
5.2	36R	36P[1]	36Q 2
5.3	36S		36Q 1
5.4	36T	36V[2]	36W 4
5.5	36U		36W 3
5.6	36X	36V[1]	36W 2
5.7	36Y		36W 1
N 1	33E	34D[2]	33F [1]
N 2	33K	33P[2]	33J [1]
N 3	33L	33P[2]	33J [4]
N 4	33S	33P[1]	33M [1]
N 5	33U	33P[1]	33T [1]
X 1	33E	33D[4]	33F [1]
X 2	33K	33J[2]	33J [1]
X 3	33L	33M[3]	33J [4]
X 4	33S	33T[4]	33M [1]
X 5	33U	33T[3]	33T [1]

CHAPTER 4

THE ENGINEERS' TEST PROGRAMMES

4.1 General

The engineers' test programmes are stored permanently on the isolated part of the magnetic drum and can be run by setting up the appropriate instruction on the handswitches. (See 4.2.)

4.1.1 Simple Stores Test

On entering the test programmes by normal entry, a sum check of block 0 of the computing store is performed and then blocks 1 to 5 inclusive of the computing store are tested by writing into and reading back a word from each register.

By means of the handswitches the computer may be made to perform this first test repetitively or to commence test programmes 0-9 after completing the first test satisfactorily. (See Fig. 8.)

4.1.2 Test Programme 0. (66-65 orders.)

This programme tests the jump orders 60-65 inclusive for jumps from a to a, a to b, b to a and b to b orders. The setting of overflow by 10 and 01 orders is checked, and also the clearing of overflow by 64 and 65 orders but not by other orders in Group 6, nor by 4 and 5 orders in any other group.

4.1.3 Test Programme 1. (Groups 0 and 1 orders.)

All 0 and 1 group orders are obeyed in this test and the mill adder/subtractor is tested with specially chosen numbers for addition and subtraction.

4.1.4 Test Programme 2. (Group 4 orders.)

All 4 group orders are obeyed in the test and the modification of groups 0, 1, 4 and 6 orders is checked. Orders 66 and 67 are checked including the carry suppression of order 67.

4.1.5 Test Programme 3. (50-53 orders.)

The single length shift orders 50-53 inclusive are obeyed. The test also checks the rounding and modification of all 5 group orders.

4.1.6 Test Programme 4. (54 and 55 orders.)

This test checks double length shift facilities.

4.1.7 Test Programme 5. (20 and 24 orders.)

This test uses specially chosen numbers to test the two multiplier adders and subtractors.

4.1.8 Test Programme 6. (21, 22 and 25 orders.)

This tests the 21, 22 and 25 orders and the setting of overflow when multiplying -1 by -1.

4.1.9 Test Programme 7. (26 order.)

This tests the setting of overflow for out of range division, the action with zero remainder, the 26 order and the modification of all group 2 orders.

4.1.10 Test Programme 8. Justify (23 order.)

All the cases of the 23 order are tested by this programme.

4.1.11 Test Programme 9. Normalise (56 order.)

All the cases of the 56 order are tested by this programme.

4.1.12 On the successful completion of test programme 0-9, the computer automatically advances to test programmes 10 and 11 unless the handswitches have been set to cause the previous tests to be repeated. If a test fails, the computer stops and by examining the monitor it is possible to discover in which test the failure has occurred.

4.1.13 Test Programme 10 and 11. (Computing Store.)

A set of *pseudo-random* patterns is read into and checked out of the registers 0.0 to 5.7. Accumulators 1-5 are tested in a similar manner. During these tests a failure is indicated by a 77 stop and the programme can be continued from this point.

4.1.14 Depending on the setting of the handswitches, on satisfactory completion of test programmes 10 and 11 the computer either repeats these tests or advances to test programmes 12-16, or to the test programmes 17-19.

4.1.15 Test Programme 12. (Break-through.)

The test checks that no break-through occurs in any of a number of sections of the drum circuits.

4.1.16 Test Programme 13. (Drum Surface Test. Timing.)

The timing of the reading and writing operations for non-isolated part of the drum store is checked by this test.

4.1.17 Test Programme 14. (Drum Surface Test, Routing.)

4.1.18 Test Programme 15. (Single Word Operations.)

This test checks the single word operations of the computer.

4.1.19 Test Programme 16. (Read Drum Surface.)

All blocks from 0 to 638 inclusive are read from the drum surface. Block 639 is excluded from the test as it is arranged to have incorrect parity.

4.1.20 On satisfactory completion of test programmes 12-16, the setting of the handswitches will determine whether the computer repeats all the previous tests or repeats test programmes 12-16, or advances to test programmes 17-19.

4.1.21 Test Programme 17. (Tape Reader Test.)

This test is used in conjunction with a loop of tape punched 0-31 in *checked* binary notation. The test programme causes tape reader 1 to read characters from the tape at various input speeds, each character being checked as it is read. Tape reader 2 is then tested in the same way.

4.1.22 Test Programme 18. Tape Reader Switching. (74 order.)

This test checks the switching action between the two tape readers. A character is read from one tape reader and then the same character is read from the other tape reader. As each character is read from the second tape reader it is checked against the corresponding character already read in from the first reader.

4.1.23 Test Programme 19. (Output Punch Test.)

This test causes the punch to produce a tape punched with groups of selected characters at various speeds.

On completion of test programme 19 the computer may be made, by means of the handswitches, to repeat test programmes 17-19 or to enter test programme 12, or to repeat the whole of the test programmes.

4.2 Using the Test Programmes. (This section should be read in conjunction with Fig. 2 'Flow Diagram of Test Programmes.')

General

The test programmes can be entered into by any one of the three methods to be described.

Note. After switching on the computer, and before any tests are commenced, the 'Start' / 'Normal' / 'Manual' switch should be moved to 'Start' (the switch is spring loaded and will return to 'Normal'), and the 'Run' / 'Stop' / 'Single Shot' switch moved to 'Run' and back to 'Stop'. This sets in the computer certain conditions that should obtain at the beginning of a computation.

4.2.1 'Normal Entry'

Set up the instruction 576 0 72 on the handswitches, i.e., 100 1000000 000 111010 000.

Move the 'Start' / 'Normal' / 'Manual' switch from 'Normal' to 'Manual' and back to 'Normal'.

Move the 'Run' / 'Stop' / 'Single Shot' switch to 'Single Shot'. (The switch is spring loaded and will return to 'Stop'.)

Set up the instruction 0.0 0 60 (Go) on the handswitches, i.e., 001 1000000 000 110000 000.

Move the 'Start' / 'Normal' / 'Manual' switch from 'Normal' to 'Manual' and back to 'Normal'.

Clear the handswitches

Move the 'Run' / 'Stop' / 'Single Shot' switch from 'Stop' to 'Run'.

The functional tests (test programmes 0-9) and the simple stores test will then cycle indefinitely.

Putting the handswitches at 2^{-10} (handswitch 10 selected) in the functional tests will cause any chosen test in the functional tests to be looped continuously, unity will be added to the counter position of accumulator 2 for each incorrect answer but the computer will not stop.

Note. It is not possible to enter into T.P. 11 using the 'Normal Entry' as this will cause a loop stop in 0.5+, but this test programme can be entered into by reading B590 to U1, B591 to U4 and entering at line 4.5, provided that accumulator 6 does not contain zero.

4.2.2 Putting down handswitch 0, thus making the handswitches negative, will cause any chosen test in any test programme (excepting T.P, 10 and 11) to be looped continuously without going through the checking subroutine. This is especially useful when fault finding as it enables the contents of registers and etc., to be examined on the monitor by 'Beat Trigger' operation whilst the programme is running, but keeps the test as short as possible.

If the handswitches be made equal to zero during test programmes 0-9, 10 and 11, 12-16, 17-19, then, on completing the particular programme on which it is engaged the computer will recommence the test programmes from the 'Normal Entry' point.

If the handswitches be made equal to 2^{-13} (handswitch 13 selected) during T.P. 10-11 or T.P. 12-16 the computer will perform T.P. 17-19 after completing the test programmes on which it was engaged when the handswitch was operated.

If the handswitches be made equal to 2^{-1} (handswitch 1 selected) during T.P. 17-19 the computer will enter T.P. 12-16 after completing T.P. 17-19.

4.2.3 'Enter any Test' 993

Set up the instruction 609 0 72 on the handswitches, i.e., 100 1100001 000 111010 000.

Move the 'Start' / 'Normal' / 'Manual' switch from 'Normal' to 'Manual' and back to 'Normal'.

Move the 'Run' / 'Stop' / 'Single Shot' switch to 'Single Shot'. (The switch is spring loaded and will return to 'Stop'.)

Set up the instruction 0.0 0 60 on the handswitches i.e., 001 1000000 000 110000 000.

Move the 'Start' / 'Normal' / 'Manual' switch from 'Normal' to 'Manual' and back to 'Normal'.

Move the 'Run' / 'Stop' / 'Single Shot' switch to 'Single Shot'.

Set the handswitches 0 and 1 down and set the number of the test required in the block modifier position on the handswitches.

Move the 'Run' / 'Stop' / 'Single Shot' switch to 'Run'.

The remarks in 4.2.2 concerning handswitch control of test programmes, apply also to this method of entering the programmes.

4.2.4 'E' Sequence

The test programmes may be entered into by using the 'E' sequence facility in the computer.

Thus: -

Set the handswitches 17 and 19 down, (these are the most significant and the least significant of the 'M' handswitches) the switches then represent the number 5, corresponding to E, the fifth letter of the alphabet.

Set the address of the location of the main store required, in the block modifier position of the handswitches. (Handswitches 1-10).

Move the 'Start' / 'Normal' / 'Manual' switch to 'Start' and back to 'Normal'.

Move the 'Run' / 'Stop' / 'Single' Shot' switch to 'Run'. This will cause the block containing the location previously specified to be transferred to U0 in the computing store and the three following blocks to be transferred to U1, U2, and U3 respectively.

When a 77 stop occurs return the 'Run' / 'Stop' / 'Single Shot' switch to 'Stop'.

Set the handswitches as required according to the particular tests to be performed. (See 4.2.1.)

Move the 'Run' / 'Stop' / 'Single Shot' switch to 'Run'.

4.3 Notes on Fault Stops in Test Programmes.

4.3.1 Simple Stores Test.

An error in the check sum of U0 is indicated by an Optional stop in order number 0.7.

A fault occurring during reading or writing to blocks U1-U5 is indicated by a 77 stop in order number 0.4+.

4.3.2 Functional Tests (T.P. 0-9)

A failure in T.P. 0-9 is indicated by an Optional stop in order number 0.1, the number of the test programme in which the failure has occurred is contained in the counter position of accumulator 4. The orders concerned in the failure can be found, with the aid of the

FLOW DIAGRAM OF TEST PROGRAMMES.

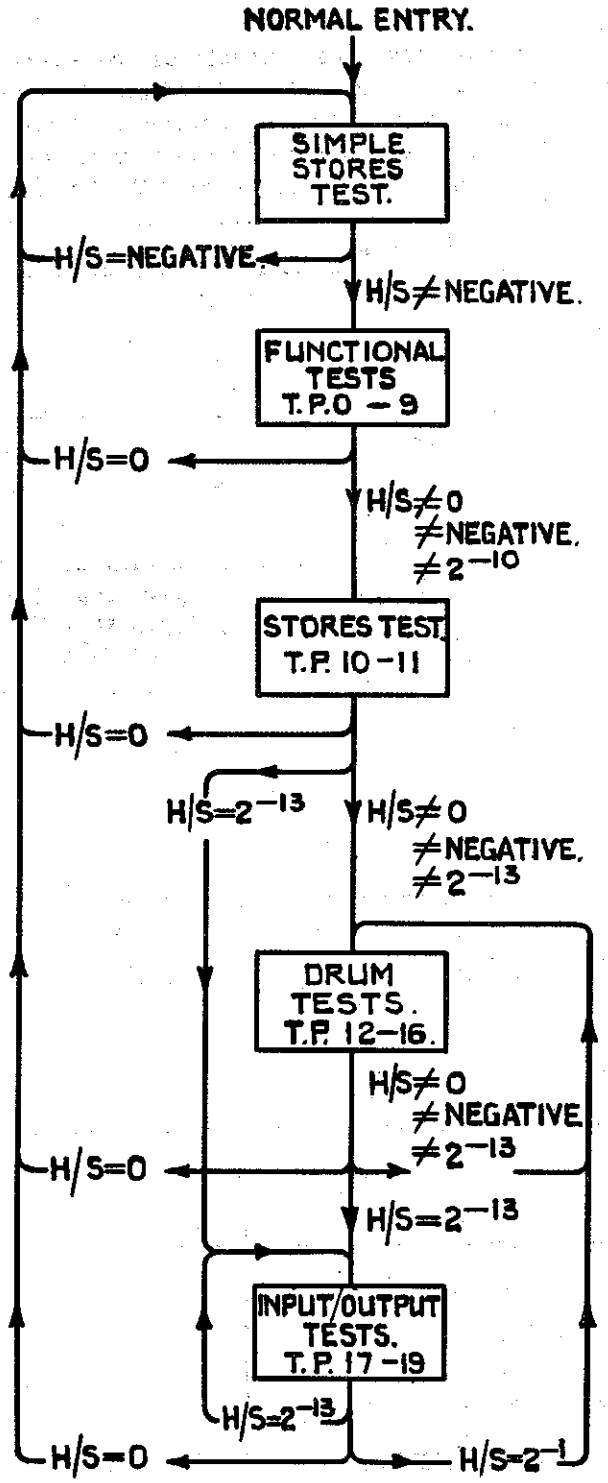


Fig. 2.

following table, by comparing the contents of the pairs of registers 5.0 and 5.1, 5.2 and 5.3, 5.4 and 5.5, 5.6 and 5.7. The contents of the two registers in each pair would be identical if no failures had occurred; if a failure has occurred one or more of the pairs of registers will exhibit non-equivalence between the two registers.

Registers	5.0 & 5.1	5.2 & 5.3	5.4 & 5.5	5.6 & 5.7
T.P.0	60 60 [a-b] 65 [a-a] 64 [a-b]	61 61 [a-a] 64 [a-a] 65 [a-a]	62 62 [b-b] 65 [b-a]	63 63 [b-a] 64 [b-b]
T.P.1	01 11 06	03 13 04 14	02 12	05 15
T.P.2	40 43 45 41 42 44 46 40, mod. X5 [A, B]	67 mod.	41, mod. X2 [A, B] 41, mod. X7 [A, B] 43, mod. X6 [A, B] 44, mod. X6 41, mod. X6	01, mod. X1 66, 10, mod. X6 67 16, mod. X3 [A, B]
T.P.3	50 50, set ovr,	52 52, set ovr, test.	51	53 52, mod.
T.P.4	54: p-ve; q+ve 54: p-ve; q-ve	54: p+ve; q+ve 54: p+ve; q-ve	55: p-ve; q+ve 55: p-ve; q-ve	55: p+ve; q+ve 55: p+ve; q-ve
T.P.5	20 [Test M8] and associated adder-subtractor	20 [Test M9] and associated adder	20 [Test M10] and associated adder	24 [X7 cleared]
T.P.6	21	22	25 20 [-1 x -1 sets ovr.]	
T.P.7	Division out of range set OVR. Test for zero residue. Modification of 2 group.	26		

Registers	5.0 & 5.1	5.2 & 5.3	5.4 & 5.5	5.6 & 5.7
T.P.8	23 Conditions: [a] Ovr. clear: n+ve; q+ve [b] Ovr. clear; m+ve; q-ve	23 Conditions: [a] Ovr. set; n+ve; q+ve [b] Ovr. set; n+ve; q-ve	23 Conditions: [a] Ovr. clear; n-ve; q-ve Check Ovr. set in E of 23 instruction	23 Conditions: [a] Ovr. set; n-ve; q+ve Check Ovr. set in E of 23 instruction [b] Ovr. set n+ve; q-ve
T.P.9	56 Positive fraction. Termination by standard form. Shift up 25 places.	56 Negative fraction. Termination by standard form. Shift up 12 places.	56 Positive fraction. Termination by N. Shift up 3 places.	56 Negative fraction. Termination by standard form. Shift down 1 place.

4.3.3 Computing Store Parity Failure.

This fault can be traced by the methods described in Chapter 3.

4.3.4 Stores Tests. T.P. 10 and 11.

Test programme 10 occupies blocks 590 and 598.0-598.6 of the drum store, the test of accumulators 1-5 occupies blocks 598.7, 599, and 591.0-591.4 of the drum. Test programme 11 is stored on the drum in blocks 591.5-591.7, 607.0-608.2.

Part of block 611 is used for organisation purposes for these test programmes.

A fault in T.P. 10-11 is indicated by a 77 stop. If the stop occurs in U2.4 this indicates a failure in T.P. 10, the previous line, i.e., 2.3, gives the block address of the line that has failed and accumulator 5 gives the position within the block. Similarly, a 77 stop occurring in U3.7 indicates a fault in T.P.11, line 3.6 giving the block address of the line that has failed and accumulator 5 giving the position within the block. If this line is the same as all others within the block, then the fault is either a multiplier failure, a failure of the 0.6 order, a failure of the 10 order used in storing the numbers, a failure of accumulator 6 or accumulator 7 or a failure of the 00 order used in copying accumulator 6 into accumulator 7.

Accumulator 6 should contain the same number as the block being tested and accumulator 7 should contain the digits that differ. If, therefore, the number in accumulator 6 differs from that in the storage line, then a fault in either the initial formation of the number or in the checking circuits is indicated.

A 77 stop occurring in U4.2 indicates either a failure in one of the accumulators 1-5, (they should all contain the same number) or a fault of the type previously described.

4.3.5 Drum Tests. (T.P. 12-16).

A failure in T.P. 12-15 is indicated either by an Optional stop in order number 5.1 or by a drum parity failure.

A failure in T.P. 16 can only be indicated by a drum parity fail

Test Programme 12.

The programme generates a pattern P1 in U0 and this pattern is written to blocks 0 of track [8n], track [8n + 1], track [8n + 2]. . . [8n + 7].

A second pattern, P2, is then generated in U0 and this pattern is written to block 0 of track [8n]. Block 0 of track [8n] is then checked against P2 and blocks 0 of track [8n + 1], track [8n + 2]. . . track [8n + 7] are checked against P1. This loop is cycled eight times for each value of n, where n assumes values of 0-4 in that order.

Test Programme 13.

The programme generates a pattern, P1, in U4 and this pattern is written eight times to blocks B0, B1 . . . B511, these blocks are then checked against P1.

A second pattern, P2, is generated in U4 and is written once to block B0, B1. . . B511, these blocks are then checked against P2.

Test Programme 14.

If the address of a word on the drum is b.p. then b. [p + 1] is written into the counter position of that word and 1 into the modifier position of the same word. These markers are written into their respective word positions in the non-isolated store in the direction of increasing addresses and are then checked in that direction. If no failures occur during these actions, the markers are then written in the

direction of decreasing addresses so that 0.1 is written to block B511.7, and B512.0 is written to B0.0. In general, m.n. is written to B[512-m] [-n]. The markers are then checked in the same direction as they were written.

Test Programme 15.

If the address of a word on the drum is b.p., then b.p. is written into both the counter position and the modifier position of that word. Unlike T.P. 14, these markers are not written on all words but in the following sequence.

T0, W0; T1, W1; T2, W2; ------ T31, W31;
T0, W32; T1, W33; T2, W34; ------ T31, W63;
T0, W64; T1, W65; T2, W66; ------ T31, W95;
T0, W96; T1, W97; T2, W98; ------ T31, W127.

The programme checks by reading back these tagged word positions.

Test Programme 16.

The programme reads down each block of the main store sequentially including the isolated store. A fault is indicated by the occurrence of a drum parity failure.

4.3.6 Test Programme 17, 18, 19.

A failure in these tests is indicated by an Optional stop in order number 2.3.

4.4 Bootstrap Operation

4.4.1 General

The bootstrap programme is designed to put into the computing store a sufficient number of orders to enable the computer to read in simple tapes, when, for any reason, the permanent record on the drum is not available.

A full description of this programme is given in Volume 1, Chapter 4.

4.4.2 Bootstrap Manual Operations

Note: All orders 'go' unless otherwise stated.

1. Insert tape on 'zero'.

2. S/G to stop.

3. NORMAL to START to NORMAL.

4. H/S 0.0 0 60.

5. NORMAL to MANUAL

6. H/S 34 2 02.

7. S/S [Single shot].

8. H/S 0 15 1 00 [Stop order].

9. S/S S/S S/S.

10. H/S 0.0 1 10 2.

11. S/S S/S

12. MANUAL to NORMAL

13. S/S S/S

14. H/S 0.1 1 10.

15. NORMAL to MANUAL

16. H/S 0.0 2 66.

17. S/S S/S.

18. MANUAL to NORMAL.

19. RUN, RUN.

20. H/S 5 2 50.

21. RUN.

22. H/S 16 2 01.

23. RUN.

24. H/S 0.3 2 64.

25. RUN.

26. H/S 0.6 2 10 2.

27. RUN, RUN.
    Reads tape.

For commissioning input, at 77 stop, obey manual order 0.7+ 0 60 before reading tape.

4.5 Dynamic loop or Error stops in Initial Orders

Note:- An explanation of the Initial Orders and of the use of the warning characters is contained in the "Ferranti Pegasus Computer Programming Manual."

Order No.	Order	Causes of Stop.	Routine & Block Nos.
0.5	0.0 7 60 6	Unassigned warning character	W6 525
0.5+	0.5+ 5 61	Either:- (a) Wrong Character in α search (b) Warning character not followed by figure shift character [Ø] or (c) Wrongly punched order or number	R1 534
0.6 0.6+	0.6 7 62 0.6+ 2 62	Letter shift [λ] in order pair or number.	R1 534 R1
1.5	1.5 5 61	CR not followed by LF after warning character address	R7 518
1.6	1.6 2 62	Sign [+ or -] at start of b-order or after warning character X	R3 541
2.2+ 2.3	7 1 01 2.2+ 4 67	Binary input. Order overflow due to addition of relative address [Stop occurs after 9½ hours]	F2 552
2.6	2.6 5 61	Address after warning character either:- (a) includes wrong character or is incorrectly terminated or (b) overflows.	R8 524
3.2+	3.2+ 1 62	Wrong character after warning character A	W15 566
3.3	3.3 3 63	'b' order address after warning characters F, G, I or S.	W8 517
3.4	3.4 6 61	Binary input. Check sum disagreement.	F3 558
3.4	3.4 1 61	Assembly. L and Ø's after cue list not followed by λ, N or CRLF	C1 563

4.5 Dynamic Loop or Error stops in Initial Orders (Contd).

Order No.	Order	Causes of Stop	Routine & Block Nos.
4.1	4.1 3 63	Either:- (a) 'b'-order address afrer warning character T (b) Warning character B with negative transfer address in order number 5.7	W9 542

4.6 Stops on writing with Overflow

Order No.	Order	Causes of Stop	Routine & Block Nos.
1.1	0 4 735	Binary input. Relative address too large after warning character 27 [J]	F1 556
1.1+	0 0 71 3	After warning character X. New order overflowing	W10 536
3.0	0 0 71 6	Word from tape overflowing may de due, for example, to:- (a) too many digits in the number (b) number too big (c) order + relativiser too big	R5 537

-150v
+200v
+300v

CHAPTER 5

SETTING UP AND ADJUSTMENTS

5.1 The Power Cubicle. (See Fig. 2.11, Vol. 3A.)

N.B. Modifications to this method of setting up the Power Cubicle may be necessary where installations have heavier power loading than normal.

NOTE PCB 2 uses Control Amplifier Type 31776 Function of RV1 & RV2 have been reversed

5.1.1 Set the current limit potentiometers RV.3, on the three shunt regulator control amplifiers, so that the three shunt stabilisers each pass 2 amps. These adjustments should be made with the potentiometers RV.2 on each of the shunt regulator control amplifiers in their maximum positions.

5.1.2 Put the marginal test switch to the 'Off' position. Adjust RV.2, on the shunt regulator control amplifiers, so that the shunt stabilisers draw 1.3 amps for the -150 volt supply, 1.5 amps for the +200 volt supply, and 1.5 amps for the +300 volt supply.

5.1.3 Switch off the bias supply and adjust the position of the tapping band on each of the three rheostats RV.1, RV.2, RV.3, to give the required output voltages on the three supply lines. These potentiometers are mounted near the top of the power cubicle and are accessible from the rear of the unit.

5.1.4 Switch on the bias supply. Reduce the value of the H.T. lines by 15% by means of the marginal potentiometers. Set RV.1, on the shunt regulator control amplifiers, so that the shunt stabiliser currents are maintained as before; this adjustment may have to be made in conjunction with the previous adjustments.

5.1.5 Outputs

The following figures are taken from the Power Unit Specification.

1) + 300 volts ± 2%. Ripple. ¼% or less.
2) + 200 volts ± 2%. Ripple. ¼% or less.
3) - 150 volts ± 2%. Ripple. ¼% or less.
4) + 13 volts ± 5%. Ripple. 2% or less.
5) - 10 volts ± 5%. Ripple. 2% or less.
6) - 20 volts ± 5%. Ripple. 2% or less.

5.2 To set up the Tape Reader

5.2.1 Set up the tape reader mechanically according to the instructions given in the tape reader manual DC3/IM.

5.2.2 Connect the tape reader to the computer. Remove the two type 4 packages from package locations 11C and 11D in the computer.

5.2.3 Set the "Digit" and "Location" potentiometers to their midway positions.

5.2.4 Measure the voltage output of each photocell amplifier. This may be done by connecting a high resistance voltmeter on the 100 V range across condensers C1-C5 in turn. (The condensers C1-C5 are mounted on the Input/Output tag board in Bay 1 of the computer). The voltage swing between "hole" and "no hole" conditions should be greater than 120 volts. There is considerable variation in output voltage amongst individual photocells of a batch, a difference of up to 50 volts in voltage swing between the two photocells having the greatest and the least sensitivity is tolerable.

Valves V5, V6B and V7 should be matched to give outputs rising from approximately the same 'dark' level.

5.2.5 Testing. (See also 5.2.9 and 5.2.10 for alternative tape reader tests.)

Replace the two type 4 packages in package locations 11C and 11D in the computer. The binary loop tape test is a specially punched binary

Test programme used to obtain variable tape reader speeds

0.0	0	4	00	
	0	3	00	
0.1	32	2	40	
	16	1	00	
0.2	1	4	06	
	0.6	4	61	
0.3	1	3	41	
	3	4	00	
0.4	15	5	00	
	0	0	50	5
0.5	0.1+	2	67	
	0.0	0	60	
0.6	0	0	77	
	0.1+	0	60	

tape which is read in under the control of initial orders (input routine), the binary tape is added by the computer and the result compared with a check sum, if the two sums are not equivalent the computer comes to a loop stop in order number 3.4. Insert the binary loop tape in the tape reader. This tape is punched 0 - 31 in binary form. It should be started on zero and read in to the computer by an instruction specifying address 16. A test programme containing a time-wasting instruction is used in conjunction with the binary loop, enabling the test to be conducted at various speeds.

5.2.6 "Location" potentiometer

Run the loop of tape with the handswitches at zero; that is, at full speed. Turn the location potentiometer first in one direction and then in the other until the tape reader programme fails. Mark both the fault positions of the potentiometer. Let these positions be designated "P1" and "P2". (See Fig.3).

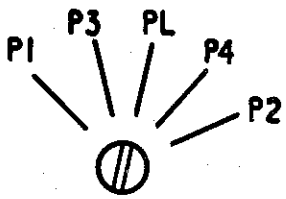


Fig.3.

Set the location potentiometer midway between the positions P1 and P2. Depress the handswitches d1 - d13; the tape reader will then run at low speed. Adjust the location potentiometer as before to obtain the two fault positions "P3" and "P4". Set the potentiometer to PL; midway between P3 and P4. The angle between P3 and P4 should be at least 30^0; if this cannot be obtained, then after investigating all possible electronic causes, the tape reader should be set up mechanically.

Although the setting up procedure for the "Location" potentiometer assumes that the "Digit" potentiometer is correctly set, it has been found that the "Location" potentiometer can be set satisfactorily with the "Digit" potentiometer set to its mid-position.

5.2.7 "Digit" potentiometer

The setting up procedure for this potentiometer is identical with that used for the location potentiometer. Again, at low tape reader speeds, the angle of adjustment will normally be smaller than at high speeds. The potentiometer should be set midway between the two fault positions found in the low speed test.

5.2.8 Monitoring

A loop tape punched with "Figure Shift" and "Erase" characters may be read in using a manual 16 1 00 instruction. Trigger the monitor unit from AD (order number) and inspect the outputs of the two type 4 packages in locations 11C and 11D. The waveform should be clean and free from spurious pulses.

5.2.9 Alternative Method A

The tape reader can be set up in the following manner.

(a) Run the tape reader test programme. Reduce the -150V line by 20%. Adjust the "Location" potentiometer until overshooting ceases, by turning the potentiometer in an anti-clockwise direction. Restore the -150V line to its normal value.

(b) Reduce the +200V line by 20% and adjust the "Digit" potentiometer until misreading just ceases, by turning the potentiometer in an anti-clockwise direction. Restore the +200V line to its normal value.

(c) Test the tape reader in the normal manner.

This method will only give satisfactory results with tape readers on which the mechanical adjustments have been carried out correctly and in which the valves and photo-electric cells have been matched as described in 5.2.4.

5.2.10 Alternative Method B. Tape Reader and Punch Test

Operating Instructions

(a) Read in the programme tape - a 77 stop will occur when the tape has been read in.

(b) Clear the handswitches.

(c) Put the special loops of tape (these are punched 0-31 in 'checked' binary notation) in the tape readers, either of these tapes may be started on any chacacter.

(d) Switch to 'Run'.

The programme tests tape reader 1 in a succession of random combinations of numbers of digits full and slow speeds alternately. Tape reader 2 is then tested in the same manner. The programme then performs a check of '17' input against '16' input combined with a test of the

'74' order at maximum speed and then enters into the punch test. The punch test causes four blocks of 31----0 in '17' output to be punched; this is followed by a section of blank tape which is followed by a test pattern in '16' output. This test is performed at various speeds (as in the tape reader tests) and ends with an Optional stop.

The punched tape produced by the previous test can be checked as follows: -

Insert the tape in the tape reader with the first character of the test pattern over the location hole and set handswitch 1 [2^{-1}] down. Switch to 'Run'. The tape reader will now stop on errors and at the end of the tape.

Failures in the Tape Reader test due to misreading are indicated by a 77 stop in order number 5.7, the correct number is contained in accumulator 4 and the incorrect digits are contained in accumulator 3. The test can be restarted by switching to 'Run'.

A check sum failure in '74' and '17' tests is indicated by a 77 stop in order number 4.6+. The test operates by forming a check sum of 128 characters from each tape reader and comparing the two sums. Since, in this test, one tape reader produces '17' input and the other '16' input, the contents of accumulator 3 do not give a direct indication of any error, for this reason it is necessary when a failure occurs to set handswitches 0 and 1 down, and Switch to 'Run'.

The two tapes will then be aligned automatically and characters will be read alternately from each tape reader (in '17' input). Tape reader 1 is read into accumulator 4 and tape reader 2 into accumulator 5, the comparison being made in accumulator 3. This accumulator will then contain any error digits. As before, a failure is indicated by a 77 stop.

Punch Test

The part of the tape punched in '17' output can be checked visually. The test pattern in '16' output can be checked by the computer as previously described. A failure is indicated by an Optional stop in order number 4.2, the incorrect digits being in accumulator 4 and the correct number occupying the least significant five digit places in accumulator 3. To assist in the diagnosis of the fault, the error position on the tape should be marked before returning to 'Run' and continuing the test. This test is concerned with failures of an intermittent nature and normally the correct character is punched on resuming

the test.

Should difficulty be found in restarting the test (usually due to double punching), note that the last character punched should be two holes past the location hole on the tape being checked.

Handswitch Control

The setting of handswitch 0 [2^0] alone, causes the tape reader to stop, but this handswitch is used in conjunction with those listed to control the speed at which the tests are performed.

The particular tape reader tests are selected by the handswitches in accordance with the following table.

H.S.0 [2^0]	Select manual speed control.
H.S.1 [2^{-1}]	Select '74' test.
H.S.2 [2^{-2}]	Select tape reader 2.
H.S.3 [2^{-3}] or any other handswitch excepting [0, 1 and 2].	Select tape reader 1.

Speed Control

The least significant six handswitches set the number of characters to be tested at full speed. The least significant 3 Modifier handswitches set the number of characters to be tested at slow speed. The remaining seven handswitches set the speed of the slow speed tests.

The Punch Test is controlled by the handswitches as follows:-

Handswitch 1.	Select checking programme.
Handswitch 0.	Select manual speed control. Speed is controlled as in the tape reader tests except that only the least significant 4 handswitches are used to set the number of characters to be tested at full speed.

Notes:

Counting is inhibited by the selection of any handswitch. By selection of handswitch 2, without handswitch 0, the test of tape reader 2 can be continued indefinitely at random speeds. Similarly, by selecting handswitch 3 or any other handswitch (except handswitches 0, 1, or 2) the test of tape reader 1 can be performed continuously.

The check sum test of '74' order in '17' input can be looped continuously by selecting handswitch 1 (only). When handswitch 0 is also selected the two tapes will be automatically aligned and then each character will be read first from tape reader 1 and then from tape reader 2. These characters are then compared. Changing any other handswitch then causes the tapes to be re-aligned and the test is continued. On exit to the punch test tape reader 1 is selected.

To enter into the tests directly an 'E' sequence must be used, thus;

Tape Reader test	E.6.0
Punch test	E.12.0

5.3 Nickel Lines

Many methods of setting up nickel lines are in use; those described have been found convenient in practice.

5.3.1 42 digit lines. Method A.

This method relies upon the computing store parity checking circuitry to indicate that a line is operating correctly.

A test pattern is put into accumulator 1. For simplicity this pattern may be unity.

5.3.2. Let the line to be checked be, say, 4.0, carry out the manual order 4.0 1 11 on "Run"; this will produce a consecutive count in 4.0 when the line is correctly adjusted.

5.3.3 Reduce the value of the -150V line by 20%. Turn the "Gain" potentiometer fully clockwise to its maximum gain position and then slowly rotate the potentiometer in an anti-clockwise direction until the line commences to operate correctly. (This point will be indicated by the extinguishing of the computing store parity failure lamp.) Mark this position of the potentiometer "P1". (See Fig.4.) Restore the -150V line to its normal value.

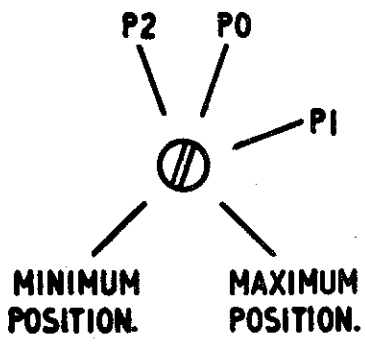


Fig.4.

5.3.4 Reduce the value of the +200V line by 20%. Turn the "Gain" potentiometer fully anti-clockwise to the minimum gain position and then slowly rotate the potentiometer in a clockwise direction until the line commences to work correctly. Mark this position of the potentiometer "P2" (see Fig.4). Restore the +200V line to its normal value.

5.3.5 Set the potentiometer to P0, midway between the positions P1 and P2.

5.3.6 Test the line for sensitivity to percussion by lightly tapping the package.

5.3.7 35 digit lines. Method A.

The procedure described for the setting up of the 42 digit nickel lines may be used also for the 35 digit lines if a temporary minor modification be made to the computer. The modification causes a parity check to be made on accumulator 7. The parity check is only effective when accumulator 7 is specified by the X digits of an instruction.

Modification.

(1) Remove the lead from pin 15 of the package location 33Y. This removes inverse P39 waveform.

(2) Connect pin 25 (spare input pin) of location 32Q to -10 volts, available on pin 22 of location 33Q. This inhibits P39 of E.

(3) Connect pin 29 (spare input pin) of location 32W to -10 volts, available on pin 22 of location 32W. This removes the inhibit from the parity count on the X/M-bus.

Operation

The line to be tested is plugged into location 31Y (accumulator 7 position). The manual instruction 1 7 41 is then employed to produce a consecutive count in accumulator 7. The line is then adjusted as detailed previously. On completion of testing, the temporary modification to the computer must be removed and the wiring restored to normal.

5.3.8 42 digit lines. Method B.

This method is suitable for setting up a line that is known to be in good order.

Reduce the value of the -150V by 20%.

Turn the "Gain" potentiometer fully clockwise to its maximum gain position and then slowly turn the potentiometer in an anti-clockwise direction until the line commences to operate correctly. (This point will be indicated by the extinguishing of the computing store parity failure lamp). Adjust the length of the line until the overshoot on the digit pulses just disappears. (Viewed on the built-in monitor on the computer.)

Restore the -150V line to its normal value.

Reduce the value of the +200V line by 20%; if the line then continues to operate correctly the adjustment is satisfactory.

Restore the +200V line to its normal value.

5.3.9 35 digit lines. Method B.

The following short programme may be used for checking 35 digit lines in accumulator 6 or accumulator 7 position. Failure of the line is indicated by an optional stop in 0.0+, error digits in accumulator 5.

0.0	0 6	6000 0 700
0.1	0.4 0.4	701 601
0.2	7 6	500 506
0.3	0.1 0.0+	560 060
0.4	89 5.3	5712 6525

E 2.0

5.4 Computer testing of spare packages. ('Critical Positions').

5.4.1 General

Certain package locations in the computer are particularly suitable for the testing of repaired packages because they use a maximum number of inputs and outputs on the packages. In general, packages that function satisfactorily in these particularly critical positions will operate in all other package locations in the computer appropriate to the type of package under consideration.

5.4.2 The table gives the testing location for each type of package and the test required. Any part of the package circuitry not tested is listed in the table.

5.4.2 (Contd).

Table of Package Testing Locations in the Computer

Package Type	Testing Location	Waveform Outputs	Functions not tested	Test
1	21S	Overflow Jump.	D2	T.P. 0 - 9.
2	26C	R00, R01, R02.		T.P. 16.
3	26J	R10, R11, R12.	M1, M2, M3.	T.P. 12 - 16.
	26P 21X		For mixed outputs only.	T.P. 0 - 9.
4	26T	Sections 1-3 Order Adder inputs.		T.P. 0 - 9.
6/42	30T	Section 4, S decode Multiplicand.	Inverter Inputs	T.P. 0 - 9.
	39C	Register 0.0 or any N Register.		T.P. 10 - 11
6/35	30D	Accumulator 6.	Inverter Input 5	T.P. 0 - 9.
7	24G	Handswitches and 2 P-pulses.		Manual.
8	34E	1) Decode X1.		
		2) ~ 40 to S staticisers.		
		3) ~ S10 for X/M decoding.		T.P. 0 - 9.
		4) X38. Erase registers 0 & 1.	M4.	
		5) Y35, Input-bus registers 1.0 - 1.7 and 0.0 - 0.3	M5.	
		6) X218. N/X discriminator on S1.		
9	35G	External conditioning and Track selection neons.		T.P. 18 and Handswitches

5.4.2 (Contd).

Package Type	Testing Location	Waveform outputs	Functions not tested	Test
10	11M	Tape Reader		T.P. 17, 18.
11	27J	Oscillator		Visual computer functions, especially nickel lines.
12	10C 10S	Clock Reset		Visual check on Monitor.
13	10D 10J	Clock Reset		Visual check on Monitor.
14	27S	+100V		Check with C.R.O & on Engineer's meter, [± 1½%]
	28R	Write Switch control		T.P. 12 - 16.
15	27G	Read strobe. (Information).		T.P. 12 - 16.
16	28C	Write/Read Switch		T.P. 12 - 16.
17	28F	Write Drive		T.P. 12 - 16.
18	27D	Address		T.P. 12 - 16.
	28G	Read Amplifier. (Information).		T.P. 12 - 16.
19	28Q	Row selection.		T.P. 12 - 16.
	29Q	Column selection		T.P. 12 - 16.
20	27C	Sine wave amplifier.		Monitor pin 17 and tune for maximum amplitude. Computer functions, especially nickel lines and drum Servo.
21	27H	Discriminator		Computer functions, especially nickel lines and drum Servo. Monitor the point 'A', this point should be +20V to +230V limiting. The difference frequency should be less than 300 c.p.s. with a warm drum, i.e., one which has been running for at least 1 hour.

5.5 Thermal Overload Trips

5.5.1 General

The thermal overload trips are provided to prevent overheating of the computer installation should the cooling system fail. It should not be necessary to adjust the setting of the trips in service. If, for any reason, a fault is suspected in a thermal trip, it should be replaced by a new unit. The suspected unit should be returned to the factory for testing and resetting.

5.5.2 The correct temperature settings are as follows:-

Unrefrigerated Computers	113^0F
Refrigerated Computers	100^0F

5.5.3 Assembly and setting-up instructions for the thermal overload trips are given in Ferranti drawings, numbers 65/20497 and 65/20510.

5.6 Teleprinter Auto-Carriage Return Facility. Adjustment of line length.

The "Carriage Length" indicator is only intended as an approximate guide to the length of the line. It is essential that the equipment be set up according to the following instructions.

5.6.1 Setting-up Procedure

Set the "Line Length" indicator to the number of characters required, less one. Print out a row of characters up to two characters less than the required line length. Switch off the teleprinter. Operate the trip solenoid and turn the motor manually. The "Carriage Count Contacts" should operate after three revolutions of the motor. If the adjustment is unsatisfactory, repeat the setting-up procedure.

5.7 Writing a Clock Track

N.B. Special equipment is used at Ferranti Ltd., for the writing of clock tracks. It is recommended that the drum be returned to the factory if adjustments of this nature be required. The following notes are intended to give guidance in cases where the operation must be done on site.

5.7.1 Drum/Crystal Clock Switch

When this switch is in the 'Crystal' position; the contacts of the write relay are opened and writing cannot take place. For the purpose

of writing a clock track, the switch must be in the 'Crystal' position and the contacts numbers 1 and 2 on the write relay must be connected together. This may conveniently be done by connecting pin 10 of package location 28D to pin 11 of package location 28F. (See Figures 4.3 and 4.5 Vol. 3A).

5.7.2 Co-incidence

Connect pin 25 of package location 20G to -10 volts, this causes the co-incidence signal to be produced without interruption, thus enabling a continuous track to be written.

5.7.3 Anti-clock

In order that the write drive package used in writing the clock track may be provided with a push pull drive, an anti-clock waveform is required. This waveform is obtained from package location 10F which is connected in a different manner from the other clock waveform output package locations. In package location 10F, the inner core of the output coaxial cable is connected to pin 27 on the package location, and the outer screening is connected to pin 25 on the same package location. The inner core of the other end of the coaxial cable should be taken to pin 15 of the appropriate write drive package; the screening of the cable should be brought as near to the pin as possible in order to avoid unwanted pick up effects. The coaxial cable should be terminated in 30 ohms at the write drive package and the outer screening taken to -4 volts.

5.7.4 Speed control

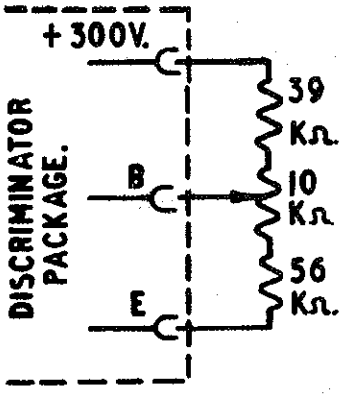
A resistor chain is used to provide manual control of the drum speed by variation of the bias voltage of the drum alternator field regulator. The resistor chain should be plugged into the discriminator package. (See Fig. 5).

5.7.5 Dummy Read/Write Switch

This is a package on which is mounted a three winding transformer having connections as shown in Fig. 6. This package should be plugged into location 28C.

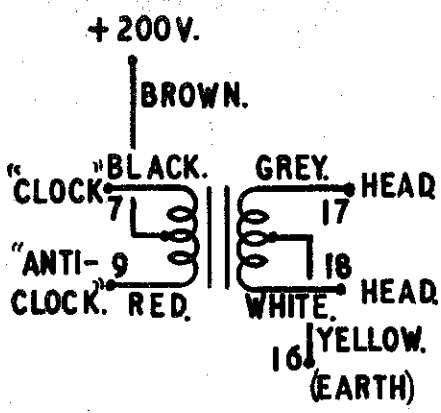
5.7.6 Clock Amplifier

Remove the valve from the first stage of the clock amplifier to prevent servo action taking place. Connect an oscilloscope to the low level monitor poin X1.



SPEED CONTROL ADAPTOR.

Fig.5.



DUMMY READ/WRITE SWITCH.

Fig.6.

5.7.7 Drive

The clock waveform should be connected to pin 15 on package location 28P. (Y30 bus.) The anticlock waveform should be connected to pin 13 on package location 28L. (Y31 bus.) An extra write drive package is plugged into package location 28P to increase writing current when writing clock tracks.

5.7.8 Bias

Connect a voltmeter across monitor point Z of the discriminator and earth to measure the bias voltage of the drum alternator field regulator.

5.7.9 "Clock Track Selector Box"

The selector box has mounted upon it the following components:-

Two 10 position switches.	(Labelled 'A' and 'B'.)
One 2 position switch.	(Labelled 'Write B read A' and 'Write A read B'.)
One 6 pin Plessey socket.	(Labelled 'Clock Amp'.)
One 25 pin Plessey socket.	(Labelled '28C'.)
Two leads terminated in 25 pin Plessey plugs.	(Labelled 'A' and 'B'.)

The 25 way Plessey plug from package location 28C and the 6 way Plessey plug to the clock amplifier are connected to the appropriate sockets on the selector box. The plugs A and B from the selector box are connected through Plessey sockets to two stacks of heads.

5.7.10 Monitoring

The oscilloscope connected to the clock amplifier should be triggered from package 13F, socket D1. This package supplies a suitable waveform when the monitor trigger switch is set to CD and the correct order number is set up on the handswitches.

5.7.11 R1100

This is the code number of the "Write Clock" programme. It provides a 128-word trigger, every order pair being "padded" out to 128 beats. It also provides a 128 word-time gate when a handswitch is depressed. The "Bootstrap" programme, see Vol. 1, Chapter IV, is used to take in the "Octal D" input and this in turn is used to take in the "Write Clock" programme. Normally, this latter programme selects column 1 (Track 8 decoded) but on depressing a hand switch, column 0 (Track 1) is selected for 128 word-times so activating the write drive 28D. This allows writing to take place through the dummy read/write switch in 28C to the head selected by the selector box.

The output waveform S26 from 26M pin 18, is connected to R00 (27L pin 5) to provide the necessary one revolution gate (128 word times + 1 digit time) to the write drive. The extra digit is required to give one digit overlap.

Switch the oscilloscope to 3 x 1 ms scan.

5.7.12 Writing

Allow the "Write Clock" programme to run, bring the drum to full speed and then by adjustment of the speed control potentiometer, apply a bias of -20 volts to the drum alternator field regulator unit in order to reduce the speed below that of normal running.

Write on to the selected track. Switch the appropriate switch on the selector box to display the 'Clock' track that has just been written and adjust the bias voltage by means of the manual speed control so that the displayed "Clock" track waveform is drifting slowly to the left, this indicates that the drum is running above normal speed, the displayed track waveform should contain a large gap and is used purely as a marker.

Now write on to the track again. The clock track produced by this second writing action should contain an overlap and should be capable of operating the drum servo circuits when the first stage of the clock amplifier is replaced and manual speed control is removed.

Reconnect the manual speed control and apply bias so that the displayed waveform is stationary on the 3 x 1 uS scan. Write once again; this track should be suitable for a "final" clock track. With the read strobe package in location 27F removed and Drum/Crystal clock switch set to "Drum" it should be possible to run Octal D programmes.

Check that the correct number of cycles are on the track by carrying out the manual instruction 123 0 50 (on "Drum" clock). Using the same trigger as before, inspect the low level output of the clock amplifier. The trace should appear to be stationary when the correct number of cycles are on the track.

A check on the track is made in the following manner:-

Use a repetitive trigger for the oscilloscope; by means of the adjustment provided, shorten the length of a nickel line so that a pulse of short duration is produced superimposed on the leading edge of the digit pulse. Assuming the rise time of the digit pulse to be 0.5 μS [25v]; inspect the short duration pulse for phase variation. Should the phase variation be greater than 0.2 μS, [10 volts] the track is not satisfactory and must be written again.

5.7.13 Track Amplitude

When a satisfactory clock track has been obtained, the clock amplifier should be adjusted by means of C8 and C9, to give an output of maximum amplitude.

5.7.14 Master Clock Track

With the Drum/Crystal clock switch set to "Drum", copy the new clock track onto the Master Clock track position. (See "Copying a Clock Track" 5.8). Then using this "Master Clock" to control the computer, copy the clock track onto the Clock 1 and Clock 2 positions. The extra write drive package must be removed from package location 28P on completion of these tasks.

5.7.15 Address Track

The next step is to write an address track to Address 1 position. (See "Writing an Address Track". 5.9). Then, using Clock 1 and Address

1 to control the computer in the normal manner, Address 2 is copied on to the appropriate tracks using the "Copy Address" programme.

5.7.16 Isolated Store

Check the drum tracks with the "Check Non-Isolated Store" test, (R1103) while controlling the computer from Clock 1 and Address 1. If the test result is satisfactory, the isolated store programme should be written onto tracks 32-39. (See instructions for using binary tape, "Quick replacement of Isolated Store" 5.10.) It should then be possible to test the computer and drum comprehensively, using Clock 1 and Address 1 to control the computer in the normal manner.

5.7.17 Testing

The magnetic surface of the drum may be checked by running Drum Test 3; this test writes a special pattern on the non-isolated tracks of the drum. The patterns already existing on the isolated tracks are satisfactory for the purpose of the test. Connect the output of the read amplifier 28G to the Y plates of an oscilloscope and connect the normal input terminal of the oscilloscope to one of the "re-set" lines. Trigger the oscilloscope with a drum revolution trigger pulse.

Select track 0. Adjust the gain of the oscilloscope on the 60 volt range, superimposing the re-set waveform on the track display. Adjust the oscilloscope velocity to give 6 centimetres between re-set pulses and measure the timing of re-set (in centimetres) from the front edge of one particular digit pulse. Having noted this value on the standard track 0/0, each block of the main store should then be read down in succession by means of T.P.16 of the engineer's test programmes. The capacitors C8 and C9 on the clock amplifier should then be adjusted for maximum and for minimum capacitance, drum parity failures usually occurring before either of these positions is reached. The timing with respect to track 0/0 of a failing track should be noted. All the tracks should have operating margins of at least ± 0.5μS. that is 1 cm. in either direction from the centre of the pulse.

5.7.18 Drum Track Amplitude Measurements

The method of measurement of drum track amplitudes is detailed in 2.4.

5.8 Copying a Clock Track. (See also 5.7.)

5.8.1 The connections to the Master Clock track head are brought out to a pair of terminals under the drum covers. One end of the head

winding is taken through a resistor of 100 K ohms to earth. A six pin Plessey socket (wired according to the usual code) is required with leads connected to pins A and B, these should be connected to the Master Clock head terminals. (See Fig.7.) The 6 pin Plessey plug that carries the clock track signal to the clock amplifier should be connected to the aforementioned socket and the drum may then be tested for satisfactory servo operation from the Master Clock track.

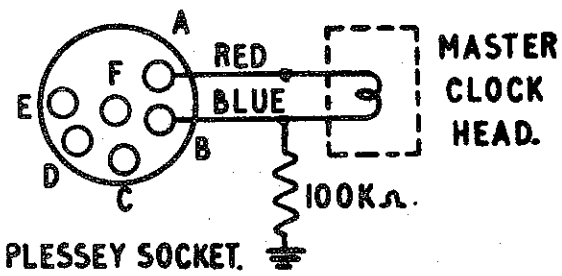


Fig.7.

5.8.2 Dummy Read/Write Switch. (See 5.7.5 and Fig.6.)

This package should be placed in location 28C.

5.8.3 Adaptor Box

The 25 pin Plessey plug, concerned with drum tracks 0-7, should be removed from drum socket No. 2 and plugged into the socket marked 'Clock' on the adaptor box. The adaptor box should be connected via the 6 pin Plessey plug to the socket appropriate to the drum track on which it is desired to write.

5.8.4 Anticlock. See 5.7.3

5.8.5 Drives. See 5.7.7.

5.8.6 Calibration

The writing current may be measured by monitoring the voltage developed across a resistor of 1 ohm inserted in the lead to pin 18 of package location 28C.

The monitoring oscilloscope should be connected across the 1 ohm resistor, the oscilloscope will then indicate the writing current in amps if switched to the 1 x 1 volt range.

5.8.7 Monitoring

A suitable drum trigger pulse can be obtained from pin 19 of package location 13R. The clock amplifier may be monitored at the low level monitor point. (pin 17, package location 27C).

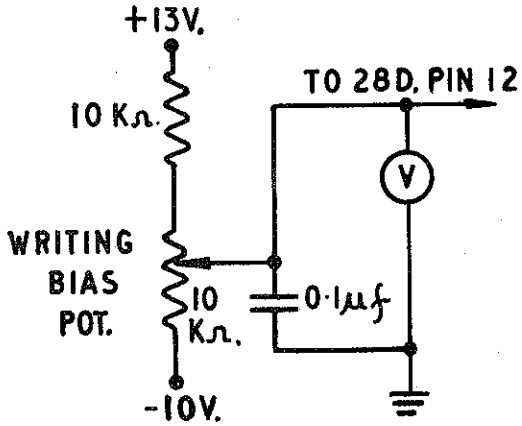
5.8.8 Writing Bias

A potentiometer chain connected across the +13 volt and -10 volt supplies is used to provide a variable bias supply, suitable component values are shown in Fig. 8. A voltmeter is connected across the potentiometer to indicate the bias voltage.

5.8.9 Operation

Select the column and row appropriate to the track on which writing is to take place.

Set the writing bias voltage to -10 volts.



BIAS POTENTIOMETER.
Fig. 8.

Rotate the writing bias potentiometer; as the negative bias is decreased writing will take place. The minimum value of bias will give a writing current of approximately 2 amps. (peak to peak). The writing bias potentiometer should be wound down slowly from the minimum to the maximum value (-10 volts.) The clock track produced from this copying action should operate the drum servo circuit.

N.B. The bias voltage must not be removed before the package in 28C or the 6 pin plug to the clock head has been removed.

5.9 Writing an Initial Address Track. (See also 5.7.)

5.9.1 Adaptor Box

The adaptor box has mounted upon it two 25 pin Plessey sockets which are connected to a lead bearing a 6 pin Plessey plug. The two 25 pin Plessey plugs from package locations 28C and 29C should be plugged into the appropriate sockets on the adaptor box, the lead from the adaptor box should be plugged into the Plessey 6 pin socket concerned with Address Track 1 or Address Track 2 on the drum.

5.9.2 Co-incidence

Connect pin 25 of package location 20G to -10 volts.

5.9.3 Remove the Read Strobe package from location 27F.

5.9.4 Switch to drum clock.

5.9.5 Carry out the Bootstrap operations (see Chap. 4 Vol.1) and read in Octal D input. Perform the manual instruction 0.7+ 0 60 and then with the 'Write Address Track' tape, R1101, in the tape reader, switch to 'Run'. After reading in the tape, switch to 'Run' again and the write address programme should operate. Allow the programme to run for about a minute.

5.9.6 Replace the Read Strobe package in location 27F and remove the link connecting pin 25 of location 20G to -10 volts. Connect the 25 pin Plessey plugs from 28C and 29C to the appropriate sockets on the drum. Examine the address track output by monitoring with an oscilloscope.

5.10 Copying an Address Track. (See also 5.7).

5.10.1 The computer is to be controlled by the initial address track. (See 5.9).

5.10.2 Connect the two 25 pin Plessey plugs from locations 28C and 29C to the adaptor box. (The plug positions for copying address tracks are reversed from those used when an address track is being written.) Connect the 6 pin plug to the second address track socket on the drum.

5.10.3 Carry out the Bootstrap operations and read in the Octal D input. Perform the manual instruction 0.7+ 0 60 and read in the 'Copy Address Track' tape R1102. Allow the programme to run for a minute or so with the optional stop inhibited.

5.10.4 Check the address track by its effectiveness at controlling the computer.

5.11 Quick Replacement of the Isolated Store

5.11.1 Writing into the Isolated Store.

With the H.T. and Drum supplies switched off, change the control of the computer from Clock 1 and Address 1 to Clock 2 and Address 2 by moving the 6 way Plessey plug from socket 12 to socket 6 on the drum.

Remove the two Write Drive (Type 17) packages from package locations 28J and 29J and plug them into package locations 28P and 29P. Switch on the Drum supplies and check that the Drum is synchronised. Switch on the H.T. supplies.

5.11.2 Inhibit parity failures by means of the handswitch on the engineer's panel.

5.11.3 Insert the tape 'Quick Replacement of the Isolated Store' into the Tape Reader. The tape may be started on any zero character at the head of the tape.

Insert Bootstrap

When the first 6 feet or so of tape have been read there will be an optional stop in 1.2 at the end of a section of blank tape. At this point the inhibit parity failure hand switch should be returned to its normal position.

Operate the 'Run' switch to read the remainder of the tape. When the isolated store has been filled a 77 stop will occur in 0.6. A loop stop in 2.7 or 3.4 indicates an error, if this occurs the tape must be read in again. It is not necessary to read in the whole of the tape again in this event; the second part of the tape from the blank section previous to the optional stop occurring in 1.2 is all that is necessary. If any other stop should occur the complete procedure should be repeated, that is, from section 5.11.2.

5.11.4 When the preceding operations have been carried out satisfactorily, switch off the H.T. and Drum supplies and restore the computer to normal, that is; remove the two write drive packages from locations 28P and 29P and replace them in package locations 28J and 29J, remove the connections to Clock 2 and Address 2 and reconnect the computer to Clock 1 and Address 1.

5.12 To obtain a tape 'Quick Replacement of the Isolated Store'.

(This information has been extracted from Pegasus Library Specification R2056).

5.12.1 General

This routine causes the contents of the Isolated part of the Main Store to be punched out in a compact form suitable for reading by the Bootstrap routine.

5.12.2 Procedure

Depress handswitch 0 in order to suppress optional punching. Insert the steering tape R2056 in the main tape reader.

Operate the 'Start' and 'Run' keys; the first part of the tape R2056 should then be read by the tape reader and the punch should commence to punch out the contents of the Isolated Store. The end of the tape

should be marked by about one inch of blank tape followed by about one inch punched with erase characters. The omission of these characters indicates an error and in this event the process must be repeated.

When the Isolated Store tape has been punched, the tape reader should read the remainder of the R2056 tape and the computer should then reach a 77 stop in 4.0.

5.12.3 To check the Isolated Store Tape.

If writing action to the Isolated Store is not inhibited, the 'Inhibit Drum Write' key should be depressed during this procedure.

Insert the Isolated Store tape in the main tape reader on any of the zero characters at the head of the tape.

Operate the 'Run' key to read the new tape. An optional stop will occur in 1.2; operate the 'Run' key at this point to read the remainder of the tape.

A tape that is free from errors will be read without any further stops. At the end of the tape a tape reader pause of about two seconds will occur in 3.0 and the computer will then reach a 77 stop in 0.6. Satisfactory performance of this test indicates that the tape is correct.

5.12.4 Errors

Errors in the punching of the tape will normally be indicated during checking by loop stops in 2.7 or 3.4; the same stops will occur if a character is misread by the tape reader.

The tape reader may be checked by reading the last part of R2056. Insert the tape on the blank section about one foot from the end and operate the 'Start' and 'Run' keys. Should the computer come to the same stop as before and the contents of accumulators 4 and 6 are identical, the tape is probably at fault and the whole procedure must be repeated. If the contents of accumulators 4 and 6 are not identical, the tape reader is probably at fault.

CHAPTER 6

The information contained in this chapter has been supplied by Lancashire Dynamo and Crypto Ltd., and is quoted with their permission.

POWER SUPPLY EQUIPMENT CUBICLE TYPE 26646

6.1 General (See Fig.2/11, Sheet 1, Vol.3A.)

The equipment is built into a robust cubicle which consists of stout sheet aluminium skins on a framework of angle aluminium. Forward opening doors give access to controls at the front of the cubicle, and the rear mounted components are accessible by means of removable back panels.

The cubicle is arranged in two halves, the right hand side contains the A.C. control section. The left hand side contains the D.C. section.

6.1.1 The A.C. Section. (See Fig.2/11, Sheet 2, Vol.3A.)

The A.C. Section of the cubicle contains the fan for cooling purposes, and interlocking protective switching, together with the relevant fuses. Also in this half is the Sunvic Delay Timer, which is included for protection purposes. The two Field Regulator Units, type 20695, and the Control Amplifier type 7217 are also mounted in the A.C. side of the cubicle.

6.1.2 D.C. Section. (See Fig.2/11, Sheet 3, Vol.3A.)

Transformers TR4 and TR5 supply the D.C. voltages and are connected delta primary and star secondary. The outputs from these are rectified by 6 bridged banks of metal rectifiers, MR6-MR16 with appropriate smoothing circuits. The rectified outputs of TR5 are controlled by the Shunt Stabilisers via the Shunt Regulator Control Amplifiers. The rectified outputs of TR4 provide the following low voltage bias supplies +13V, -4V, -10V, and -20V.

This cubicle contains the following chassis:-

One Control Amplifier, type	7217.	Fig.2/5.	Vol.3A.
Two Field Regulator Units, type	20695.	Fig.2/15.	Vol.3A.
Three Shunt Regulator Control Amplifiers, type	20698.	Fig.2/14.	Vol.3A.
Six Shunt Stabilisers, type	20709.	Fig.2/12.	Vol.3A.

6.1.3 Principles of Control

The equipment is required to produce two fully stabilised voltage supplies, 1 KVA 150 c.p.s. at 220V and 14 KVA 48.5 c.p.s. at 415V from two alternators.

The output from the 14 KVA 48.5 c.p.s. 415 volt alternator is tapped to feed the D.C. cubicle, giving required negative and positive voltages, and phase to neutral supplies for the shunt regulator components.

6.1.4 A.C. Control Circuits

The Control Amplifier samples the voltage across the 3 phases and produces a D.C. control signal derived from it. This is fed into the Field Regulator unit which controls the main alternator field via the exciter.

The 1 KVA Alternator Field is controlled directly by a similar Field Regulator Unit. The control signal for this is derived externally.

6.1.5 D.C. Control Circuits

The three D.C. outputs derived from TR5 are all controlled in the following manner:-

The voltage drop across a small series resistor in one side of the supply is sampled and fed into the Shunt Regulator Control Amplifier, this voltage is directly proportional to the current that the Shunt Stabiliser draws from the D.C. output.

6.1.6 Metering

A.C. Section

Metering in this section is provided on the front panel in the form of two watt-hour meters which are connected in the heater and H.T. supplies respectively. Further metering is provided in the form of a 6-way switch, S.W.1., used in association with the voltmeter M7. The purpose of this metering circuit is to measure the voltage of the incoming 3 phase A.C. and the generated A.C. These voltages are metered phase to phase.

D.C. Section

Meter M1. monitors the H.T. current to Shunt Stabiliser No.1.

Meter M2. monitors, by means of a three way switch, the +13, -10 and -20 volt outputs.

Meter M3. monitors the H.T. current to Shunt Stabilisers 2, 3 and 4.

Meter M4 monitors, by means of a three way switch, the three H.T. supplies provided by the rectified outputs of TR5.

Meter M5 monitors the H.T. current for Shunt Stabilisers 5 and 6.

Meter M6 monitors the current at selected points as designated on the schematic diagram.

Meter M8 is a 0-5 m.A. meter with flying lead and jack plug which may be connected to suitable sockets provided on the electronic control chassis.

6.1.7 Protective Circuits

Incoming supplies and transformer primaries are separately fused according to circuit requirements.

The incoming mains and transformers TR1 and TR2 are fused with HRC type fuse cartridges. Outgoing mains and the main alternator outputs are also fused with HRC cartridge fuses.

'Under' and 'Over' voltage protection is provided by RL8 and RL9 respectively. These are supplied from TR3.

6.2 Operation

The equipment must be brought into operation in a set sequence. There are protective interlocks to ensure that if the set sequence is not adhered to the equipment will not respond, and damage will not be caused as a result.

Correct Sequence

1) Close the Cubicle Isolator.

2) Start the Motor Alternator.

3) Operate the 'Filament Supply On' pushbutton.

4) Operate the 'Bias Supply' Switch.

5) Operate the 'H.T. Supply On' pushbutton.

6.2.1 The operation of the cubicle isolator switch energises transformer TR2. The secondary winding of TR2 provides 220V A.C. which in turn energises TR7 causing the 'A.C. supply on' lamp to light. This also energises contactor CR3 via the upper limit switch on the Motorised Potentiometer Unit. Contacts CR3/1 and CR3/2 provide 220V A.C. from TR2 to energise the three electronic control chassis in the A.C. Section.

6.2.2 The motor alternator set may now be started with the Starter Unit. A contact in the starter closes, and energises transformer TR6 causing the 'Alternator Running' lamp to light. With this contact and the contact across A3 and A4 in the control amplifier closed the 'Filament Supply On' pushbutton may now be depressed. This energises the contactor CR1 which is held on by CR1/4. Contacts CR1/1, CR1/2, CR1/3 energise transformer TR1 and the fan. The rectified output of TR1 provides the current supplying the fields of the alternators.

6.2.3 Contacts CR1/5 and CR1/6 isolate the 'Lower' side and energise the 'Raise' side of the motor of the Motorised Potentiometer Unit. This drives up until it runs on to the 'upper' limit switch. The limit switch causes contactor CR3 to release and energises contactor CR4. This changes the power input to the three chassis in the A.C. section from the mains to the alternator supply. CR4/4 energises the delay timer together with the 'Heater Hour Meter'.

6.2.4 When the delay time is up (about 2 minutes) relay RL1 is energised and is held in by contact RL1/2; RL1/1 disconnects the timer. Contact RL1/3 connects one alternator phase to the outgoing terminal 52.

6.2.5 The 'H.T. Supply On' pushbutton may now be depressed. This brings in contactor CR2 which has the H.T. Hour Meter in parallel with it. CR2 is held in by contact CR2/4. Contacts CR2/1, CR2/2 and CR2/3 energise the transformers providing the H.T. Supplies.

6.2.6 In addition to the 'On' and 'Off' pushbuttons provided on the cubicle for the filament and H.T. supplies, there are duplicate controls provided on the main equipment. These consist of 'On' and 'Off' pushbuttons for the filament supplies which control the external relay RL9, and those for the H.T. supplies which control the external relay RL8. There is an overriding 'stop' pushbutton which will de-energise both RL8 and RL9 which switch off both the filament and H.T. supplies.

6.3 Protective Circuits and Interlocks

6.3.1 A switch section on the cubicle isolator ensures that the starter cannot be operated until the cubicle supplies have been switched on.

6.3.2 A normally open contact in the starter unit in series with contactor CR1 ensures that the filament supplies cannot be switched on before the motor alternator set is running. The normally open contact of the relay in series with the H.T. supply of the control amplifier is also in series with the starter contact and ensures also that CR1 cannot be operated until the control chassis are in operation.

6.3.3 Contactors CR3 and CR4 are interlocked to ensure that the two contactors cannot be operated simultaneously which would connect the mains directly to the alternator output.

6.3.4 Contact CR4/3 in series with the normally open contact on the Bias Switch ensures that the field of the 150 c.p.s. alternator cannot be energised until the bias supplies are in operation.

6.3.5 There is an overload relay in the output of the 150 c.p.s. alternator which opens a contact in series with contactor CR1, under overload conditions. This causes CR1 to open, which through the operation of the motorised potentiometer unit de-energises supply CR4. CR4/3 stops the alternator output by disconnecting the supply to its field.

6.3.6 Relays RL10, RL11 and RL12 ensure that the H.T. Supply cannot be switched on unless there is power applied to the D.C. control chassis. This is effected by having a normally open contact of each relay wired in series, and in series with RL7. Normally open contacts of relays RL5, RL6, and RL7 also in series with these contacts ensure that H.T. is not applied unless the bias supplies are also in operation.

6.3.7 Under and Over Voltage protection is provided by RL8 and RL9. These are operated by thermal switches connected in parallel pairs. Under normal conditions both RL8 and RL9 are operated. If the voltage goes high RL9/1 causes contactor CR1 to open. This cuts off the filament, bias, and H.T. supplies. If the voltage goes low RL8/1 causes relay RL1 to open which cuts off the H.T. supplies.

6.4 The Motorised Potentiometer Unit

This unit consists of a small reversing motor with the potentiometer connected to the drive spindle on one side and with two cams connected

to the other side. As soon as the cubicle isolator is closed the 'Lower' winding on the motor is energised and the motor drives down on to the lower limit switch, stopping the motor. When CR1 is energised the 'Lower' winding is disconnected and the 'Raise' winding is energised. The motor now drives up to the upper limit switch; this brings the slider of the potentiometer round the track from minimum to maximum in about one minute. This potentiometer controls the voltage level in the control amplifier and hence as the slider moves round its track so does the output of the alternator increase. Thus a steady and controlled increase from starting to running voltage is provided for the alternator.

When the potentiometer is in the minimum position, the lower limit switch, which is nearer the motor, should be released and there should be continuity between terminals 5, 7 and 12. When the potentiometer is in the maximum position the upper limit switch should be released and there should be continuity between terminals 3, 5 and 6.

6.5 Control Amplifier Type 7217 Stabilised Power Supply (See Fig 2/5 Vol.3A.)

6.5.1 240V 50 c.p.s. is taken to terminals A5 and A6 from the cubicle supply. The primaries of TR1 and TR2 are connected in parallel to terminals A5 and A6. TR1 supplies the heaters of V1-V10 as shown on the schematic.

6.5.2 The secondary of TR2 feeds 350-0-350v to the full-wave rectifier V1 type 5Z4. The positive output from V1 is smoothed by the filter network C1, L1 C2. It is then taken via relay RL1 to the anode of the series regulator valve V1, type EL37.

6.5.3 Relay RL1 via its normally open contact, ensures that the external supplies cannot be switched on until the control amplifier is ready to operate.

6.5.4 The control grid of V2 controls the conductivity of the valve and thus controls the voltage of the H.T. supply derived from its cathode, V3, a twin triode type ECC81 controls the V2 control grid in the following manner:-

Resistor R8 supplies a stabilising neon V4 type 85A2. This maintains V3A cathode and V3B grid at a highly stable potential. Any fluctuation in H.T. voltage appearing at V2 cathode is applied to V3B cathode from the potentiometer chain R7, RV1, R10 via RV1 slider. Since the grid of V3B is stabilised at V4 potential a variation on its cathode has the same effect as an opposite variation on the grid. This alters the

current flowing through V3 and its anode load resistor R5. This, in turn, alters the anode potential V3B which changes the potential of the grid of V3B via the potential divider R6, R7. The amplified voltage variation appears at V3A anode and is applied to the control grid of V2 via R3. This counteracts the original change in H.T. voltage. The stabilised H.T. voltage is controlled by the setting of RV1. This determines the overall conduction of V2.

6.6 Control Amplifier Type 7217 Amplifier Circuit

6.6.1 3 Phase Rectifier Network

The three phases are fed to the primaries of TR3, TR4 and TR5 which are connected in delta. These feed 100-0-100 volts to three full-wave indirectly heated rectifiers, V8, V9 and V10 type EB91. The positive output from these valves is combined and smoothed by the filter network L2, C5. It is then applied to the potentiometer network formed by R26, the 'Set Alternator Volts' potentiometer and R28.

6.6.2 Control Circuit

The slider of the 'Set Alternator Volts' potentiometer applies the potential from the 3 phase rectifier network to the grid of V7B. The motorised potentiometer also controls the input voltage by setting the potential of the negative output from the rectifiers. V7, a twin triode type ECC81, has its cathodes connected together; the fixed resistance of the motorised potentiometer acts as the cathode bias resistor. The potential on the grid of V7A is held within fine limits by the neon stabiliser V6 type 85A2. The anode of V7A is taken directly to the stabilised H.T. line.

6.6.3 Operation

Consider for instance, a reduction in V7B grid potential. There is a corresponding reduction in the cathode potential due to the decrease in valve current. This decrease in cathode potential increases the current through V7A, since its anode and grid potentials are stabilised. This, in turn, decreases the change in cathode potential. This maintains a constant cathode potential; thus for a very small change, either positive or negative, in V7B grid potential there is an appreciable corresponding change in V7B current.

The output from V7B anode controls the grid of V5B via the potential divider R18, R19. V5B is a cathode follower; this operates in the following manner:-

The anode is taken direct to the stabilised H.T. line: for any change in grid potential there is a corresponding change in current flowing through the valve and consequently through the cathode bias resistor. This current variation causes a change in potential developed across the load corresponding to the change in grid potential, hence the name cathode follower.

The output across the V5B cathode bias resistor is applied to the cathode of V5A: i.e. the two cathodes are connected together. The grid of V5A is held at a fixed potential by the potential chain R11, R12, R13. For a potential change on V5A cathode there is a change in valve current. This causes a corresponding change in anode potential developed across the anode load R16 and metering resistor R15.

The output terminal A1 is connected to V5A anode, and terminal A2 to the junction of R11 and R12. In the balance position A1 and A2 should be at the same potential. The "set alternator volts" potentiometer sets the level of input to V7B for a given alternator voltage so that there is no voltage difference between terminals A1, A2.

When the alternator volts drop below the set value terminal A1 goes positive with respect to terminal A2; when the voltage rises above the set value, terminal A1 goes negative with respect to terminal A2.

6.6.4 The current being passed by V5A and V7B may be monitored by means of the Test Milliameter, M8. This may be plugged into JK1 and JK2 in turn, measuring the potential drop across R15 and R22 which act as meter shunts.

6.7 Alternator Field Regulator Unit Type 20695 (See Fig. 2/15, Vol. 3A).

6.7.1 Principles Employed

The function of this unit is to convert the voltage variations from the control system into a variable current supply which controls the alternator field. This output controls the field directly (150 c.p.s. system), or controls the exciter which in turn controls the alternator field (48.5 c.p.s. system).

6.7.2 Method of Operation (See Fig.2/15, Vol.3A.)

Four valves type 12E1 are used, connected in parallel, to provide a controlled current output of up to 400 m.A. An external cubicle supply applies 240 volts at 50 c.p.s. to transformer TR1 primary via terminals

1 and 2. The secondary winding supplies the valve heaters at 6.3 volts.

The input signal voltage is taken to terminals 3 and 4. Terminal 4 is connected to the control grids of V1, V2, V3 and V4 by resistors R5, R8, R11, and R14. Current is supplied to the screen grids of the valves by the resistor chain R1, R2 and R3. The cathode of each valve is connected to terminal 3 by a metering resistor, R6, R9, R12 or R15. The Jack sockets JK1, JK2, JK3 and JK4 provide monitoring of the individual valve currents using the test Milliameter M8.

6.8 Shunt Regulator Control Amplifier Type 20698 (See Fig. 2/14, Vol.3A).

6.8.1 Power Supplies

Transformer TR1 supplies 250-0-250v to the anodes of the indirectly heated full-wave rectifier valve V1, type EZ80. The positive D.C. voltage appearing at its cathode is fed through the smoothing filter network C1, L1, C2 to the H.T. line.

R1 supplies the neon stabilisers V2 and V3, type 90C1. V2 supplies a stabilised line feeding the cathodes of V4 and of V7A. Valves V4 and V7 are twin triodes type ECC81. V3 provides the fixed potential point to which the positive end of the resistor chain formed by R2, R3 and RV2 is connected.

6.8.2 Control System

RV1, via terminals 8 and 9, is shunted across a small series resistance in one arm of the supply to be regulated. As the supply current varies, so does the potential vary across RV1. The position of RV1 slider determines the amplitude of the variation applied to the resistor chain R2, R3, RV2. This signal is fed to the grid of V4A by R4. Stability is ensured by feeding transient signals to V4A grid via the condensers C3 and C6. The output signal appearing at V4A anode is passed to the grid V7A by R10. The signal appearing at V7A anode is combined with a negative feedback signal appearing at V4B anode. This signal is produced by a voltage which appears across the potentiometer chain formed by RV3 and R7 and derived externally. R6 feeds the signal to V4B grid. The position of the slider of RV3 sets the level of this feedback signal which provides shunt current limiting.

The resultant voltage developed across R11 by the currents drawn by V4 and V7A is d.c. coupled by the neons V5 and V6, type NT2. This

signal is then applied to V7B grid by R12. V7B anode is taken directly to the H.T. line. The output from V7B is developed across the cathode load resistor R13 and is taken to terminal 5.

Negative feedback for transient signals, which are fed through the circuit from V4A anode to V7A grid by C5, and from V7A anode to V7B grid by C4 is provided by C8 which is connected from V7A anode to V7A grid.

6.9 Shunt Stabiliser Unit Type 20709. (See Fig.2/12, Vol.3A.)

6.9.1 Power Supplies

The valve heaters are supplied by transformer TR1 at 6.3v. The transformer primary is fed from the internal 240v 50 c.p.s. supply via terminals 1 and 2.

The supply to be stabilised is connected, positive to terminal 8, negative to terminal 3. The H.T. supply source is also connected to terminal 7 to feed the valve screens via fuses F1, F2, F3 and F4. The chassis contains 10 valves (type 12E1) operating in parallel. The screen grids are taken to terminal 7 in two's and three's via F1, F2, F3 and F4 to enable low current fusing to be employed.

6.9.2 Principles of Control

Each anode is taken via a 33 ohm resistor, R39-R48, to the common line terminating at terminal 8.

Each cathode is connected to the terminal 4 line by a 1 ohm metering resistor. This line is connected to terminal 3 by resistors R37 and R38.

Each grid is taken to terminal 5 by a 10K resistor R2, R5, ...R29.

Terminals 3 and 8 are connected across the supply to be stabilised. The shunt regulator chassis provides a control signal which is fed in through terminal 5 and controls the valve grids. The potential on the grid of each valve determines the current flow in that valve. Hence for an increase in potential at terminal 5, the current drawn across terminals 3 and 8 increases, and vice versa.

6.9.3 Metering

The test milliameter M8 may be plugged into the test socket JK1; switch SW1 shunts it in turn across the metering resistor in the cathode line of each valve. This provides a measure of the current drawn by each valve.

6.10 Power Supply Equipment Cubicle Type 26646. Maintenance

It is anticipated that very little trouble will be experienced with the main cubicle, as this contains only the connecting wires, suppressor units, certain relays and the contactors, together with the transformers and rectifiers supplying D.C.

6.10.1 Routine Maintenance

The contactors and relays should be periodically checked. The relay contacts should be cleaned with an approved relay contact cleaning fluid.

Accumulated dust should be periodically removed; a blast of clean, dry, low pressure air may be used for this purpose.

6.10.2 Fault Location

Cubicle

In the event of a failure that has been isolated in the main cubicle, the most simple causes of failure should be checked first.

1) Check all fuses.

2) Examine all leads, connecting plugs or sockets, as any fractures in the leads are far more likely to occur at the terminations than at any other point.

3) Check all relays and contactors to ensure that they are making good electrical and mechanical contact.

6.10.3 In the event of faulty operation being experienced the following techniques may be of value:-

Control Amplifier

1) Check each voltage in turn and compare it with that obtained during commissioning to verify that there is no great discrepancy.

2) In the event of H.T. failure check fuses, all power supplies to the input and check that the filaments of V1 and V2 are glowing.

3) In the event of an excessively high voltage being experienced check that V2 is in good order and that V3 is controlling this valve properly; check also that V4 has its normal glow and the voltage developed across it is correct.

4) Check that the voltage readings obtained at JK1 and JK2 approximate to those recorded during commissioning for the given setting of the alternator volts. Check also that a swing in input produces a corresponding swing at JK1 and an opposite swing at JK2.

6.10.4 Alternator Field Regulator

1) Check fuses and each input voltage in turn and see that the output of TR1 is 6.3V ± 0.3V.

2) Check that the filament of each valve is glowing and that its top cap is firmly in place.

3) Check the valve currents at the Jack points.

6.10.5 Shunt Regulator Control Amplifier

1) Check each voltage against that given in the commissioning instructions to verify that there is no great discrepancy in the results.

2) In the event of H.T. failure check fuses and all power supplies to the input, and check that the filament of V1 is glowing.

3) V2 and V3 should glow when the H.T. is applied. If they do not, check for short circuits across them, and also check that R1 is not open circuit.

6.10.6 Shunt Stabiliser Unit

1) Check fuses and each input voltage in turn and see that the output of TR1 is 6.3V ± 0.3V.

2) Check that the filament of each valve is glowing and that its top cap is firmly in place.

3) Check the valve currents at the Jack point, and compare them with those obtained during commissioning.

When undertaking any voltage checks or examining individual components always use a good quality meter of at least 10,000 ohms per volt sensitivity.

When examining components, i.e., resistors, condensers, switch contacts, etc., always isolate them from the circuits to which they are connected before checking.

6.11 Contactor and Relay Sequencing Schedule

	Isolator Closed	Motor Alternator Running	Filament Supply On		Bias Supply On	HT Supply On
CR1	-	-	ON		ON	ON
CR2	-	-	-		-	ON
CR3	ON	ON	ON	-	-	ON
CR4	-	-	-	ON	ON	ON
RL1	-	-	ON	-	-	-
RL2	-	-	-	ON	ON	ON
RL5, RL6	-	-	-		ON	ON
RL8	-	-	ON		ON	ON
RL9	ON	ON	-		-	-
RL10, RL11 & RL12	-	ON	ON		ON	ON

6.11.1 Contactor and Relay Operation Analysis

Contactor or Relay	Contact	Initiator	Function
CR1		'Filament Supply On' pushbutton	
	CR1/1 CR1/2 CR1/3	]	Apply the 3 phase mains to TR1, the Fan, and the output to the computer.
	CR1/4		Holds the contactor on.
	CR1/5 CR1/6	]	Apply power to the 'raise' or 'lower' windings of the Motorised Potentiometer Unit.
CR2		'HT Supply On' pushbutton.	
	CR2/1 CR2/2 CR2/3	]	Apply the 3 phase Alternator output to T.R.5
	CR2/4		Holds the contactor on.
	CR2/5		Energises the 'H.T. on' Indicator Lamp.
CR3		Upper Limit Switch on the Motorised Potentiometer Unit.	
	CR3/1 CR3/2 CR3/5	]	Apply mains from TR2 to the electronic control chassis. Ensures that CR4 is not energised at the same time as CR3.
CR4		Upper Limit Switch on the Motorised Potentiometer Unit.	
	CR4/1 CR4/2	]	Apply the alternator output to the electronic control chassis.
	CR4/3		Is in circuit with the field of the 150 c.p.s. alternator.

6.11.1 Contactor and Relay Operation Analysis. (Contd).

Contactor or Relay	Contact	Initiator	Function
	CR4/4		Energises RL2.
	CR4/5		Ensure that CR3 is not energised at the same time as CR4.
RL1		RL2	
	RL1/1		De-energises RL2.
	RL1/2		Holds the relay on.
	RL1/3		Applies one alternator phase to outgoing terminal 52.
	RL1/4		Energises the 'Heaters On' indicator Lamp.
RL2	RL2/1	Contact CR4/4	Energises RL1
RL5		-10V Bias Supply	Ensures that the H.T. Supply is interrupted if this bias supply fails.
RL6	RL6/1	-20V Bias Supply	Ensures that the H.T. Supply is interrupted if this bias supply fails.
RL7	RL7/1	+13V Bias Supply	Ensures that the H.T. Supply is interrupted if this bias supply fails.
RL8	RL8/1	The 2 U.V. Relays	De-energises RL1, switching off the H.T. supplies if the alternator output goes low.
RL9	RL9/1	The 2 O.V. Relays	De-energises CR1.
RL10	RL10/1	The output across 2 phases of the Alternator	Ensures that the H.T. Supply is interrupted if one phase fails.
RL11	R11/1	The output across 2 phases of the Alternator	Ensures that the H.T. Supply is interrupted if one phase fails.
RL12	RL12/1	The output across 2 phases of the Alternator	Ensures that the H.T. Supply is interrupted if one phase fails.

6.11.2 A.C. Cubicle Fuses

Fuses	Rating	Function
F1 and F2	6 amp H.R.C.	Protects the primary of the Auto Transformer TR2.
F3, F4 and F5.	3 amp.	Protects the 3 phases to the voltmeter switch, SW1.
F6 and F7; F8 and F9	10 amps.	Protects the secondary of the Auto Transformer TR2.
F10, F11 and F12	6 amp H.R.C.	Protects the primary of Transformer TR1.
F13, F14 and F15	10 amp H.R.C.	Protects the 3 phase mains output to the computer.
F16, F17 and F18	10 amp H.R.C.	Protects the main alternator output to the computer.
F19, F20 and F21	3 amp.	Protects the alternator supply to the Control Amplifier.
F22 and F23	5 amp.	Protects the main alternator input for the power supplies of the Control Amplifier and Field Regulator.
F24, F25 and F26	3 amp.	Protects the supply to the over and under voltage relays.
F27, F28 and F29	3 amp.	Protects the main alternator supply to the voltmeter switch SW1.

6.11.3 D.C. Cubicle Fuses

F30, F31 and F32	2 amp.	Protects the 3 phase supply to the fan.
F33, F34 and F35	10 amp.	Protects the supply to the Shunt Regulator and Shunt Stabiliser Chassis.
F36, F37 and F38	10 amp H.R.C.	Protects the primary of transformer TR4.
F39, F40 and F41	20 amp H.R.C.	Protects the 10v secondary of TR4.
F42, F43 and F44.	60 amp H.R.C.	Protects the 18.5v secondary of TR4.

6.11.3 D.C. Cubicle Fuses. (Contd).

Fuses	Rating	Function
F45, F46 and F47	30 amp H.R.C.	Protects the 13v secondary of TR4.
F48, F49 and F50	15 amp H.R.C.	Protects the primary of transformer TR5.
F51, F52 and F53	15 amp.	Protects the 162v secondary of TR5.
F54, F55 and F56	15 amp.	Protects the 200v secondary of TR5.
F57, F58 and F59	15 amp.	Protects the 285v secondary of TR5.
F60,	15 amp.H.R.C.	Protects the rectified output of the 162v secondary of TR5.
F61.	10 amp.H.R.C.	Protects the rectified output of the 200v secondary of TR5.
F62.	6 amp. H.R.C.	Protects the rectified output of the 285v secondary of TR5.
F63.	5 amp.	Protects the rectified output from the 10v TR4 secondary to voltmeter switch, SW3.
F64.	5 amp.	Protects the rectified output from the 18.5v TR4 secondary to the voltmeter switch, SW3.
F65.	5 amp.	Protects the rectified output from the 13v TR4 secondary to the voltmeter switch, SW3.
F66.	5 amp.	Protects the rectified output from the 162v TR5 secondary to the voltmeter switch, SW2.
F67.	5 amp.	Protects the rectified output from the 200v TR5 secondary to the voltmeter switch, SW2.
F68.	5 amp.	Protects the rectified output from the 285v TR5 secondary to the voltmeter switch, SW2.
F69.	5 amp.	Protects the common return to SW2 & SW3.
F70.	100 M.A.	Protects a main alternator phase output to the computer.

6.12 Instructions for the Maintenance of Lancashire Dynamo and Crypto Alternators.

6.12.1 Cleanliness.

The preservation of clean conditions inside machines and the power house generally is the essential to lowest maintenance costs, long life of plant, continuity of supply and security against breakdown.

Dust, foreign matter, moisture or oil, etc., in suspension in the atmosphere are deleterious to insulation. Solid matter deposits and chokes the ventilation passages in the windings and cores, causing excessive heating. Moisture particles condense on surfaces, reducing the effective leakage path, and may combine with active chemicals to attack the insulation properties very seriously. Remove greasy deposits by washing or spraying with clean, lead-free petrol. The usual precautions against fire should be taken. Dry dust is best removed by blowing out with compressed air.

6.12.2 Standing Plant (Including Storage).

Protection against dampness and dirt or foreign matter is essential. In unheated buildings, atmospheric humidity will cause insulation deterioration by moisture penetration and corrosion of metal parts. To avoid condensation, the room temperature should be maintained somewhat (10 degs. - 15 degs. F.) above outside temperature, especially in damp seasons. Heat is always the best protection against dampness. To safeguard against dirt, etc., cover with light dust sheets and if conditions are severe, blow out as necessary.

Megger tests, regularly taken and recorded are advantageous in showing the state of insulation and whether deterioration requires action. When, after a thorough cleaning, dampness is indicated by low insulation test, drying out is desirable. The best method is to run the Alternator on short circuit under technical supervision; the alternative is heating up the machine externally with radiators or gas-filled lamps fixed inside the machines, not in direct contact with insulation, etc. To obtain a reasonably high temperature - say 150/160 degs. F. maximum, the machines may require sheeting over, but a slow current of air through the machine is necessary to drive away the moisture. The heat should be maintained until normal insulation resistance values are recorded by megger test (See 6.12.3).

During drying out processes, several thermometers should be used, placed in different parts of the windings and cores and every care

should be taken to maintain proper control of the temperature. Thermometer readings should be taken every fifteen minutes until the maximum (mentioned previously) is reached and then maintained constant when half-hourly readings only will suffice.

Before commissioning plant after long stoppages, brushgear requires careful inspection. Make sure that the brushes slide freely in their boxes, and that brush springs are correctly set and unclogged. Polish sliprings and exciter commutator.

6.12.3 Windings

In clean conditions, windings require practically no attention during many years' service. In abnormal atmospheres maintenance attention must be regulated to suit conditions. (See 6.12.1).

Regular inspection reports and records of insulation resistance by megger test provide an invaluable indication of change of condition. Abnormal variations require investigation (see 6.12.1). Monthly readings suffice for normal conditions; where machines are situated in ideal conditions there is no necessity to carry out these checks so frequently, but where conditions are severe, weekly tests are recommended.

The minimum safe value of insulation resistance, in megohms, as measured by a 500 volt megger applied for at least 1 minute, must not be less than:-

10 x Rated Volts ÷ (1000 + rated KVA output)

Where conditions are unavoidably severe, the windings, after cleaning, should occasionally be coated with a good quality insulating varnish. Winding bracings - when fitted - should be examined after first twelve months' running, and at longer intervals subsequently. Make sure all nuts and bolts are tight.

6.12.4 Rotor Sliprings and Brushgear

These require occasional attention. Slipring surfaces should be kept clean and smooth. Uneven or eccentric wear necessitates resurfacing or grinding the sliprings. It is usually caused by mechanical vibration, unequal or incorrect (usually insufficient) pressure on brushes on the same ring, faulty brush connections, dirt or dust or greasy matter preventing free sliding action of the brushes in their holders or unsuitable grade of brush.

The correct brush pressure on sliprings is approximately 3 lbs. per sq.in. of contact area.

6.12.5 Exciter

The commutator surface and brushgear require attention on similar lines to sliprings and brushgear.

After resurfacing commutators, the micas between commutator bars should be carefully examined to determine whether they require further recessing. It is advisable to maintain the depth of recess at about 1/32in. Where proper tools are not available, a small piece of hack-saw blade can be used. It is essential to ensure that no flakes of mica adhere to the sides of the commutator bars. After recessing it is advantageous to chamfer the edges of the bars very lightly to remove all burrs and finally the surface of the commutator should be polished.

The correct brush pressure on commutators is about 2 lbs. per sq.in. contact area.

Sparking is detrimental. Adjustment of the brush position usually cures this. The correct brush position is marked, but if under actual running conditions this does not give sparkless commutation, a trial should be given to moving the brushes a little forward or backward on the marked position. When the rotation is known, the brush position is marked for this rotation only and neutral. If the rotation is not known, the correct brush position is marked for each rotation, the neutral position being the intermediate marking.

Cleanliness is again very important. Failure to excite is often the result of oil vapour condensing invisibly on the commutator surface. In such cases, clean the commutator surface with a rag lightly soaked with petrol, and finally polish with fine glass paper. The use of emery cloth for this purpose is very strongly condemned because of its conductive properties and the risk of faults developing later from its use. High or protruding mica flakes at the edges of the commutator bars also prevent excitation.

6.12.6 Bearings.

These should be examined periodically. With oil-lubricated bearings, clean oil is essential. Change the oil when deterioration and sludging is evident. Where ball and roller bearings are fitted, reference should be made to the comprehensive instructions included in the instruction list for induction motors or direct current motors (see 6.13).

Particular attention is recommended to 6.12.1.

Slipring and exciter commutator brushes wear. This necessitates adjustment of the spring pressure from time to time to maintain the correct pressure at the brush face. Failure to attend to this will reduce the life of brushes and slipring and exciter commutator surfaces. Well-worn brushes should be replaced without delay. Provision is made on the exciter brushgear for lowering the position of the brush boxes, which is necessary after resurfacing or grinding the commutator. The clearance between the commutator surface and the bottom of the brush boxes should never exceed $\frac{1}{8}$ in. The adjustment is made by removing one of the sheet iron laminations from the underside of the brush support arm in the bracket and placing the lamination between the clamp bar and brush support arm. Excessive clearance causes the brushes to chip.

When fitting new brushes grind in the full brush section to the curvature of the commutator with glass - or sand-paper so that contact is made over the full brush face. Blow the carbon dust out afterwards, do not allow it to remain inside or be drawn inside.

On no account should different qualities of brushes be used on one machine without the maker's consent.

High-speed machines necessarily require greater care and attention than low speed machines.

6.13 Instruction for the Maintenance of Lancashire Dynamo and Crypto D.C. Machines.

6.13.1 Delayed Installation

Machines not put into service immediately should be stored in a warm, clean, dry atmosphere. Unfinished or unheated new buildings, sheds, etc., are not suitable for storage. Dampness or humid atmospheres cause condensation on windings which will deteriorate the insulation. When machines are damp, breakdown is only prevented by drying them out. Surround the machine with lamps or radiators, etc., raising the temperature to 150^0-160^0F. Maintain the temperature constant and allow slow air circulation until the insulation resistance figure by Megger test, steadies at not less than

$$\frac{\text{Rated volts x 10}}{\text{Rated kW. or B.H.P. + 1000}} \text{ megohms}$$

D.C. Generators can be dried by running them on short circuit at reduced speed. Do not let the winding temperature exceed 120^0F.

Blow out dirt or dust with compressed air or bellows. Bearings will be damaged if the storage floor vibrates appreciably. To lessen the risk of bearing damage from the effects of unnoticed stationary vibration, give the shaft a part turn every 3-4 weeks. Stiffness to rotation by hand is relieved by a spot of oil applied where the wipers (attached to the outside bearing caps of totally enclosed machines) rub on shafts.

Refer also to 6.13.4

6.13.2 Bearings.

Standard D.C. Motors are fitted with a roller bearing at the driving end and a ball bearing at the non-driving end (except where solidly coupled to worm gears, etc., having their own thrust bearings: the Motor then has a roller bearing at each end). On direct coupled 3-Bearing sets, the 2-Bearing Machine has a ball bearing at the commutator end, the other bearings are Roller.

Use care when handling bearings. Avoid exposure to dirt, foreign matter, moisture, etc. Cleanliness of bearings, housings, and lubricants is of the utmost importance. Clean hands are a first necessity.

Use only ball and roller bearings of the "Cage on rolling elements" type.

Operating temperature. See 6.13.4.

Overhauling

When changing the grease, wash the bearings and the end caps thoroughly by immersion in clean white spirit or petrol. After all traces of cleaning spirits have been dried off the cleaned bearing, it is most important immediately to protect all steel parts by oiling - the procedure recommended is detailed in 6.13.4. Never allow cleaned, dry bearings to remain exposed to the atmosphere - rust pitting will commence instantly - oil prevents this. Where possible, cleansed bearings should be refitted to machines immediately they are clear of the cleaning spirit so that they become oiled without delay by process A or B described in 6.13.4.

Bearings fail by neglect, abuse or mechanical faults. Inefficient lubrication i.e., improper greasing, starvation or use of unsuitable

grease usually produce cage wear. Components suffer injury if harshly treated, e.g., forcing outer race over rollers when relatively canted. Races suffer indentation if subjected to vibration while stationary. If cause of any failure is to be determined, handle the bearing as little as possible - do not clean or remove any grease - return it, if possible, in the condition observed when first exposed, also send in a suitable tin a liberal sample of the grease taken from adjacent caps. Strict adherence to this procedure in invaluable.

6.13.3 Grease

We use and recommend "SHELL ALVANIA No. 3." It is satisfactory for all natural (high and low) ambient temperatures. Supplies are obtainable direct from all Shell lubricants stockists.

Alternative approved greases are:- SPEEDWELL RBB No.8
CALTEX REGAL
STARFAK No.2

N.B. Dirt and dust (grit or chemical) will damage bearings - Keep grease tin lids tightly closed.

6.13.4 Lubrication: The bearings of new machines are charged before despatch with the correct filling of grease.

To maintain adequate lubrication with the recommended grease, fresh grease should be added at the rate of ¼ cu. inch (approx. 4 c.c.) per inch of shaft seating diameter for every 3,000 operating hours or every six months, whichever is the more frequent.

Delayed Installation. Where machines are not put into service until after 6 months from the date of despatch from works, the outer bearing cap should be removed and the bearings and grease examined, to check there has been no deterioration under the conditions of storage. It is especially important to ensure the grease in the cap is still in intimate contact with the bearing over 50% of the area, i.e., has not shrunk away from the bearing. We recommend injecting 5 to 10 drops of approved oil (see below) into each bearing. If the grease has become contaminated the bearings should be washed out and packed with fresh grease. During any inspection great care must be taken to ensure that no dirt or other foreign matter enters the bearing assembly or caps and housing.

At intervals of about two years all old grease should be flushed out

of the bearings and housings, etc., and the bearings recharged, adopting the following procedure to which we attach the utmost importance:-

To grease a New or Cleansed Bearing. There are two alternatives; each includes pre-oiling.

Process A. This is our Works method, which accomplishes shrink fitting of the bearings with pre-oiling, and is recommended where facilities permit. Before any grease is applied, immerse the bearing vertically in a tank of heated oil (thermostatically controlled) to the average temperature of 170°F. (77°C.). The oil used is "Shell Turbo 29", but any good, light, turbine oil may be used if the former is not available.

Time of Immersion - for bearings of shaft seating diameter 4½" and below, 10 minutes, and for larger bearings 15 minutes, then lift the bearing out of the hot oil by a hook, allow to drain lightly then grasp the bearing with clean closely-woven (non-fluffy) cloth and thread the bearing on to its correct shaft seating position. Do not bump it on but be sure the bearing is pressed hard against the shaft shoulder.

N.B. The whole operation must be completed within two minutes of removal from the hot oil. The separate outer race of roller bearings must not be fitted until the rotating member has cooled off.

Process B, used where hot oil bath is not available. The bearings have then to be tupped into position, first applying a thin film of oil on the shaft seating to assist fitting. Apply distributed blows on the inner race only until it is correctly positioned against the shaft shoulder. A piece of piping loosely fitting the shaft makes a good driver. The bearing is now ready for pre-oiling. Gently inject oil (Type as in Process A) into the bearing on the outer diameter of the cage between 10 and 2 o'clock positions (shaft assumed horizontal). Avoid oil splashing out, escaping or being shot right through the bearing. The quantity of oil to be applied is approx. 2 c.c. per inch of bearing bore (shaft seating diameter) ignoring fractions, i.e.,

Brg. bore (inches)	1⅞ & below	2-2¾,	3-3¾,	4-4¾,	5-5¾,	6 & over
Quantity of oil (c.c.)	2	4	6	8	10	12

(A convenient means of applying the measured amounts is to use a "3340 WESCO" Special oil can which ejects approx. 2 c.c. per full depression of lever. If this is not available an average teaspoon will hold 3 c.c. when full.)

Having pre-oiled by either of the above processes the grease is now to be applied as follows:-

(a) Press grease well into the bearing all round each side and face it off flush with the ends of the races. Smear grease over shafts where caps will fit and over the spigots of bearing caps to establish grease seals.

(b) Fill bottom half only of each cap so that when cap is pressed into final position the grease is squeezed into the bearing - but there must not be so much excess of grease in the cap that it is forced into the empty half. Each bearing cap must be slipped back after first pressing into position before being finally bolted up, in order to check that the above conditions are achieved and, if necessary, the grease quantity adjusted.

N.B. The aim is to ensure that the bearing assembly, including caps, is exactly 50% full of grease with the grease in the most intimate contact with the bearing. Over-packing must be avoided, particularly on high speed machines.

With vertical spindle motors, the same procedure is to be followed except that with the outer bearing cap, the portion which is filled with grease is to be the half on the side in which the grease replenishing device is fitted; while with the inner cap, the portion which is filled with grease is to be the half which is on the same side as that which is empty in the outer half.

Operating Temperature of Bearings. A bearing should exhibit a certain temperature rise. It is a symptom of ample and efficient lubrication. Cold running frequently indicates insufficient lubrication. Reasonable maximum bearing temperatures are:

Peak Temperature (total) occurring shortly after start of a bearing newly packed with grease ... ... 80^0C. (176^0F.)

Final steady Temperature Rises:-
Ventilated machines ... ... 35^0C. (63^0F.)

Plain totally enclosed machines, also totally enclosed external fan cooled type where the bearing is fitted in the totally enclosed end-cover -

Running on No Load ... ... 35^0C. (63^0F.)
Running on Full Load ... ... 50^0C. (90^0F.)

6.13.5 Dismantling

Disconnect external cables and internal field leads in terminal box and interpole lead to brush arm. Lift brushes. Remove outer bearing cap and end-cover bolts. Ease end-cover off frame spigot but prevent armature dropping heavily on poles, then gently pull end-cover off bearings. Ball bearings will remain on shaft. Roller bearing outer race will probably slide off rollers and remain in housing. Bearing outer races are a piston fit in housing. Force must not be applied for withdrawing end-covers. *Caution:* When withdrawing armature do not pull it along the pole tips.

Note: A fan is usually fitted at driving end - withdraw armature from driving end when required.

Bearings are a light interference fit on shaft, secured at non-driving end by a nut locked by cheese-headed screw embedded in nut and shaft. Remove locking screw before attempting to remove nut.

Remove bearings with the Bearing Extractor tool specially designed for the purpose.

Note: No drawing-off gear is required to remove the driving end bearing of LANCASHIRE-CRYPTO D.C. machines, the specially strengthened inner bearing cap may be used instead:-

(1) Take out screws of outer bearing cap and remove cap.

(2) Take out screws securing end-cover to frame; remove end-cover by gently prising off spigot. As this is a roller bearing the outer race will be drawn off with the end-cover.

(3) Fit withdrawing screws of suitable length through the tapped holes in inner cap and rotate them alternately until each screw is resting on recess in fan hub and until face of inner cap touches inner roller race.

(4) Further tightening of the screws, evenly, draws off the bearing.

Main and Inter-poles detach complete with coils by removing set-screws externally. Carefully note any "Liners" between poles and magnet, they must be put back exactly as fitted. Coils lift off easily when pins in pole ends nearest magnet are pulled out. Take care of the insulation packing. Handle coils gently. Keep grease and oil off windings and commutator.

6.13.6 Reassembling. (See 6.13.4)

Do not use force in sliding end-cover over bearings. Tighten all screws and nuts securely.

6.13.7 Brushgear

Correct brushgear position is clearly indicated by painted cast arrow on brush rocker, and arrow-marked line on end-cover. The direction of latter arrow indicates armature rotation looking at commutator end. Set rocker arrow to line on end-cover corresponding to required rotation. (An end-cover non-arrow marked line indicates neutral position.) Brushes should slide easily and smoothly in their holders. Keep brushgear clean. Brush pressure (E.G. quality) approx. 3 lbs. per square inch of contact area. Tension should be equal on all brushes. Adjust spring pressure as brushes wear. When fitting new brushes grind in full brush section to curvature of commutator with glass-paper. Brush arms should be adjusted for commutator wear. Clearance between bottom of holders and commutator should never exceed ⅛ inch. Liners should be removed from under carrier arm in rocker and transferred to top side. Adjacent pairs of brush arms are staggered ¼ inch. Arms should be parallel to axis of machine and spaced equally round the commutator. Be certain brush flexible connections and main connections are clean and tight.

6.13.8 Commutator.

Keep clean, free from oil, grease and dirt. Surface should never be allowed to blacken, wear roughly or unevenly. Under normal conditions surface takes a highly polished, clean skin, and wears little over many years service. All commutators have recessed micas. Care is required when recutting to recess cleanly not more than 1/32nd inch below surface of bars, and that no mica flakes are left adhering to sides of bars. This is important, and also afterwards, to polish commutator and remove raised copper edges. Slightly bevel the edges of the commutator bars on heavy current machines.

Except when eccentric, commutators are quickly, effectively and more economically resurfaced by using a non-clogging stone. State condition of the commutator when ordering, e.g., grooved, blackened, high micas, etc., so that the most suitable grade can be supplied.

There should be no eccentricity when running. Eccentricity is best removed by lathe turning. It is advisable, especially when high bars are suspected, to heat up commutator previously to about 150°F. (bunsen

flame played evenly over surface while in lathe) and try to tighten up commutator screws or end nut in front end ring. Excessive spanner pressure is unnecessary. When turning commutators in a lathe, remove all traces of tool marks. Then recess micas, clean and finally polish with carborundum cloth or glass-paper. Machines should run sparklessly over normal load range.

6.13.9 Sparking

We recommend attention to the following:-

(a) Check carefully if all external connections are correctly made, if machine has been dismantled internal connections may have been incorrectly re-made.

(b) The brush position may be incorrect (See 6.13.7). Try adjustment by lightly slacking off rocker screws in front of end-cover above bearing and moving brushgear gently by light taps on the rocker projection (not on any insulation or brush arm). For motors, move brushgear against rotation and generators vice versa. Opposite movement is only necessary if sparking is increased by above adjustment.

(c) Check, with an ammeter inserted, whether machine is overloaded.

(d) Brushgear and brushes in bad condition. Attend to recommendations in 6.13.7.

(e) Commutator in bad condition, e.g., grooved, dirty, high micas or odd flakes raised at edges of bars. Attend as recommended, 6.13.8.

(f) Vibration makes brushes and brushgear unstable. Probable causes are non-rigid foundations, faulty alignment, harsh gears or knock from heavy belt fasteners or transmitted engine defect.

(g) Heavy current machines. It is most important that all connections, particularly brush flexibles, be thoroughly sound and commutator and brushgear kept clean.

Periodical examination of all mechanical connections (including switchgear) for slackness and soldered joints for faulty sweating is advised; they should be quite clean. Hot joints or connections show certain defects.

6.13.10 *Cleanliness keeps the Repair Bill down.* Moisture, oil, grease, dirt, metallic dust (carbon, copper, etc.,) and chemical fumes destroy insulation. Dry matter should be blown out by compressed air or bellows. Remove greasy accumulations by washing or spraying with petrol, taking the usual fire precautions. Occasionally, after cleaning, a coat of good insulating varnish gives added security; dry out subsequently.

Emery cloth must NEVER be used for cleaning or polishing commutators or connections, or grinding in brushes. Use only Resurfacing Stone, Carborundum Cloth or Glass-paper. After bedding in new brushes, or polishing commutator, blow out to remove dust.

6.13.11 General

A diagram of connections is sent out with every motor, usually under terminal box lid. Motors are despatched connected for clockwise rotation looking at driving end and Generators for opposite rotation unless specified otherwise when ordered.

On compound wound motors make certain that series coils are connected correctly, for required rotation.

On totally enclosed and pipe vent machines, etc., it is very important that bands and pipes are properly secured to prevent dirt, moisture, fumes, etc., getting inside.

It is important that brushes of same quality only should be used on commutators of any motors or generators. Mixing different grades of brushes disturbs current distribution. When ordering spare brushes, specify quality as stamped on side of existing brushes.

Exercise care when fitting or removing pinions, pulleys and couplings. Draw cramps are best for removing these, but when forcing them off by other means, and when fitting, support a heavy bar firmly against opposite end of shaft to prevent bearings taking shock of blows.

6.14 Instructions for the Maintenance of Lancashire Dynamo and Crypto Induction Motors

6.14.1 Bearings. (See 6.13.2).

6.14.2 Grease. (See 6.13.3).

6.14.3 Lubrication. (See 6.13.4).

6.14.4 Dismantling.

Squirrel Cage Type. - Remove bearing caps. Remove end-cover screws, ease cover off spigot in stator, withdraw cover from bearing, which will remain on shaft with inside cap.

Do not force end-covers off bearings. The outer races are a thumb press fit in housings, and will slide out. The roller bearing outer race will probably remain in the housing when withdrawing end-cover.

Wound Rotor Motors:-

External Slip Ring Type. - Disconnect rotor cables, remove grub screw in front of slip ring bush and shaft; lift brushes. Withdraw slip rings complete with bush by lightly levering bush end - not on slip rings. Lift key. Collector gear comes away with bracket when hexagon-headed screws outside brackets are removed, then unscrew bearing cover nuts and withdraw cover as for Squirrel Cage Type.

Internal Slip Ring Type. - Disconnect connections between brushgear and terminal box, also interlock switch connection. Lift brushes before removing end-cover.

Bearings are a light interference fit on shaft, and secured at non-driving end by a nut locked by cheese-headed screw embedded in nut and shaft. Remove locking screw before attempting to remove nut. Remove bearings with the bearing extractor tool specially designed for the purpose. When withdrawing rotor, take care not to damage stator end windings or core plates. Keep grease off windings.

Re-assembling. (See 6.13.4).

Do not use force in sliding end-cover over bearings. Avoid any cant which injures bearings. Tighten all screws and nuts securely.

6.14.5 Cleanliness keeps the repair bill down. Moisture, oil, grease, dirt, metallic dust (carbon, copper, etc.,) and chemical fumes impair insulation. Dry matter should be blown out by compressed air or bellows. Remove greasy accumulations by washing or spraying with petrol, taking the usual fire precautions.

Slip rings and brushgear require attention. Eccentricity, grooving or roughness of slip ring surfaces is detrimental and often caused by dirt or insufficient brush pressure. Ring surfaces should be trued and polished and permanently maintained in this condition. Brush or other dust should not be allowed to settle between slip rings and on brush-

gear support bars. Brushes should slide freely in their boxes. Spring pressure must be adjusted as brushes wear down.

Correct brush pressure is essential for satisfactory performance. It is important the following pressures be maintained continuously. Metallic brushes (Bronze tint) require greater pressures than other grades. Essential MINIMUM actual pressure in ounces per brush for standard grades:-

Brush Size (width x thickness).		Pressure (ounces per brush).	
New Type (inches)	Earlier Type (m/m.)	Metallic Grades (e.g. MC94 & M.3)	Other Grades (e.g. EG.98 & E.4)
3/8 x 3/4	8 x 22	29	18
3/8 x 1	10 x 25	36	22
5/8 x 1 1/4	16 x 32	56	38
7/8 x 1 1/2	-	68	53
-	25 x 40	74	62

N.B. For general conditions and to allow for normal wear of brushes (which will lower the initial pressure), always, when fitting new brushes, apply pressures approx. 15% higher than the minimum listed above. Pressures below list value encourage excessive wear and grooving of brushes and slip rings. Whenever these symptoms develop, increase the pressure as indicated above and if undue wear continues increase again to the nearest higher value which prevents abnormal wear. Slip ring grooving or roughness should be removed by applying a resurfacing stone or carborundum cloth and finally polishing with glass paper. When vibration is present, higher pressures are recommended. Severest conditions will permit pressures 33% to 50% more than listed without detriment. When fitting new brushes, grind in full brush section to curvature of ring with glass paper. Make certain brush flexible connection to brush-holder is making good electrical contact.

Slip ring short-circuiting gear, when fitted, should operate freely without forcing. Action is easy when clean and lightly lubricated. Smear the shaft lightly with grease occasionally where the sliding

collar (behind slip rings) rides, also the faces of the sliding collar groove. In the "on" and "off" position the operating blocks in the groove should be clear of the side flanges when the gear is in correct adjustment, and this should be carefully watched when reassembling these parts. It is important when operating the gear that the handle should be given full travel. Incomplete travel maintains the operating blocks in contact with the side flanges, causing destructive wear of the sliding collar flanges.

Short circuiting switch contacts require occasional trimming, cleaning and adjusting to maintain adequate pressure between the contacts with switch closed. Faulty or burnt contacts may adversely affect adjacent bearings and motor speed, etc.

6.14.6 General

A diagram of connections is sent out with every motor, usually inside terminal box lid. Soldered joints necessary in wiring should be soundly made.

Exercise care when fitting or removing pinions, pulleys and couplings. Draw cramps are best for removing these, but when forcing them off by other means, and when fitting, support a heavy bar against opposite end of shaft to prevent bearings taking shock of blows.

6.15 Parts List. Power Supply Equipment. Cubicle Type 26646.

Circuit Reference	Designation	Specification	Part Number
TR1	Transformer	Three phase, open air cooled transformer with terminal board. Pri: 440V 50 c.p.s. tapped for inputs at 400-370-340 volts line, star connected. Secondary 290V at 0.5 amps line, delta connected, rating 250 VA type No. 28077.	Special
TR2	Transformer	Auto Transformer	528
TR3	,,	Pri: 220V Sec: 30V	
TR4	,,	Three Phase open, air cooled transformer with terminal board. Pri: 415V 48.5 c.p.s. delta connected. Sec: Star Connected [A] 18.5V 32 amps line with tappings at 16.5 and 17.5 volts [B] 13V 22 amps line, with tapping at 12 and 11 volts. [C] 10V 17.5 amps line, with tappings at 9 and 9.5 volts ref: 28101	500/1
TR5	Transformer	Three Phase, open type air cooled transformer with terminal board. Pri: 415 volts 48.5 c.p.s. delta connected Sec: Star connected. [A] 285V 4.4 amps line, with tappings at 270 and 265 volts. [B] 200V 5.6 amps line, with tappings at 190 and 180 volts. [C] 162V 9.2 amps line, with tappings at 155 and 148 volts.	Special
TR6,7	,,	Pri: 230V Sec: 5V	500/2
RL5, 6, 7	Relay	3 relays mounted on a common bar	Special
RL10, 11, 12	Relay	1 N/O 1 N/C wound for 220V A.C.	Special

WHEN ORDERING SPARE PARTS THE EQUIPMENT SERIAL NUMBER SHOULD BE QUOTED

6.15 Parts List. Power Supply Equipment. Cubicle Type 26646. (Contd).

Circuit Reference	Designation	Specification	Part Number
OVR's	Relay	Over voltage relays	Special
UVR's	„	Under voltage relays	Special
RL1	Contactor	4 N/O 2 N/C with interlocks	906
CR1, 2, 3, 4	„	4 N/O wound for 220V AC	902
BIAS SWITCH	Switch	Rotary Switch Type A304	Special
SW2, 3	„	Voltmeter Switch	Special
SW4	„	Switch, 2 pole, 6 way	887
SW1	„	Rotary switch	Special
	Meter	Hour meters [2 off]	Special
M1	„	0-2 amp ammeter	Special
M2	„	0-3 Volts Voltmeter	Special
M3	„	0-5 amp Ammeter	Special
M4	„	0-250 volts Voltmeter	Special
M5	„	0-150 volts Voltmeter	Special
M6	„	0-10 amps Ammeter	Special
M7	„	0-500 volts Voltmeter	Special
R1	Resistor	10K 12W	370
R2	„	5K 30W	387A
R5, 7	„	0.5 ohm 26A	Special
R6	„	0.5 ohm 40A	Special
R8	„	35 ohm 3.0A	Special
R9, 10	„	17 ohm 3A	Special
MR1, MR2	Metal Rectifier	4A 217	Special
MR2, MR4	„ „	4A 218	Special
MR5	„ „	B18/2/1W	776A
MR6	„ „	2L147	Special
MR7 & MR8	„ „	Rectifier arrangement comprising 2 units code 12L147	Special
MR9	Metal Rectifier	2L206	Special
MR10 & MR11	„ „	Rectifier arrangement comprising 2 units code 12L309	Special
MR12, MR13 & MR14	„ „	Rectifier arrangement comprising 3 units code 12L255	Special

WHEN ORDERING SPARE PARTS THE EQUIPMENT SERIAL NUMBER SHOULD BE QUOTED.

6.15 Parts List. Power Supply Equipment. Cubicle Type 26646. (Contd).

Circuit Reference	Designation	Specification	Part Number
MR15 & MR16	Metal Rectifier	Rectifier arrangement comprising 1 unit code 12L271 and 1 unit code 12L272	Special
MR17 & 18	„ „	H18-3-1W	770A
RV1	Variable Resistor	6 ohm 10A, DOX4, with two tapping bands	Special
RV2	„ „	7.9 ohm 7A,OX6, with two tapping bands	Special
RV3	„ „	12 ohm 6A,OX6, with two tapping bands	Special
RV4	„ „	1250 ohm 0.4A,OX4, with one tapping band	Special
RV5	„ „	6 ohm 11A	Special
RV6	„ „	9 ohm 7A	Special
RV7	„ „	23 ohm 5.5A	Special
RV8	„ „	10K 3W	968
C1, 2, 3	Capacitor	100 mfd 400V	Special
C4, C8	„	1 mfd 400V	404
C5, 6, 7	„	4 mfd 400V	414
L1	Choke	2mH 30A D.C. max RMS A.C. voltage across winding 1 volt at 290 c.p.s.	Special
L2	„	2mH 40A max. RMS A.C. voltage across winding 1 volt at 290 c.p.s.	Special
L3	„	2mH	Special
L4 & L5	„	0.2H 11A D.C. max. RMS A.C. volts across winding 20 volts 290 c.p.s.	Special
L6	„	0.2H 5A D.C. max. RMS A.C. volts across winding 20 volts at 290 c.p.s.	Special

WHEN ORDERING SPARE PARTS THE EQUIPMENT SERIAL NUMBER SHOULD BE QUOTED.

6.16 Parts List. Power Supply Equipment. Control Amplifier Type 7217.

Circuit Reference	Designation	Specification	Part Number
V1	Valve	5Z4	116
V2	,,	EL37	100
V3, 5, 7	,,	ECC81	150
V4, 6	,,	85A2	131
V8, 9, 10	,,	EB91	155
C1, 2	Capacitor	4mfd 750V	416
C3	,,	0.1 mfd 350V	445
C4, 5, 6	,,	0.5 mfd 350V	449
L1	Choke	10H 100mA	521
L2	,,	20H 20mA	520
R1, 15, 22	Resistor	100 ohms	253A
R2, 4	,,	220K	281
R3	,,	10K	270
R5, 14, 16 24 & 27	,,	100K	279
R6, 18	,,	500K H.S.	322
R7	,,	1M H.S.	326
R8, 20	,,	47K 1W.	233
R9	,,	20K. 12W	373
R10	,,	7K 12W	369
R11	,,	47K	265
R12, 13, 17	,,	27K 1W	232A
R19	,,	750K H.S.	324
R21	,,	270K	282A
R23	,,	68K	277A
R25, 29	,,	1M	285A
R26	,,	50K H.S.	308A
R28	,,	80K H.S.	300/24
RV1	Variable Resistor	5K 3W	967
RL1	Relay	1K coil IN/O Contact	631
TR1	Transformer	Pri: 10-0-200-220-240V Sec a) 6.3V 1A b) 6.3V 2A C) 6.3V 2A d) 5V 5A	Special
TR2	,,	Pri: 10-0-200-220-240V Sec a) 350-0-350V b) 6V 2A c) 5V 2A	500

WHEN ORDERING SPARE PARTS THE EQUIPMENT SERIAL NUMBER SHOULD BE QUOTED

6.17 Parts List. Power Supply Equipment. Alternator Field Regulator Unit Type 20695.

Circuit Reference	Designation	Specification	Part Number
V1,2,3,4	Valve	12E1	166
R1	Resistor	25K 30W	386
R2,3	„	1K 12W	364A
R4,7,10,13	„	100 ohm	253A
R5,8,11,14	„	10K	270
R6,9,12,15	„	1 ohm 4W	356
TR1	Transformer	Pri: 200-250 volts Sec: 6.3 volts 22 amps	544

WHEN ORDERING SPARE PARTS THE EQUIPMENT SERIAL NUMBER SHOULD BE QUOTED

6.18 Parts List. Power Supply Equipment. Shunt Regulator Control Amplifier Type 20698.

Circuit Reference	Designation	Specification	Part Number
R1	Resistor	5K 12W.	368
R2	"	270K	282A
R3	"	82K H.S.	300/11
R4,12	"	10K	270
R5,6,7,11	"	100K	279
R8	"	470K	283A
R9,10	"	1M	285A
R13	"	27K	273A
V1	Valve	EZ80	170
V2,V3	"	90C1	160
V4,V7	"	ECC81	150
V5,V6	"	NT2	186
C1,2	Capacitor	4mfd 400V	415
C3	"	8mfd 400V	420
C5,9	"	0.02mfd 750V	463A
C6	"	100pfd	400/9
C7	"	0.05mfd	441
C8	"	33pfd	461
L1	Choke	20H.20mA	520
TR1	Transformer	PTM11A	501
RV1	Variable Resistor	2K 3W	966
RV2	" "	50K 3W	970
RV3	" "	20K 3W	969

WHEN ORDERING SPARE PARTS THE EQUIPMENT SERIAL NUMBER SHOULD BE QUOTED

6.19 Parts List. Power Supply Equipment. Shunt Stabiliser Type 20709.

Circuit Reference	Designation	Specification	Part Number
V1-V10	Valve	12E1	166
R1, 4, 7, 10, 13, 16, 19, 22, 25, & 28.	Resistor	100 ohms	253A
R2, 5, 8, 11, 14 17, 20, 23, 26, & 29.	Resistor	10K	270
R3, 6, 9, 12, 15, 18, 21, 24, 27, & 30.	Resistor	1 ohm 4W	356
R39-48	Resistor	33 ohms	250
R37, 38	Resistor	15 ohm 12W	357
TR1	Transformer	Pri: 200-250 volts. Sec: 6.3 volts 22 amps	544
C1	Capacitor	0.01mfd 1KV	463
SW1	Switch	1 pole 12 way	888
F1, 2, 3, 4.	Fuses	1A.	991

WHEN ORDERING SPARE PARTS THE EQUIPMENT SERIAL NUMBER SHOULD BE QUOTED

CHAPTER 7

REPAIRS

7.1 General

Only approved components of the correct type must be used in the computer. Stocks of all spare items are held by Ferranti Ltd., and these can be supplied as required. When ordering spares a full description of the components required should be given together with relevant details of the computer installation for which the parts are required.

Packages that are beyond local repair may be sent to Ferranti Ltd., for overhaul and testing.

7.2 Table of Connections for Creed Model 25. High Speed Reperforater.

Output I package location	11L19	11L28	11K28	11K19	11K9	11L9	..	..	..
Connector	11A28	11A32	11A31	11A27	11A26	11A25	..	..	..
Relay Board	R19	R18	R17	R16	R15	R20	+300	..	..
Input-Output Board	..	..	..	..	..	..	..	R13	C7
S11	F (Black)	E (White)	D (Yellow)	C (Green)	B (Blue)	G (Brown)	A (Red)	L (Light Green)	M (Grey)
Painton Plug									
18 pin	3	6	9	12	15	18	2	5	1
24 pin	3	6	9	12	15	18	2	20	1
Destination	S1	S2	S3	S4	S5	Clutch	Common	Sync.	Sync.

7.3 Relay and Socket Panel, External Connections

(The abbreviation T.B. has been used for 'Terminal Block' in these tables).

7.3.1 Socket 1 to Engineers' Panel

Pin	Function	T.B.
A	220V. A.C. CONTROL (AB)	184
B	220V. A.C. CONTROL (BD)	181
C		
D	H.T. ON BUTTON (B.C.)	182
E	M/A ON LAMP (B.J.)	173
F	H.T. ON BUTTON (B.B.)	183
G		
H		
J	STARTER HEATERS LAMP AND HEATERS ON BUTTON (B.H.)	174
K		
L	HEATERS ON BUTTON (B.F.)	175
M		
N		
O	H.T. HOLD ON CIRCUIT	180
P		
Q	HEATER HOLD ON CIRCUIT	176
R		
S	START M/A (D.J.)	171
T	THERMAL TRIP (BAY 1)	177
U		
V	THERMAL TRIP (BAY 2)	178
W		
X	START M/A. (D.F.)	172
Y	THERMAL TRIP. (BAY 3)	179

7.3.4 Socket 4 to Engineers' Panel

Pin	Function	T.B.	Input Board
A	48.5 c.p.s. PHASE A'	[153]	[F.D.]
B	48.5 c.p.s. PHASE B'	[154]	[F.E.]
C	48.5 c.p.s. PHASE C'	[155]	[F.F.]
D	NEUTRAL N'	[156]	[F.H.]
E	HEATERS READY LAMP	[186]	[A.K.]
F	H.T. ON LAMP	[187]	[F.C.]

7.3.5 Socket 5 to Engineers' Panel

Pin	Function	T.B.
A	FAN ALARM BAY 1	[161]
B	FAN ALARM BAY 2	[162]
C	FAN ALARM BAY 3	[163]
D	HEATER/H.T. ALARM BAY 1	[164]
E	HEATER/H.T. ALARM BAY 2	[165]
F	HEATER/H.T. ALARM BAY 3	[166]

7.3.2 Socket 2 to Engineers' Panel

Pin	Function		T.B.
A		+300V	[550]
B		+200V	[551]
C	MONITOR	+300V	[570]
D	DRUM	+300V	[188]
E			
F	DRUM	+100V [R]	[658]
G			
H			
J	DRUM	+100V [S]	[659]
K	'MARGINS OFF" LAMP		SW1B
L		-4V	
M	EARTH		[564]
N		+13V	[567]
O			
P			
Q			
R	Y-PLATE SWITCH		[571]
S	C.R.T. Y SHIFT		[572]
T			
U	DRUM	-150V	[189]
V		-150V	[552]
W		-20V	[569]
X		-10V	[568]
Y	MONITOR	-300V	[563]
Z			

7.3.3 Socket 3 (not used)

Pin	Function	T.B.
A	MAINS PHASE A	[558]
B	MAINS PHASEE B	[559]
C	MAINS PHASE C	[560]
D	MAINS NEUTRAL	[557]
E	EARTH	[564]

7.3.7 Socket 7. (Not used.)

Pin	Function	T.B.
A	+300V	[550]
B	+200V	[551]
L	-4V	[566]
M	EARTH	[564]
N	+13V	[567]
V	-150V	[552]
W	-20V	[569]
X	-10V	[568]

7.3.8 Socket 8 (Spare 25 Pin Socket)

7.3.9 Socket 9. Tape Reader 1. Plug A.

Pin	Function	Destination
A	48.5 c.p.s. PHASE A'	T.B. [553]
B		
C		
D	48.5 c.p.s. NEUTRAL N'	T.B. [556]
E		
F	BRAKE COIL [11A 29]	T.B. [672]
G	BRAKE COIL TO R 22	Relay panel
H		
J	CLUTCH COIL TO R 21	Relay panel
K	CLUTCH COIL TO RL 10-1	Relay panel
L	EARTH	T.B. (565]
M	+300V	T.B. [550]

7.3.6 Socket 6. External Conditioning Relays.

Pin	Function
A	RL1 - 7 Relay panel
B	RL1 - 6 Relay panel
C	RL1 - 5 Relay panel
D	RL2 - 7 Relay panel
E	RL2 - 6 Relay panel
F	
G	RL2 - 5 Relay panel
H	
J	RL3 - 7 Relay panel
K	RL3 - 6 Relay panel
L	
M	RL3 - 5 Relay panel
N	
O	RL4 - 7 Relay panel
P	RL4 - 6 Relay panel
Q	
R	RL4 - 5 Relay panel
S	
T	RL5 - 7 Relay panel
U	RL5 - 6 Relay panel
V	RL6 - 7 Relay panel
W	RL5 - 5 Relay panel
X	
Y	RL6 - 6 Relay panel
Z	RL6 - 5 Relay panel

7.3.12 Socket 12 to Interpreter Unit

Pin	Function	T.B.
A	MAINS PHASE B	[559]
B	MAINS NEUTRAL	[557]
C	EARTH	[565]
D	+200V	[551]
E	-150V	[552]
F		

7.3.13 Socket 13 to Creed Punch Auto-Transformer

Pin	Function	T.B.
A	MAINS PHASE A	[558]
B	MAINS PHASE B	[559]
C	MAINS PHASE C	[560]
D	MAINS NEUTRAL N	[557]
E	EARTH	[564]
F		

7.3.14 Socket 14 (Not used)

Pin	Function	T.B.
A	48.5 c.p.s. PHASE A′	[553]
B	48.5 c.p.s. PHASE B′	[554]
C	48.5 c.p.s. PHASE C′	[555]
D	48.5 c.p.s. NEUTRAL N′	[556]
E	EARTH	

7.3.10 Socket 10. Tape Reader 1. Plug B.

Pin	Function	Destination
A	LOCATION o/p TO RL8-1	Relay panel
B	PC0 o/p TO RL 11-5	Relay panel
C	PC1 o/p TO RL 10-5	Relay panel
D	PC2 o/p TO RL 9-5	Relay panel
E	PC3 o/p TO RL 8-5	Relay panel
F	PC4 o/p TO RL 11-1	Relay panel
G		
H		
J	EARTH	T.B. [565]
K	MONITOR -300V	T.B. [563]
L	-150V	T.B. [552]
M	+200V	T.B. [551]

7.3.11 Socket 11 to Creed Punch

Pin	Function	Destination
A	+300V	T.B. [550] Relay & Socket panel
B	DIGIT COIL 4	[R15] Relay & Socket panel
C	DIGIT COIL 3	[R16] Relay & Socket panel
D	DIGIT COIL 2	[R17] Relay & Socket panel
E	DIGIT COIL 1	[R18] Relay & Socket panel.
F	DIGIT COIL 0	[R19] Relay & Socket panel
G	CLUTCH COIL	[R20] Relay & Socket panel
H		
J		
K		
L	SYNCH CONTACT	[656] [I.O. BOARD R13]
M	SYNCH CONTACT	[657] [I.O. BOARD C7]

7.3.18 Socket 18. Tape Reader 2. Plug B.

Pin	Function	Destination
A	LOCATION o/p	RL 8-3 Relay panel
B	PC0 o/p	RL11-7 Relay panel
C	PC1 o/p	RL10-7 Relay panel
D	PC2 o/p	RL 9-7 Relay panel
E	PC3 o/p	RL 8-7 Relay panel
F	PC4 o/p	RL11-3 Relay panel
G		
H		
J	EARTH	T.B. [565]
K	MONITOR -300V	T.B. [563]
L	-150V	T.B. [552]
M	+200V	T.B. [551]

7.3.15 Socket 15 to Loud Speaker

Pin	Function	T.B.
A	SPEAKER COIL [12A20]	[661]
B	SPEAKER COIL +200V	[551]

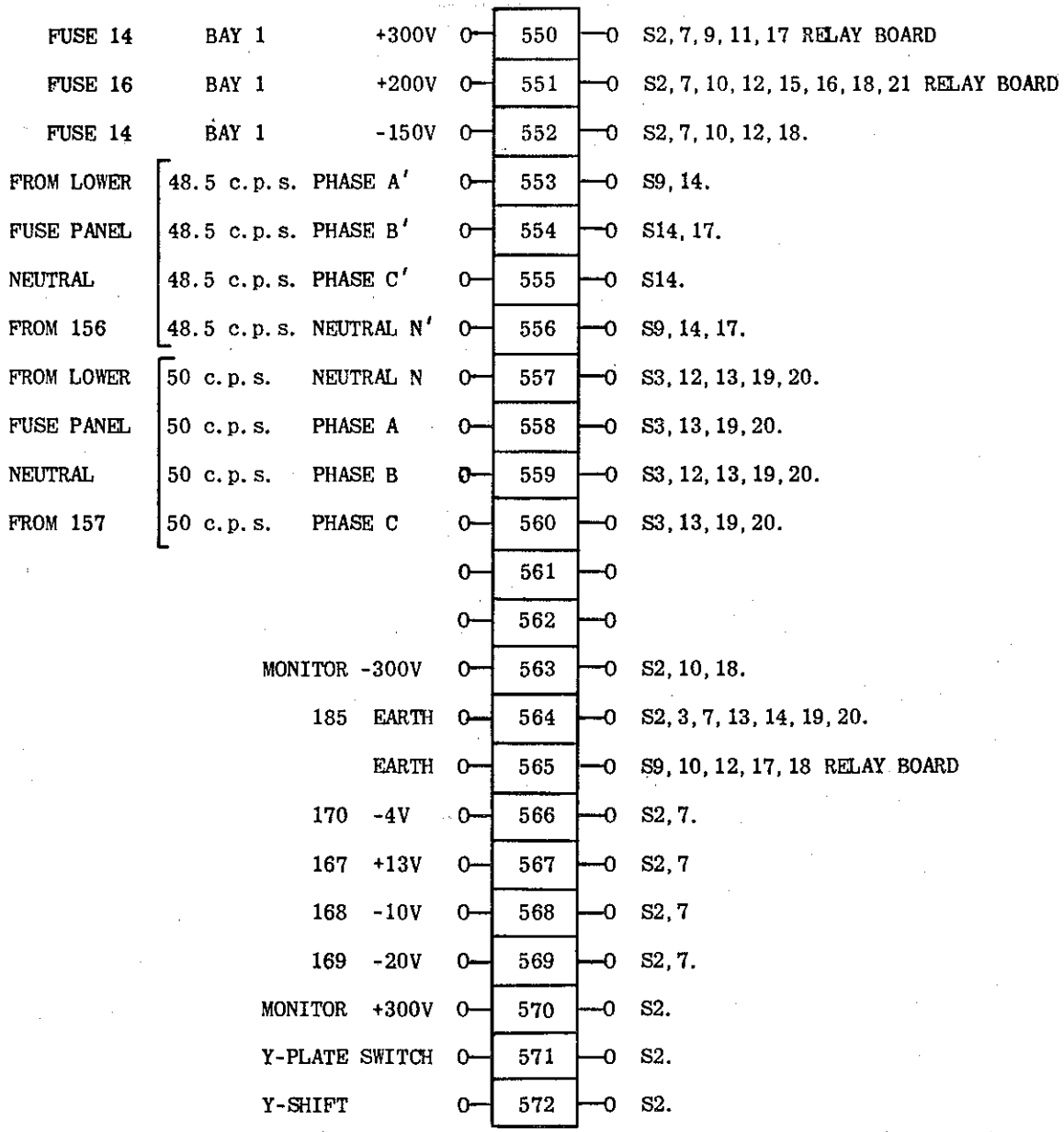
7.3.16 Socket 16 to Loud Speaker

Pin	Function	T.B.
A	SPEAKER COIL [12A20]	[661]
B	SPEAKER COIL +200V	[551]

7.3.17 Socket 17. Tape Reader 2. Plug A.

Pin	Function	Destination
A	48.5 c.p.s. PHASE B'	T.B. [554]
B		
C		
D	48.5 c.p.s. NEUTRAL N'	T.B. [556]
E		
F	BRAKE COIL [11A21]	T.B. [660]
G	BRAKE COIL	R23 Relay panel
H		
J	CLUTCH COIL	R21 Relay panel
K	CLUTCH COIL	RL10-3 Relay panel
L	EARTH	T.B. [565]
M	+300V	T.B. [550]

7.3.22 Terminal Block.



7.3.19 Socket 19. Tape Spooler.

Pin	Function	T.B.
A	MAINS PHASE A	[558]
B	MAINS PHASE B	[559]
C	MAINS PHASE C	[560]
D	MAINS NEUTRAL	[557]
E	EARTH	[564]

7.3.20 Socket 20. Tape Spooler.

Pin	Function	T.B.
A	MAINS PHASE A	[558]
B	MAINS PHASE B	[559]
C	MAINS PHASE C	[560]
D	MAINS NEUTRAL	[557]
E	EARTH	[564]

7.3.21 Socket 21 (Not used).

Pin	Function	T.B.
A	SPEAKER COIL [12A20]	[661]
B	SPEAKER COIL +200V	[551]

7.4.2 Plug 14B.

Pin	Internal connection	External connection
1	V13/2 LHS [Y shift up]	13G/26
2	V13/7 LHS [Y shift down]	13C/9
3	SW1a/2 LHS	12Z/3 SWA via cathode follower
4	SW4c/1 RHS	13H/19
5	SW3b/1 LHS	13G/6
6		
7	MR15 LHS [clock]	13P/21
8	MR16 LHS [scale]	13P/23
9	V31/2RHS [Y shift up]	13G/23
10	V31/7 RHS [Y shift down]	14b/2
11	SW4c/6 RHS	External trigger
12	V33/2 RHS	13K/19 [S1 & -S2]
13	V33/7 RHS	13G/4 [-S1 & -S2]
14	MR27 RHS	13W/19 [Number]
15	MR37 RHS	13P/21 [clock]
16	MR38 RHS	13P/14

7.4 Pin Connections of Monitor Plugs

7.4.1 Plug 14A

Pin	Internal Connection	External Connection
1		
2	SW1a/5 Y plate switch	S2R Relay and Socket Panel
3	SW1a/6	Probe 1A
4	SW1a/7	Probe 1Z
5		
6		
7	SW3c/1	13G/27
8	SW5/2	13P/28
9	SW1a/8	11Z/5 Probe 2A
10	SW1a/9	11Z/6 Probe 2Z
11	SW1a/10	11Z/7 Probe 3A
12	SW1a/11	11Z/8 Probe 3Z
13		
14		
15	SW4d/10	13C/24
16	SWb/2	13P/7

7.4.3 Plug 14C

Pin	Internal Connection	External connection
1	SW4a/10	13H/14[Z158]
2	SW4a/11	11R/15[Z159]
3	SW4a/12	13J/15[Z160]
4	SW4a/1	13E/23[Z161]
5	SW4a/2	13F/4 [Z162]
6	SW4d/9	10Y/28[Z171]
7	SW4d/8	10Y/25[Z170]
8		
9	SW4a/3	13J/4 [Z163]
10	SW4a/4	13F/7 [Z167]
11	SW4a/5	13H/4 [Z169]
12	SW4b/10	13M/27[Z168]
13	SW4b/1	13J/29[Z200]
14		
15		
16	R173 Y shift	S2S Relay and Socket Panel

7.4.4 Plug 14D

Pin	Internal connection	External connection
1	Monitor +300V	S2C Relay and Socket Panel. TB570
2		
3	+13V	13L/12
4	Earth	
5	Earth	
6	Earth	
7	Earth	
8	-10V	13Y/22
9	-20V	13P/30
10	-150V	13Y/11
11		
12	Monitor -300V	S2Y, S10K, S18K, Relay and Socket Panel
13		
14	Monitor Power Unit	240V Neutral.
15		
16	Monitor Power Unit	240V Phase C.

7.5 Connections to Magnetic Drum Heads

7.5.1 stack H1

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire Colour	Plessey SKT. No.	Socket pin	External Cableform	Wire colour	Package Connections
0	0/0	28C	Black	2	A	28C	Red	28C/17
			Black	2	B	28C	Blue	28C/18
1	1/0	28C	Brown	2	C	28C	Green	28C/19
			Brown	2	D	28C	Yellow	28C/20
2	2/0	28C	Red	2	E	28C	White	28C/21
			Red	2	F	28C	Black	28C/22
3	3/0	28C	Orange	2	G	28C	Brown	28C/23
			Orange	2	H	28C	Violet	28C/24
4	4/0	28C	Yellow	2	J	28C	Orange	28C/25
			Yellow	2	K	28C	Pink	28C/26
5	5/0	28C	Green	2	L	28C	L. Green	28C/27
			Green	2	M	28C	Grey	28C/28
6	6/0	28C	Blue	2	N	28C	Red/Blue	28C/29
			Blue	2	O	28C	Red/Green	28C/30
7	7/0	28C	Violet	2	P	28C	Red/Yellow	28C/31
			Violet	2	Q	28C	Red/White	28C/32
8	Spare	28C	Grey					
			Grey					
9	Spare	28C	White					
			White					

Spare heads: leads not connected.

7.5.2 stack H2

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT. No.	Socket Pin	External Cableform	Wire colour	Package Connections
0	0/1	29C	Black	1	A	29C	Red	29C/17
			Black	1	B	29C	Blue	29C/18
1	1/1	29C	Brown	1	C	29C	Green	29C/19
			Brown	1	D	29C	Yellow	29C/20
2	2/1	29C	Red	1	E	29C	White	29C/21
			Red	1	F	29C	Black	29C/22
3	3/1	29C	Orange	1	G	29C	Brown	29C/23
			Orange	1	H	29C	Violet	29C/24
4	4/1	29C	Yellow	1	J	29C	Orange	29C/25
			Yellow	1	K	29C	Pink	29C/26
5	5/1	29C	Green	1	L	29C	Lt. Green	29C/27
			Green	1	M	29C	Grey	29C/28
6	6/1	29C	Blue	1	N	29C	Red/Blue	29C/29
			Blue	1	O	29C	Red/Green	29C/30
7	7/1	29C	Violet	1	P	29C	Red/Yellow	29C/31
			Violet	1	Q	29C	Red/White	29C/32
8	Spare	29C	Grey					
			Grey					
9	Spare	29C	White					
			White					

Spare heads: leads not connected.

7.5.3 Stack H3

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT. No.	Socket Pin	External Cableform	Wire colour	Package Connections
0	8/0	28E	Black	4	A	28E	Red	28E/17
			Black	4	B	28E	Blue	28E/18
1	9/0	28E	Brown	4	C	28E	Green	28E/19
			Brown	4	D	28E	Yellow	28E/20
2	10/0	28E	Red	4	E	28E	White	28E/21
			Red	4	F	28E	Black	28E/22
3	11/0	28E	Orange	4	G	28E	Brown	28E/23
			Orange	4	H	28E	Violet	28E/24
4	12/0	28E	Yellow	4	J	28E	Orange	28E/25
			Yellow	4	K	28E	Pink	28E/26
5	13/0	28E	Green	4	L	28E	Lt. Green	28E/27
			Green	4	M	28E	Grey	28E/28
6	14/0	28E	Blue	4	N	28E	Red/Blue	28E/29
			Blue	4	O	28E	Red/Green	28E/30
7	15/0	28E	Violet	4	P	28E	Red/Yellow	28E/31
			Violet	4	Q	28E	Red/White	28E/32
8	Spare	28E	Grey					
			Grey					
9	Spare	28E	White					
			White					

Spare heads: leads not connected to socket pins.

7.5.4 Stack H4

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT. No.	Socket Pin	External Cableform	Wire colour	Package Connections
0	8/1	29E	Black	3	A	29E	Red	29E/17
			Black	3	B	29E	Blue	29E/18
1	9/1	29E	Brown	3	C	29E	Green	29E/19
			Brown	3	D	29E	Yellow	29E/20
2	10/1	29E	Red	3	E	29E	White	29E/21
			Red	3	F	29E	Black	29E/22
3	11/1	29E	Orange	3	G	29E	Brown	29E/23
			Orange	3	H	29E	Violet	29E/24
4	12/1	29E	Yellow	3	J	29E	Orange	29E/25
			Yellow	3	K	29E	Pink	29E/26
5	13/1	29E	Green	3	L	29E	Lt. Green	29E/27
			Green	3	M	29E	Grey	29E/28
6	14/1	29E	Blue	3	N	29E	Red/Blue	29E/29
			Blue	3	O	29E	Red/Green	29E/30
7	15/1	29E	Violet	3	P	29E	Red/Yellow	29E/31
			Violet	3	Q	29E	Red/White	29E/32
8	Spare	29E	Grey Grey	Spare head: leads not connected to socket.				
9	Master clock	29E	White White	Connected to Master clock terminal board				

7.5.5 Stack H5

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT. No.	Socket pin	External Cableform	Wire colour	Package Connections
0	16/0	28H	Black	7	A	28H	Red	28H/17
			Black	7	B	28H	Blue	28H/18
1	17/0	28H	Brown	7	C	28H	Green	28H/19
			Brown	7	D.	28H	Yellow	28H/20
2	18/0	28H	Red	7	E	28H	White	28H/21
			Red	7	F	28H	Black	28H/22
3	19/0	28H	Orange	7	G	28H	Brown	28H/23
			Orange	7	H	28H	Violet	28H/24
4	20/0	28H	Yellow	7	J	28H	Orange	28H/25
			Yellow	7	K	28H	Pink	28H/26
5	21/0	28H	Green	7	L	28H	Lt. Green	28H/27
			Green	7	M	28H	Grey	28H/28
6	22/0	28H	Blue	7	N	28H	Red/Blue	28H/29
			Blue	7	O	28H	Red/Green	28H/30
7	23/0	28H	Violet	7	P	28H	Red/Yellow	28H/31
			Violet	7	Q	28H	Red/White	28H/32
8	Spare	28H	Grey Grey	Spare head: leads not connected to socket.				
9	Clock 2	SKT 6.	White	6	A			
			White	6	B			

7.5.6 Stack H6

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT. No.	Socket pin	External Cableform	Wire colour	Package Connections
0	16/1	29H	Black	5	A	29H	Red	29H/17
			Black	5	B	29H	Blue	29H/18
1	17/1	29H	Brown	5	C	29H	Green	29H/19
			Brown	5	D	29H	Yellow	29H/20
2	18/1	29H	Red	5	E	29H	White	29H/21
			Red	5	F	29H	Black	29H/22
3	19/1	29H	Orange	5	G	29H	Brown	29H/23
			Orange	5	H	29H	Violet	29H/24
4	20/1	29H	Yellow	5	J	29H	Orange	29H/25
			Yellow	5	K	29H	Pink	29H/26
5	21/1	29H	Green	5	L	29H	Lt. Green	29H/27
			Green	5	M	29H	Grey	29H/28
6	22/1	29H	Blue	5	N	29H	Red/Blue	29H/29
			Blue	5	O	29H	Red/Green	29H/30
7	23/1	29H	Violet	5	P	29H	Red/Yellow	29H/31
			Violet	5	Q	29H	Red/White	29H/32
8	Address 2	Skt. 6	Grey	6	C			
			Grey	6	D			
9	Address 2	Skt. 6	White	6	E			
			White	6	F			

7.5.7 Stack H7

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT. No.	Socket pin	External Cableform	Wire colour	Package Connections
0	24/0	28K	Black	9	A	28K	Red	28K/17
			Black	9	B	28K	Blue	28K/18
1	25/0	28K	Brown	9	C	28K	Green	28K/19
			Brown	9	D	28K	Yellow	28K/20
2	26/0	28K	Red	9	E	28K	White	28K/21
			Red	9	F	28K	Black	28K/22
3	27/0	28K	Orange	9	G	28K	Brown	28K/23
			Orange	9	H	28K	Violet	28K/24
4	28/0	28K	Yellow	9	J	28K	Orange	28K/25
			Yellow	9	K	28K	Pink	28K/26
5	29/0	28K	Green	9	L	28K	Lt. Green	28K/27
			Green	9	M	28K	Grey	28K/28
6	20/0	28K	Blue	9	N	28K	Red/Blue	28K/29
			Blue	9	O	28K	Red/Green	28K/30
7	31/0	28K	Violet	9	P	28K	Red/Yellow	28K/31
			Violet	9	Q	28K	Red/White	28K/32
8	Spare	28K	Grey					
			Grey					
9	Spare	28K	White					
			White					

Spare heads: leads not connected to socket pins.

7.5.8 Stack H8

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT. No.	Socket Pin	External Cableform	Wire colour	Package Connections
0	24/1	29K	Black	8	A	29K	Red	29K/17
			Black	8	B	29K	Blue	29K/18
1	25/1	29K	Brown	8	C	29K	Green	29K/19
			Brown	8	D	29K	Yellow	29K/20
2	26/1	29K	Red	8	E	29K	White	29K/21
			Red	8	F	29K	Black	29K/22
3	27/1	29K	Orange	8	G	29K	Brown	29K/23
			Orange	8	H	29K	Violet	29K/24
4	28/1	29K	Yellow	8	J	29K	Orange	29K/25
			Yellow	8	K	29K	Pink	29K/26
5	29/1	29K	Green	8	L	29K	Lt. Green	29K/27
			Green	8	M	29K	Grey	29K/28
6	30/1	29K	Blue	8	N	29K	Red/Blue	29K/29
			Blue	8	O	29K	Red/Green	29K/30
7	31/1	29K	Violet	8	P	29K	Red/Yellow	29K/31
			Violet	8	Q	29K	Red/White	29K/32
8	Spare	29K	Grey					
			Grey					
9	Spare	29K	White					
			White					

Spare heads: leads not connected to socket pins.

7.5.9 Stack H9

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT.No.	Socket Pin	External Cableform	Wire colour	Package Connections
0	32/0	28M	Black	11	A	28M	Red	28M/17
			Black	11	B	28M	Blue	28M/18
1	33/0	28M	Brown	11	C	28M	Green	28M/19
			Brown	11	D	28M	Yellow	28M/20
2	34/0	28M	Red	11	E	28M	White	28M/21
			Red	11	F	28M	Black	28M/22
3	35/0	28M	Orange	11	G	28M	Brown	28M/23
			Orange	11	H	28M	Violet	28M/24
4	36/0	28M	Yellow	11	J	28M	Orange	28M/25
			Yellow	11	K	28M	Pink	28M/26
5	37/0	28M	Green	11	L	28M	Lt.Green	28M/27
			Green	11	M	28M	Grey	28M/28
6	Spare	28M	Blue	Spare head: leads not connected.				
			Blue					
7	Address 1	SKT. 12	Violet	12	E		White	27E/6
			Violet	12	F		Black	27E/8
8	Address 1	SKT. 12	Grey	12	C		Green	27D/6
			Grey	12	D		Yellow	27D/8
9	Clock 1	SKT. 12	White	12	A		Red	27C/6
			White	12	B		Blue	27C/8

7.5.9 Stack H9

Head Terminals	Track No.	Cableform to Plessey SKT.	Wire colour	Plessey SKT.No.	Socket Pin	External Cableform	Wire colour	Package Connections
0	32/0	28M	Black	11	A	28M	Red	28M/17
			Black	11	B	28M	Blue	28M/18
1	33/0	28M	Brown	11	C	28M	Green	28M/19
			Brown	11	D	28M	Yellow	28M/20
2	34/0	28M	Red	11	E	28M	White	28M/21
			Red	11	F	28M	Black	28M/22
3	35/0	28M	Orange	11	G	28M	Brown	28M/23
			Orange	11	H	28M	Violet	28M/24
4	36/0	28M	Yellow	11	J	28M	Orange	28M/25
			Yellow	11	K	28M	Pink	28M/26
5	37/0	28M	Green	11	L	28M	Lt.Green	28M/27
			Green	11	M	28M	Grey	28M/28
6	Spare	28M	Blue Blue	Spare head: leads not connected.				
7	Address 1	SKT.12	Violet	12	E		White	27E/6
			Violet	12	F		Black	27E/8
8	Address 1	SKT.12	Grey	12	C		Green	27D/6
			Grey	12	D		Yellow	27D/8
9	Clock 1	SKT.12	White	12	A		Red	27C/6
			White	12	B		Blue	27C/8

7.5.11 Connections between drum sockets 6 or 12 and the computer circuits via cableform assembly No. 6.

Plessey Socket Pins	Plessey Plug Pins	Cableform Wire Colours	Package Connections
A	A	Red	27C/6
B	B	Blue	27C/8
C	C	Green	27D/6
D	D	Yellow	27D/8
E	E	White	27E/6
F	F	Black	27E/8

7.6 Connections to External Conditioning Relays.

7.6.1 Lines from Output 1 Packages

Waveform	Source		Routing			Relay
	Package location	Pin number	Inter-bay connectors			
Z 204	35K	30	36A32	26Z32	26A14	RL1/8
Z 205	35J	30	26A27	26Z27	26A10	RL2/8
Z 206	35J	14	36A22	26Z22	26A8	RL3/8
Z 208	35H	14	36A15	26Z15	26A15	RL4/8
Z 209	35H	30	36A20	26Z20	26A3	RL5/8
Z 224	35G	30	36A11	26Z11	26A11	RL6/8
Z 225	35G	14	36A6	26Z6	26A6	RL7/8

7.6.2 Hold-on lines to Output 1 Packages

Resistor on Relay and Socket Panel	Routing			Destination	
	Inter-bay connectors			Package location	Pin number
R2	26A13	26Z29	36A29	35 K	15
R4	26A9	26Z23	36A23	35 J	15
R6	26A4	26Z21	36A21	35 J	13
R8	26A12	26Z12	36A12	35 H	13
R10	26A16	26Z16	36A16	35 H	15
R12	26A7	26Z7	35A7	35 G	15
R14	26A5	26Z5	35A5	35 G	13

7.7 Colour Code for Back Wiring

7.7.1 *Back Wiring* - D.C. Leads

+300V ..	red	P.V.C. covered
+200V ..	pink	„
+13V ..	pink	„
Earth ..	brown	„
-4V ..	blue	„
-10V ..	blue	„
-20V ..	blue	„
-150V ..	violet	„

7.7.2 *"Logical" Leads* - are of Duratube multicolour wire, and follow a two-colour code. In general, the type of wave-form is indicated by the basic colour of the lead, and the type of source is indicated by the banding. The basic colours are as follows:-

Blue .. Timing and beats.

Red .. Outputs of decoding circuits and various other staticisers.

Green .. Waveforms that vary slowly with time - generally the X-waveforms and the V-waveforms on logical circuits.

Grey .. Waveforms that vary rapidly with time, i.e., waveforms carrying digital information - generally the Y-waveforms and W-waveforms on logical circuits.

The band colour code is as follows:-

White .. Direct outputs of delays, gates or nickel lines.

Black .. Direct outputs of inverters.

Yellow .. "Mix" outputs.

Leads with the basic colour pink, have the following significance:-

Pink/White .. "Clock".

Pink/Black .. "Reset".

Pink/Yellow .. Leads from external switches.

Direct cathode follower output leads carry the same colours as the inputs.

"Mix" cathode follower output leads have yellow bands, and the same basic colours as the inputs.

7.7.3 Number Coding

First Number	*Second Number*
1. Blue	1. White
2. Red	2. Black
3. Green	3. Yellow
4. Grey	
5. Pink	

e.g. 3.1 Green/White.

7.8 Minor Spares supplied to Pegasus installations.

7.8.1 Type 8 Carbon Resistors

Description	Part No.	No. off	
		max	min
15 ohm ±10%	65/30244	1	1
47 „ „	65/30246	2	2
68 „ „	65/30248	1	1
470 „ „	65/30258	1	1
1 K.ohm „	65/30262	1	1
1.8 „ „	65/30265	1	1
2.2 „ „	65/30266	1	1
2.7 „ „	65/30267	3	2
4.7 „ „	65/30270	1	1
6.8 „ ± 5%	65/32693	1	1
6.8 „ ±10%	65/30272	1	1
10 „ „	65/30274	2	2
15 „ „	65/30276	1	1
18 „ „	65/30277	1	1
22 „ „	65/30278	15	5
27 „ „	65/30279	1	1
33 „ „	65/30280	1	1
39 „ ± 5%	65/30349	2	2
47 „ ±10%	65/30282	1	1
56 „ „	65/30283	1	1
68 „ „	65/30284	1	1
100 „ „	65/30286	1	1

7.8.1 Type 8 Carbon Resistors (Contd).

Description	Part No.	No. off	
		max	min
180 K.ohm ±10%	65/30289	1	1
220 „ „	65/30290	2	2
270 „ „	65/30291	1	1
330 „ „	65/30292	1	1
390 „ „	65/30293	1	1
470 „ „	65/30294	1	1
820 „ „	65/30297	1	1
1.2 M.ohm „	65/30299	1	1
2.2 „ „	65/30302	1	1
33 K.ohm ± 5%	65/33178	3	2

7.8.2 Type 9 Carbon Resistors

Description	Part No.	No. off	
		max	min
12 ohm ±10%	65/30352	1	1
33 „ ±10%	65/30362	1	1
47 „ „	65/30366	4	2
68 „ „	65/30369	1	1
100 „ „	65/30374	18	5
180 „ ± 5%	65/30499	2	2
220 „ ±10%	65/30382	2	2
330 „ „	65/30385	2	2
470 „ „	65/30390	3	2
820 „ „	65/30393	2	2

7.8.2 Type 9 Carbon Resistors (Contd).

Description	Part No.	No. off	
		max	min
1 K. ohm ±10%	65/30394	2	2
2.2 ,, ,,	65/30398	10	5
3.3 ,, ,,	65/30405	8	4
4.7 ,, ± 5%	65/30498	20	10
6.8 ,, ±10%	65/30418	1	1
10 ,, ,,	65/30422	3	1
15 ,, ,,	65/30424	1	1
22 ,, ,,	65/30430	2	1
27 ,, ,,	65/30432	1	1
33 ,, ,,	65/30434	6	3
47 ,, ,,	65/30438	6	3
68 ,, ,,	65/30440	1	1
82 ,, ,,	65/30441	1	1
100 ,, ,,	65/30442	3	2
150 ,, ,,	65/30444	1	1
220 ,, ,,	65/30450	8	4
330 ,, ,,	65/30457	10	5
470 ,, ,,	65/30462	8	4
560 ,, ,,	65/30466	1	1
680 ,, ,,	65/30467	12	5
1 M. ohm ,,	65/30470	2	2
2.2 ,, ,,	65/30473	14	5
47 ohm ±20%	65/30180	3	2
2.7 K. ohm ±10%	65/30400	1	1
390 K. ohm ±10%	65/30460	1	1

7.8.3 Type 108 Carbon Resistors

Description	Part No.	No. off	
		max	min
2.7 K.ohm ± 5%	65/32658	1	1
3.9 ,, ± 1%	65/32681	1	1
9.1 ,, ± 5%	65/32660	10	5
10 ,, ± 1%	65/32682	4	2
11 ,, ± 5%	65/32661	6	3
12 ,, ,,	65/32662	1	1
13 ,, ± 1%	65/32683	1	1
20 ,, ,,	65/32684	1	1
22 ,, ± 2%	65/30479	2	2
27 ,, ,,	65/30476	2	2
30 ,, ± 5%	65/32664	12	3
47 ,, ± 2%	65/30481	4	2
51 ,, ± 5%	65/32667	18	5
68 ,, ,,	65/32665	1	1
75 ,, ,,	65/32668	20	8
82 ,, ± 2%	65/30482	2	1
100 ,, ± 1%	65/32685	1	1
150 ,, ,,	65/32686	1	1
200 ,, ,,	65/32687	1	1
220 ,, ,,	65/32688	1	1
220 ,, ± 5%	65/32672	10	5
300 ,, ± 1%	65/32689	1	1
330 ,, ± 5%	65/32673	6	3

7.8.4 Type 109 Carbon Resistors

Description	Part No.	No. off	
		max	min
150 ohm ± 5%	65/32630	6	3
330 „ „	65/32633	6	3
1 K.ohm „	65/32635	6	3
1.5 „ „	65/32636	6	3
2.4 „ „	65/32638	6	3
5.6 „ ± 2%	65/32608	4	2
10 „ „	65/32611	15	5
12 „ „	65/32612	1	1
15 „ „	65/32613	20	10
16 „ ± 5%	65/32645	6	3
22 „ „	65/32646	6	3
27 „ „	65/32647	1	1
47 „ ± 2%	65/32615	1	1
47 „ ± 5%	65/32648	6	3
100 „ ± 2%	65/32617	2	2
120 „ ± 5%	65/32649	16	8
150 „ „	65/32650	10	5
180 „ ± 2%	65/32620	10	5
200 „ „	65/32622	12	6
220 „ „	65/32623	2	2
220 „ ± 5%	65/32651	10	5
270 „ ± 2%	65/32625	1	1
330 „ ± 5%	65/32652	15	5
470 „ ± 2%	65/32626	12	5
470 „ ± 5%	65/32653	12	5
270K 5%	65/33955	15	5
3.9K „	65/32639	6	3

7.8.5 Wirewound Resistors

Description	Part No.	No. off max	No. off min	Remarks
2.2 K.ohm 1½W ±5%	65/30040	1	1	AW.3101
220 ohm 3W „	65/30009	2	1	Type V1
1 K.ohm 3W „	65/30013	1	1	AW.3115
1.5 „ „ „	65/30014	1	1	„
3.9 „ „ „	65/30017	1	1	„
4.7 „ „ „	65/30018	4	2	„
6.8 „ „ „	65/30020	1	1	„
10 „ „ „	65/30022	1	1	„
15 „ „ „	65/30024	10	5	„ P.306.
1 ohm 3.W.W. Resistor.	65/30000	1	1	„
7.5 ohm 6W ±5%	65/30050	1	1	AW.3111
3 „ 6W „	65/30048	1	1	„
6 „ „ „	65/30049	1	1	„
10 „ „ „	65/30051	1	1	AW.3111
5 K.ohm „ „	65/30083	1	1	„
5.6 „ „ „	65/30069	1	1	„
7.5 „ „ „	65/30082	2	2	„
8.2 „ „ „	65/30071	1	1	„
10 „ „ „	65/30072	2	2	„
15 „ „ „	65/30074	2	2	„
22 „ „ „	65/30076	1	1	„
27 „ „ „	65/30077	1	1	„
33 „ „ „	65/30078	1	1	„

7.8.5 Wirewound Resistors (Contd).

Description	Part No.	No. off		Remarks
		max	min	
2 ohm 10W ±10%	65/30139	1	1	AW.3112
1.5 K.ohm „ ± 5%	65/30115	2	2	„
8.2 „ „ „	65/30124	1	1	„
47 „ „ „	65/30133	1	1	„
5.5 K.ohm 15W „	65/32599	1	1	With mounting clip TGO.
3.3 „ „ „	65/32601	1	1	With mounting clip TGO.
2.5 „ 30W „	65/30140	1	1	AW.3192
6.8 „ „ „	65/32600	1	1	With mounting clip TG1.

7.8.6 Potentiometers

Description	Part No.	No. off		Remarks
		max	min	
Potentiometer 200 ohm	65/32837	6	3	Colvern CLR 1106/7s
„ 5 K.ohm	65/31493	2	2	
„ 50 „	65/31298	2	2	Reliance TW
„ 100 „	65/31299	2	2	Reliance TW
„ 250 „	65/33116	2	2	Reliance Linear SG2

7.8.7 Capacitors

Description	Part No.	No. off max	No. off min	Remarks
2.2 pF P10QK	65/30513	1	1	Ceramicon
10 pF N750K	65/30502	2	2	,,
22 pF N750K	65/30504	10	5	,,
47 pF N750K	65/30507	1	1	,,
68 pF N750K	65/30509	1	1	,,
100 pF N750L	65/30511	10	5	,,
150 pF N750M	65/30518	1	1	,,
220 pF HI-K/K	65/31342	1	1	,,
470 pF HI-K/K	65/31341	1	1	,,
560 pF HI-K/K	65/30536	1	1	,,
1500 pF HI-K/L	65/30537	1	1	,,
4700 pF HI-K/M	65/30538	1	1	,,
33 pF S635	65/30591	1	1	Silvered Mica
100 pF 101SMP	65/30580	1	1	,, ,,
330 pF S635	65/30592	10	5	,, ,,
.001 uF S635	65/30593	6	3	,, ,,
.001 uF CSM20N	65/30594	1	1	,, ,,
.001 uF CP30S	65/30617	1	1	Metalmite
.001 uF CP110N	65/30616	1	1	,,
.002 uF CP111N	65/30611	1	1	,,
.002 uF CP30S	65/30610	10	5	,,
.005 uF CP31N	65/30601	2	2	,,
.01 uF CP32N	65/30602	12	5	,,

7.8.7 Capacitors (Contd).

Description	Part No.	No. off		Remarks
		max	min	
.02 uF CP33N	65/30603	10	5	Metalmite
.05 uF CP35N	65/30604	5	2	„
.05 uF CP37S	65/30609	1	1	„
.1 uF CP37N	65/30605	10	5	„
.25 uF CP48N	65/30625	1	1	„
.50 uF CP47N	65/30614	1	1	„
.1 uF CP144KO	65/30769	1	1	Paper Rect. Can
.5 uF CP147KO	65/30777	1	1	„ „ „
1 uF CP142T	65/30766	1	1	„ „ „ with clips
4 uF CP147T	65/30775	1	1	„ „ „ „ clamps
8 uF CP150T	65/30776	1	1	„ „ „ „ „
8 uF CP149N	65/30765	1	1	„ „ „
1 uF CE69D	65/30717	2	2	Electrolytic
3 uF CE30CR	65/30716	1	1	„
60 uF CE60P	65/30705	1	1	„
3-30 pF TCK-0330	65/30878	2	2	Trimmer Cermamic

7.8.8 Coils, Chokes and Transformers

Description	Part No.	No. off max	No. off min	Remarks
Coil assembly 4 mH	65/20333	12	5	Delay
Inductor assembly	65/25871	2	2	Read Amplifier
Coil (Osmor type Q06)	65/33007	2	2	With spire clip.
Sliding Coil adj. plate	65/20354	12	6	
Choke L4	IL65/20246	5	2	Nickel Line (This item is only supplied to installations using modified lines).
Transformer assembly T1	65/20341	2	2	Waveform Output.
„ Potting „ TBA.1.	65/25859	1	1	Read Strobe T15
„ „ „ No.1-8	65/22739	5	2	Write Read T16
„ „ „ No.9	65/22747	2	2	Write Read T16
„ „ „ No.10	65/22751	2	2	Write Read Switch T16
„ „ „	65/20253	2	2	Write Drive T17
„ „ „	65/25867	1	1	Read Amp. T18
„ „ „	65/25862	1	1	Clock Amp. T20
„ „ „	65/21270	1	1	Monitor
„ „ „	65/21271	1	1	Monitor
Transformer assembly (mains)	65/32893	2	2	Parmeko 5080/20
Transformer assembly (mains)	65/32894	1	1	Haddon Ltd. JC112

7.8.9 Valves, Rectifiers, Valveholders, etc . . .

Description	Part No.	No. off max	No. off min	Remarks
Valve M8083 EF91	65/31005	20	10	
,, HR2	65/31009	2	2	
,, M8079 6 AL 5	65/31041	5	3	"Green spot selected".
,, 12 E 1	65/31028	10	6	
,, GZ32	65/31036	2	2	
,, 6060	65/31040	100	50	
,, 6132GS	65/31042	20	10	
,, 85 A 2	65/31046	2	2	
,, EL37	65/31047	2	2	
,, CV2179 A2134	65/31057	20	10	
,, EZ80	65/33344	2	2	
,, 90 C 1	65/33520	3	2	
,, NT 2	65/31011	3	2	
,, EZ81	65/33296	3	2	
Lamp 12V 36W prefocus	65/31280	12	6	Cryselco
Photo cell 90AV	65/31321	12	6	
C.R.T. 30C2/T1	65/33106	1	1	
Lamp Neon Hivac CC9L	65/32821	6	4	
Crystal Diode BTH CG10E	65/31068	200	100	
Crystal GEC HA/193	65/32698	1	1	
Rectifier STC B18-4-IW	65/30795	2	2	
Osram Valve Type Z759	65/34248	2	1	Oscilloscope Spare.
Valveholder B8U	65/30906	1	1	

7.8.9 Valves, Rectifiers, Valveholders, etc . . .

Description	Part No.	No. off max	No. off min	Remarks
Valveholder B9A	65/30910	4	2	XM9/U
,, B7G	65/30911	4	2	XM7/UK
,, B7G	65/30914	4	2	XM7/UG with B9A Fixing and Skirt
,, VH847/701	65/30917	1	1	
Valve Retainer B9A	65/30985	4	2	VRA6
,, ,, B7G	65/30986	4	2	VRA7
Screening Cans B9A/No. 7/6A	65/30952	3	2	
,, ,, B7G/No. 4/6	65/30951	3	2	
Lampholder D270/MBC	65/32822	2	2	
,, MBC4	65/32998	2	2	

7.8.10 Switches, Relays, Plugs and Sockets.

Description	Part No.	No. off max	No. off min	Remarks
Switch 1 pole, 2 way	65/21291	1	1	
„ Toggle	65/31306	1	1	Bulgin S.263
„ Key	65/31328	2	1	S.T.C. 4608
„ Push button	65/32825	1	1	15032/2V without plate
„ Push button	65/32826	1	1	15031/2 without plate
„ Packet	65/32896	1	1	Diamond H 45/41PX
„ Toggle 3A 250V	65/32897	1	1	Diamond H 8T4
Knobs	65/31360	1	1	Bulgin K.94
„	65/31372	1	1	Bulgin K357
„	65/31378	1	1	Bulgin K108
Relays, sealed, midget	65/32820	2	2	S.T.C. 4184GE
Anti-vibration mounting	65/32708	1	1	
5 Amp. M.K. Rubber Clad Plug.		4	2	For soldering irons etc.
Plug 2 way 19A 250V	65/32015	1	1	CZ49216 Cable unit 41
Plug 3 way	65/33099	1	1	CZ49218 Cable unit 42
Plug 6 way 5A 2KV	65/32032	1	1	CZ53157 Cable unit 47
Plug 12 way 5A 250V	65/32021	1	1	CZ49458 Cable unit 48
Plug 25 way 5A 250V	65/32019	1	1	CZ49228 Cable unit 50
Coupler for Plug	65/33100	1	1	CZ56731 Panel unit Mk4
Coupler for Plug 6 way	65/33112	1	1	CZ56737 Panel unit 47
Coupler for Plug 12 way	65/32055	1	1	CZ56735 Panel unit 48
Belling Lee Coaxial Plugs.	65/31289	6	3	for Solatron oscilloscope.

7.8.10 Switches, Relays, Plugs and Sockets

Description	Part No.	No. off		Remarks
		max	min	
Socket 2 way 19A 250V	65/32005	1	1	CZ49014 Cable unit 41
Socket 2 way 19A 250V	65/32016	1	1	CZ49217 Panel unit 41
Socket 3 way	65/33121	1	1	CZ49015 Cable unit 42
Socket 6 way 5A 2KV	65/32023	1	1	CZ50142 Cable unit 47
Socket 6 way 5A 2KV	65/32033	1	1	CZ53158 Panel unit 47
Socket 12 way 5A 250V	65/32009	1	1	CZ49126 Cable unit 48
Socket 12 way 5A 250V	65/32002	1	1	CZ49459 Panel unit 48
Socket 25 way 5A 250V	65/32020	1	1	CZ49229 Panel unit 50
Coupler for Socket 12 way	65/32057	1	1	CZ56745 Panel unit 48
Plug	65/32075	2	2	Pye 732560 Cable unit
Socket	65/32076	2	2	Pye 732563 Cable unit
Plug 8 way	65/20388	4	2	
Socket 8 way	65/20392	4	2	
Terminal block 10 way	65/32040	1	1	CZ50181
Terminal block 20 way	65/32284	1	1	CZ23212/1
Terminal strip 12 way	65/32936	1	1	Clinch 77/507/12

7.8.11 Screws, Nuts and Washers
(Supplied to installations abroad only).

Description			No. off
OBA x 3/8"	Ch.	steel, cadmium	½ gross
OBA x 5/8"	Hex.	brass, DNP.	½ gross
2BA x 3/16"	Ch.	brass, DNP.	½ gross
2BA x 3/8"	Ch.	steel, cadmium	1 gross
2BA x ½"	Ch.	brass, DNP	½ gross
2BA x 9/16"	Ch.	steel, cadmium	1 gross
2BA x ¾"	Ch.	brass, DNP.	½ gross
2BA x 7/8"	Ch.	steel, cadmium	½ gross
2BA x 1⅛"	Ch.	steel, cadmium	½ gross
2BA x 1¼"	Ch.	brass, DNP.	½ gross
2BA x 5/16"	C' sk	brass, DNP.	½ gross
2BA x ½"	C' sk	steel, cadmium	1 gross
2BA x ½"	C' sk	brass, DNP.	½ gross
2BA x 5/8"	C' sk	steel, cadmium	1 gross
2BA x ½"	Inst	brass, pol.chrome	½ gross
2BA x ¼"	Round	steel, pol.chrome	½ gross
2BA x ½"	Hex.	steel, cadmium	1 gross
2BA x 5/8"	Hex.	brass, DNP.	½ gross
2BA x 3/8"	Socket	(grub), Unbrako	1 gross
2BA x ¾"	Socket	(grub), Unbrako	½ gross
2BA x ¾"	Cap	(ch.), Unbrako	½ gross
4BA x 3/8"	Ch.	steel, cadmium	1 gross
4BA x 3/8"	Ch.	brass, DNP.	½ gross

7.8.11 Screws, Nuts and Washers (Contd).

Description			No. off
4BA x 7/16"	Ch.	steel, cadmium	½ gross
4BA x 5/8"	Ch.	steel, cadmium	1 gross
4BA x 5/8"	Ch.	brass, DNP.	½ gross
4BA x ¾"	Ch.	brass, DNP.	½ gross
4BA x 7/8"	Ch.	steel, cadmium	½ gross
4BA x ¼"	C' sk	steel, cadmium	1 gross
4BA x ½"	C' sk	steel, cadmium	1 gross
4BA x 5/8"	C' sk	brass, DNP	½ gross
4BA x ¼"	Inst	steel, brt. chrome	½ gross
4BA x 5/16"	Inst	steel, chrome	½ gross
4BA x 5/16"	Inst	brass, chrome	½ gross
4BA x ¼"	Round	steel, cadmium	½ gross
4BA x 5/16"	Hex.	steel, cadmium	1 gross
4BA x ¼"	Socket (grub), Unbrako		½ gross
4BA x 5/16"	Socket (grub), Unbrako cone point		½ gross
6BA x ¼"	Ch.	steel, cadmium	1 gross
6BA x ¼"	Ch.	brass, DNP	½ gross
6BA x 3/8"	Ch.	brass, DNP	½ gross
6BA x 7/16"	Ch.	steel, cadmium	3 gross
6BA x ½"	Ch.	brass, DNP	½ gross
6BA x 5/8"	Ch.	steel, cadmium	1 gross
6BA x 1"	Ch.	steel, cadmium	1 gross
6BA x ¼"	C' sk	steel, cadmium	1 gross
6BA x 5/16"	C' sk	brass, DNP	½ gross

7.8.11 Screws, Nuts and Washers (Contd).

Description		No. off
6BA x ½"	C' sk steel, cadmium	1 gross
6BA x 3/16"	Inst brass, chrome	½ gross
6BA x ¼"	Inst brass, pol, chrome	½ gross
7BA x 5/16"	C' sk brass, DNP	½ gross
7BA x 5/16"	Inst brass, chrome	½ gross
8BA x 5/16	Ch. steel, cadmium	5 gross
8BA x 7/16"	Ch. brass, DNP	½ gross
8BA x 3/16"	C' sk steel, cadmium	½ gross
8BA x 5/16"	C' sk brass, DNP	1 gross
8BA x 13/16"	C' sk brass, DNP	1 gross
9BA x 5/8"	Ch. steel, cadmium	½ gross
Special screw 6BA	65/20326	¼ gross
Special screw 8BA	65/20674	¼ gross
¼" BSF x ¼"	Hex steel, cadmium	10 only
¼" BSF x ½"	Hex steel, cadmium	20 only
¼" BSF x ¾"	Hex steel, cadmium	20 only
¼" BSF x 1"	Hex steel, cadmium	20 only
¼" BSF x 1½"	C' sk steel, cadmium	10 only
5/16" BSF x 2¼"	Hex steel, cadmium	5 only
5/16" BSF x 4"	Hex steel, cadmium	5 only
5/16" BSF x ¾"	Cap Unbrako	10 only
5/16" BSF x 7/8"	Cap Unbrako	10 only
5/16" BSF x 1½"	Cap Unbrako	10 only
5/16" BSF x 1½"	C' sk Unbrako	10 only

7.8.11 Screws, Nuts and Washers (Contd).

Description		No. off
5/16" BSW x 1½"	Hex - -	10 only
3/8" BSW x 7/8"	Hex - -	10 only
Parker Kalon 4 A x 3/8"	C' sk steel, cadmium	1 gross
Parker Kalon 4A x 3/8"	RNd, steel, cadmium	1 gross
Parker Kalon 6Z x 3/8"	Binding, s/cadmium	1 gross
Woodscrew No. 6 x ¾"	C' sk pol. chrome	½ gross
Woodscrew No. 10 x 1"	C' sk steel	1 gross
NUTS		
0BA	Hex brass, DNP	½ gross
2BA	Hex brass, DNP	½ gross
2BA	Hex steel, cadmium	2 gross
2BA Spire captive SNU 0524/17/4	65/32929	½ gross
4BA	Hex brass, DNP	½ gross
4BA	Hex steel, cadmium	1 gross
6BA	Hex brass, DNP	1 gross
6BA	Hex steel, cadmium	5 gross
8BA	Hex brass, DNP	1 gross
8BA	Hex steel, cadmium	2 gross
9BA	Hex brass, DNP	1 gross
¼" BSF	Hex steel, cadmium	20 only
5/16" BSF	Hex steel, cadmium	20 only
5/16" BSW	Hex steel, cadmium	10 only
Special nut	65/22728	40 off
Special nut	65/21863	4 only

7.8.11 Screws, Nuts and Washers (Contd).

Description		No. off
WASHERS		
0BA Plain	brass, DNP	½ gross
2BA Plain	brass, DNP	1 gross
2BA Small OD.390"	steel, cadmium	½ gross
2BA Large OD.500"	steel, cadmium	1 gross
2BA S.C. Spring	steel cadmium	1 gross
4BA Plain	brass, DNP	½ gross
4BA Small OD.300"	steel, cadmium	½ gross
4BA Large OD.375"	steel, cadmium	1 gross
4BA S.C. Spring	steel, cadmium	1 gross
6BA Plain	brass, DNP	1 gross
6BA Small OD.230"	steel, cadmium	5 gross
6BA Large OD.285"	steel, cadmium	½ gross
6BA S.C. Spring	steel, cadmium	1 gross
8BA Plain	brass, DNP	1 gross
8BA Small OD.185"	steel, cadmium	2 gross
9BA Large OD.195"	brass, DNP	1 gross
¼" BSF plain	steel, cadmium	20 only
¼" BSF S.C. Spring	steel, cadmium	20 only
¼" BSW Plain	steel, cadmium	10 only
5/16" BSF Plain	steel, cadmium	10 only
5/16" BSF S.C. Spring	steel, cadmium	20 only
5/16" BSW Plain	steel, cadmium	10 only
3/8" BSF Plain	steel, cadmium	10 only

7.8.12 Wire, Sleeving, Cleats and Tags

Description	Part No.	No.off max	No.off min	Remarks
14/.0076 PVC red	65/32767	50 yds	25 yds	To Def.12-1953-type 3
„ „ pink	65/32768	50 yds	25 yds	„
„ „ blue	65/32770	50 yds	25 yds	„
„ „ violet	65/32771	50 yds	25 yds	„
„ „ yellow	65/32772	50 yds	25 yds	„
40/.0076 PVC red	65/33059	50 yds	25 yds	To Def.12-1953-type 3
„ „ pink	65/33060	50 yds	25 yds	„
„ „ brown	65/33061	50 yds	25 uds	„
„ „ violet	65/33063	50 yds	25 yds	„
„ „ yellow	65/33064	50 yds	25 yds	„
Screened cable 14/.0076	65/31152	6 yds	6 yds	For use with oscilloscope
Univen 4 amp.	65/31221	15 yds	10 yds	
23 SWG blue-yellow-blue	65/32803	20 yds	10 yds	
23 SWG green-white-green	65/32805	20 yds	10 yds	
23 SWG Yellow	65/31197	20 yds	10 yds	as used on packages
Duvinsmall 2.5	65/33202	10 yds	5 yds	
Dumetvinsmall 2.5	65/31154	10 yds	5 yds	
6 metvinsmall 2.5	65/31157	10 yds	5 yds	
18 metvinsmall 2.5	65/31163	10 yds	5 yds	
Sleeving PVC yellow	65/31549	10 yds	5 yds	1mm bore .020 wall
Sleeving PVC brown	65/32732	10 yds	5 yds	1mm bore .020 wall
Sleeving Silk reinforce	65/33123	10 yds	5 yds	white

7.8.12 Wire, Sleeving, Cleats and Tags (Contd).

Description	Part No.	No. off		Remarks
		max	min	
Helsyn sleeve black	65/33087	20	10	AOP x 3/8" long
Helsyn sleeve white	65/33004	20	10	AP x 3/4" long
Grommet M3981	65/32956	20	10	Herts Rubber Co.
Cleats plastic 1/4" dia.	65/31344	5	2	Insuloid type X2
Cleats plastic 3/8" dia.	65/31345	5	2	Insuloid type X4
Cleats plastic 5/16" dia.	65/31512	5	2	Insuloid type X3
Solder Tags 1/4" dia. Silver Plate & Lanoline Dip	65/32960	10	5	Ross Courtney No. 15.
Solder Tags 6BA S.E. Silver Plate & Lanoline dip	65/31719	20	10	Tucker Eyelet G371
Solder Tags single Silver Plate & Lanoline Dip	65/32874	20	10	
Connecting Tag 4A	65/32036	10	5	Z. 19924 Quick release
Connecting Tag 7A	65/32290	10	5	Z. 19925 Quick release
Connecting Tag 19A	65/32037	10	5	Z. 19926 Quick release
Connecting Tag 7A	65/32292	10	5	Z. 56545 Closed end
Connecting Tag 19A	65/32293	10	5	Z. 56547 Closed end

7.8.13 Spares for Power Supply

Description	Part No.	No. off		Remarks
		max	min	
Contactor		1	1	Lanc. Dyn. 902
Transformer (filament)		1	1	Lanc. Dyn. 544
Microswitch		1	1	Lanc. Dyn. 878
Potentiometer		1	1	Lanc. Dyn. 978
Fuseholder carrier complete	65/32963	2	2	Slydlok 15A/1533
" " "	65/33395	1	1	Eng. Elec. SM.30
" " "	65/33396	1	1	Eng. Elec. SM.60
" panel mtg.	65/31260	2	2	Belling Lee L.356 Screw type
Fuses 1A cartridge 1¼"	65/31664	24	12	Belling Lee L1055/1A or in lieu 65/31265 Bulgin F.126
Fuses 2.5A cartridge 1½"	65/33359	12	6	'Alert' 370L (Allen West)
Fuses 6A	65/31651	12	6	Eng. Elec. TIA/6
Fuses 10A	65/31652	12	6	Eng. Elec. TIA/10
Fuses 15A	65/31653	12	6	Eng. Elec. TIA/15
Fuses 20A	65/31568	6	3	Eng. Elec. TIA/20
Fuses 30A	65/31649	6	3	Eng. Elec. TIA/30
Fuses 60A	65/33355	6	3	Eng. Elec. TIS/60
Lamps Lilliput 6V	65/31713	12	6	Hivac.6L50
Lubricant Shell Alvania 3			1 lb	
Oil, dashpot 12/DP1			1 bottle	Allen West
Brushes Grade EGO		1 set	1 set	for ACX10G4 alternator
Brushes Grade EG12		1 set	1 set	for C 5G exciter
Brushes Grade SB5		1 set	1 set	for drum alternator

7.8.14 Miscellaneous Spares

Description	Part No.	No. off max	No. off min	Remarks
Fuse Wire for 0.5A			¼ lb.	
„ „ „ 1.0A			2 ozs.	
„ „ „ 1.5A			2 ozs.	
„ „ „ 3.0A			2 ozs.	
„ „ „ 5.0A			2 ozs.	
„ „ „ 6.0A			2 ozs.	
„ „ „ 10. A			2 ozs.	
„ „ „ 15. A			2 ozs.	
Fuse P.O. Alarm 0.5A	65/31335	50	20	Blue Beswick
„ „ „ 1.5A	65/31634	20	10	Red Beswick
„ „ „ 3.0A	65/31333	50	20	Black Beswick
„ „ „ 6.0A	65/31334	50	20	White Beswick
Fuse cartridge 150 mA	65/33039	24	12	Belling Lee L1055 1½"
„ „ 250 mA	65/33038	24	12	Belling Lee L1055 1½"
„ „ 4A	65/33358	24	12	Belling Lee L1055 1½"
Air Filter, fibre glass	65/33057	12	6	Versil 24" x 9" x 2"
Teleprinter Ink Ribbon	65/31592	4	2	1841/20
Teleprinter Paper, 1 ply	65/31285		12 rolls	
Teleprinter Paper Tape, 5 hole	65/31308		12 rolls	
Solder, multicore	65/31373	2 lb	1 lb	
Crocodile Clips	65/31444		12	
Adhesive Tape			1 roll	
Dusters			2	

7.8.15 Instruments and Tools

Description	Part No.	No.off	Remarks
Oscilloscope CD 513	65/33434	1	Not for PC.8
AVO Model 8	65/31722	1	
Plug Board		2	4 x 5A x 230V-3 pin sockets
Gen.Hand Tools for Pegasus Computer	65/33353	1 set	consisting of:-
Universal Pliers		2 prs.	
Sniped-nosed pliers		2 prs.	
Side cutting pliers		2 prs.	
Long nosed pliers		2 prs.	
Round nosed pliers		2 prs.	
Wire strippers		2 prs.	
Tweezers		1 pr.	
Screwdriver large		2	
„ small		2	
Screwdriver electrician 10"		2	
Screwdriver electrician 4"		3	
Varney Screw Starter		2	[1-8½" Insulated, 1-5" 4BA] Supplier
Iron soldering small		2	Adcola Stanleys A-U-L
Iron soldering large		1	Solon 125W Round Pencil Bit
BA flat spanners		1 set	
BA box spanners		1 set	
Adjustable spanner 6"		1	King Dick

7.8.15 Instruments and Tools (Contd).

Description	Part No.	No.off	Remarks
Allen Key 0 BA		2	
„ „ 2 BA		2	
„ „ 4 BA		2	
„ „ 6 BA		2	
„ „ 8 BA		2	
Tension Gauge 10-80 gm.		1	G.E.C.
Tension Gauge 50-250 gm.		1	G.E.C.
Inspection Mirror		1	Dental type
Mirror flat 2" x 3"		1	
Junior Hacksaw		1	Eclipse
Hacksaw blades		6	
File & Handle		1	8" flat, medium.
File & Handle		1	8" x ¼" round, medium
Emery Cloth 3 different grades		12	4 off each, coarse, medium, fine.
Brush 1" paint		1	
Brush round		1	Fitch No.8.
Pliers bent duckbill		2 prs	for relay adjustment
Set of Screwdrivers, Instrument Maker		1	
Plessey Tool Set	65/31725	1 set	CZ54200/z970144 consisting of:-
Adjustable spanner special		1	CZ.53459 Z.970134
Small ring spanner (M)		1	CZ.53700 Z.970135
Small ring spanner (F)		1	CZ.53703 Z.970136

7.8.15 Instruments and Tools (Contd).

Description	Part No.	No. off	Remarks
Medium ring spanner (M)		1	CZ. 53701 Z. 970138
Medium ring spanner (F)		1	CZ. 53704 Z. 970139
Large ring spanner (M)		1	CZ. 53702 Z. 970141
Large ring spanner (F)		1	CZ. 53705 Z. 970142
Small half ring spanner		1	Z. 51908 Z. 970133
Medium half ring spanner		1	Z. 51909 Z. 970137
Large half ring spanner		1	Z. 51910 Z. 970140
Grip Bar		1	Z. 970143
Soldering Iron Stand, Ferranti		1	
Spare Soldering Iron Bits		4	for Item 20.
Vice 2" small		1	
Transportable Container		1	for items sheets 9, 10, 11. Only for spares going abroad.
Snipe nosed pliers (Miniature)		1	
Round nosed pliers (Miniature)		1	
Universal pliers (Miniature)		1	
Side cutting pliers (Miniature)		1	

7.8.16 Spare Packages

Description	Part No.	No. off
Package Type 1	65/20100	8
Package Type 2	65/20101	5
Package Type 3	65/20102	5
Package Type 4	65/20103	4
Package Type 6/42 Digit	65/20105	6
Package Type 6/35 Digit	65/20114	2
Package Type 7	65/20106	2
Package Type 8	65/20107	4
Package Type 9	65/20108	2
Package Type 10	65/20109	2
Package Type 11	65/20110	1
Package Type 12	65/20111	2
Package Type 13	65/20112	2
Package Type 14	65/20113	3
Package Type 15	65/20115	2
Package Type 16	65/22700	3
Package Type 17	65/20117	2
Package Type 18	65/20118	2
Package Type 19	65/20119	1
Package Type 20	65/20120	1
Package Type 21	65/20121	2
Jumper Package	65/75597	1
Knob Assy.	65/20315	1
Calibration Plate (For use with Type 6/42 Digit & Type 6/35 Digit packages.)	65/20317	1

7.9 Major Spares (These items can be supplied as required

Description	Part No.	No. off	Remarks
Transformer H.T,		1	APO.59/1/15[20685/2/TR5]
Transformer Bias supply		1	APO.59/1/15[20685/2/TR4]
Transformer 3ph P400v.S290v. 0.5A		1	APO.59/1/15[20685/2/TR1]
Auto Transf. P420,S220v.	65/33723	1	LDEP528[20685/1/TR2]
Transf. P220, S30, 2A.		1	LDEP540[20685/1/TR3]
Transf. P230, S5.		1	[20685/1/TR6,7]
Transf. P240, S2 x 6.3V.1A 6.3 2A		1	[21959/T1]
Transf. P240,S350-0-350, 6V3A, 5V, 3A		1	LDEP500[21959/T2]
Transf. P400, S100-0-100.		1	LDEP561[21959/T3,4,5]
Transf. P240, S250-0-250, 60mA 6.3V, 3A, 5V, 2A.		1	LDEP501[20699/T1].
Transf. P240,S350-0-350 120mA, 5V, 3A, 6. 3V,3A.	65/32973	1	Parmeko P2516
Transf. P240, S350-0-350 250mA, 5V, 3A, 6. 3V, 3A.	65/32974	1	Parmeko P2518.
Rect. Assy. Type 12L271		1	AP. 59/1/6 [Westalite]
Rect. Assy. Type 12L272		1	AP. 59/1/6 [Westalite]
Rect. Assy. Type 12L255		1	AP. 59/1/6 [Westalite]
Rect. Assy. Type 12L309		1	AP. 59/1/6 [Westalite]
Rect. Assy. Type 2L206		1	AP. 59/1/6 [Westalite]
Rect. Assy. Type 2L147		1	AP. 59/1/6 [Westalite]
Rect. Assy. Type 12L147		1	AP. 59/1/6 [Westalite]
Rect. Assy. Type 4A217		1	AP. 59/1/6 [Westalite]

7.9 Major Spares (Contd).

Description	Part No.	No. off	Remarks
Rect. Assy. Type 4A218		1	AP. 59/1/6 [Westalite]
Rect. HA40.25 1W	65/30793	1	Main PSU. [S.T.C.]
Rect. B18.2. 1W	65/33664	1	Main PSU. [S.T.C.]
Rect. B18.4. 1W	65/30795	1	Main PSU. [S.T.C.]
Grid Type Resistance		1	0.5ohm. 20A. 5ohm 40a. AP059
Resistor 12 ohm 6A.		1	OX6 59/1/17
Resistor 7.9 ohm 7a.		1	OX6 59/1/17
Resistor 6 ohm 10a.		1	DOX4 59/1/17
Resistor 35 ohm 3a		1	OX5 59/1/17
Resistor 1250 ohm 4a.		1	OX4 59/1/17
Resistor 17 ohm 3a.		1	OX4 59/1/17
Condenser 100uf. 400V		1	DC. 59/1/11
Drum speed adjuster	65/23886	1	
Head positioning gauge	65/21360	1	Complete with case.
Isolator Switch		1	APO. 59/1/10
Rotary Switch 2 Pos.		1	Bias SW. APO. 59/1/13
Relay 10V. DC. Coil		1	1 N/O Contact. APO 50/1/13
Moving Coil AC. Relay		1	S54[0/V] APO.59/1/12
Voltmeter Switch [SW1]		1	APO. 59/1/5.
Relay [RL10-11-12]		1	APO. 59/1/4.
Thermal Micro Switch	65/32895	1	Burgess Type BR. 68014
Thermal Trip Switch	65/32895 mod	1	
Relay 1000 ohm 2N/O.		1	Heavy Duty Contact Type 601 906

7.9 Major Spares (Contd).

Description	Part No.	No. off	Remarks
Contactor type D1-15sc+162+ 162		1	Fitted with 2N/C interlocks
Time Delay Switch		1	Tyem. 12. Ref. 668.
Smoothing Choke 0.25H		1	11a. APO. 59/1/15
Smoothing Choke 0.25H, 5A		1	APO. 59/1/55
Smoothing Choke 2mH, 40A		1	APO. 59/1/55
Smoothing Choke 2mH, 30A		1	APO. 59/1/55
Relay Adjusting Kit T.M.C.	65/31724	1	Stock No. S.52700
Potentiometer 6 ohm.	65/32846	1	Cressall RR.300
Potentiometer 9 ohm.	65/32845	1	Cressall RR.300
Potentiometer 26 ohm.	65/32844	1	Cressall RR.300
Motorised Potent. Assy.		1	Type 7226. Ref. 3548
Aux. Actuator [Mot.Pot]		1	Ref. 827
Motor Alternator Set		1	BKB/A9W/ACX10G4/C5G
Bearing for A9W Motor.		1 set	
Bearing for ACX10G4 Alternator		1 set	
Bearings for C5G. Exciter		1 set	
Contacts for Motor Starter		1 set	
Springs for Motor Starter		1 set	
Coil for Motor Starter		1 set	
Timing Relay Coil for Starter		1 set	
Trans. P. 240V, S3. 1V	65/32899	1	S9.3V, S447V, 145mA. [Drum Aux.]

7.9 Major Spares (Contd).

Description	Part No.	No. off	Remarks
Transf. P. 240V, S1 .6V, S5V	65/32900	1	S236V, 35mA. [Power Supply]
Transf. 2KV, 10mA, 6.3V.2A.	65/32972	1	4V, 2A. [Monitor] Parmeko P2561
Choke 5H100Ma.	65/32901	1	Frazer Speller
Choke 5H250Ma.	65/32902	1	Frazer Speller Assy. of PSU Aux. for
Choke 5-15H. 120Ma.	65/32903	1	Frazer Speller drum section
Choke 5-15H. 250Ma.	65/32904	1	Frazer Speller
Choke 10H, 250mA	65/32975	1	Parmeko P.468
Choke 10H, 120mA.	65/32976	1	Parmeko P.459
Rect. H18. 3-1W [interpreter unit]		3	[S.T.C.]
Rect. D18.12.1W.	65/30794	1	[Drum Aux. P.S.U].
* Creed No.25 Reperforator	65/20945	1	& Auto Transf. where required
Tape Reader TR2	65/12110	1	
Computer Drum Assy.	65/21300	2	
Nickel Line Assy.	65/20342 65/20343	12	

* Although supplied with each Reperforator, the transformer has been allocated store No. 65/33103 to facilitate replacement and storage, and it is only required for Mark 1 and Mark 2 Reperforators.

CHAPTER 8

LOG KEEPING

8.1 General

It is essential to keep detailed and accurate records of repairs, replacements and modifications to the computer and its associated equipment; from these records the performance of the computer over a period of time can be determined.

It has been found convenient to make log book entries in code letters representing the activity concerned.

Weekly reports are compiled from the log book entries and at the end of the first year of operation a computer performance report is issued. This report contains summaries of computer performance during both maintained and unmaintained periods of operations, and also analyses of repair time, 'not useful' time, lost time and components used.

8.2 Computer Operators' Log Book

The left hand side of the page is reserved for Engineers' entries; the log-keeper should record daily, in the space provided in the top left hand corner of the page, the readings of the H.T. and L.T. hour meters in the power cubicle.

8.2.1 Fault Serial Number

This enables reference to be made to previous faults.

8.2.2 Engineers' Remarks

This column contains symptom, diagnosis and corrective action. Full details of the fault should be recorded in the Engineers' Log Book.

8.2.3 Package Data

This column is subdivided into:-

(i) Position (of package in computer)

(ii) Type (of package)

(iii) Serial No. (of package) IN

(iv) Serial No. (of package) OUT

(v) Fault. The component fault code (See 8.3) should be used in combination with the component number to indicate the package fault, e.g., R 12/0, V2/E.

(vi) Engineers' Initials.

8.2.4 Time

The time, according to the 24 hour clock, at which the activity that the log entry is concerned with should be recorded in this column.

8.2.5 Activity

A code letter indicating the way in which the time was spent is recorded in this column, according to the following code.

M - Routine scheduled daily maintenance.

R - Fault repair time. (During scheduled operational time.)

E - Engineering. (Major undertakings, not merely scheduled maintenance or fault repair time.)

D - Development of programmes.

P - Production run of fully developed programme.

I - Computer attended and believed serviceable, but not in use due to lack of an operator.

N - Computer switched off and unattended, e.g., during the night or holidays or not in use because of a power cut.

8.2.6 Job Number

The reference number of the computing project or engineering modification on which the computer is engaged should be entered in this column.

8.2.7 Run Serial Number

The serial number of the run, as printed out by the computer, should be entered in this column. It is not necessary to record this number for every run but merely sufficiently frequently for output results to be subsequently related to log book entries.

8.2.8 Time Wasted

If for any reason an activity be abortive, the time wasted is noted in this column, together with a coded indication of the reason, as follows:-

C - Time wasted due to a computer fault.

T - Time wasted due to an incorrectly prepared tape. (Not including programming mistakes during development.)

O - Time wasted as a result of an operator's error.

When following a 'D' or 'P' activity, 'O' covers such contingencies as:-

(i) Pressing the wrong key.

(ii) Dirty tape, not accepted by the tape reader.

(iii) Cigarette ash, fluff or other foreign matter, on the tape readers.

(iv) Output punch running out of tape.

(v) Incorrect operating instructions.

When recorded against an 'R' activity, 'O' indicates that the engineer's time has been wasted in searching for a non-existent fault, e.g., C15, T3, 085 (time recorded in minutes).

8.2.9 Operator's Name

The name of the person operating the computer, if not the person responsible for keeping the log.

8.2.10 Recorded by:-

Initials of the person responsible for keeping the log, being the person responsible for its correctness.

8.2.11 Operator's Remarks

These should be accurate and detailed if they are to be put to any useful purpose.

8.3 Component Fault Code

Symbol	Fault
B	*Back* resistance, low.
C	*Cathode*/heater short circuit.
D	*Down.* Out of tolerance.
E	*Emission,* low.
F	*Forward* resistance, high.
G	*'Gassy'*
H	*Heaters,* open circuit.
I	*Interelectrode* short circuit.
J	*Joint,* dry.
L	*Low* insulation.
M	*Mechanical.*
N	*No* fault.
O	*Open* circuit.
S	*Short* circuit.
U	*Up.* Out of tolerance.

8.4 Engineers' Log Book

8.4.1 General

It is convenient to use a duplicate book for this purpose so that copies are available for the preparation of weekly reports.

Full details of all faults and remedial action taken should be recorded in the book. Meter readings and records of drum track amplitudes obtained in the course of routine testing should be entered in the log book.

8.4.2 Component replacements

The standard abbreviations used to indicate the conditions under which packages or components are removed from the computer are as follows:-

M1 - Testing computer during scheduled maintenance 'off margins'.

M2 - 'Marginal testing' during scheduled maintenance.

M3 - Scheduled package specification checking.

R1 - 'Off margins' during normal scheduled operating time.

R2 - Fault occurring during normal scheduled operating time that is only traceable under marginal operating conditions.

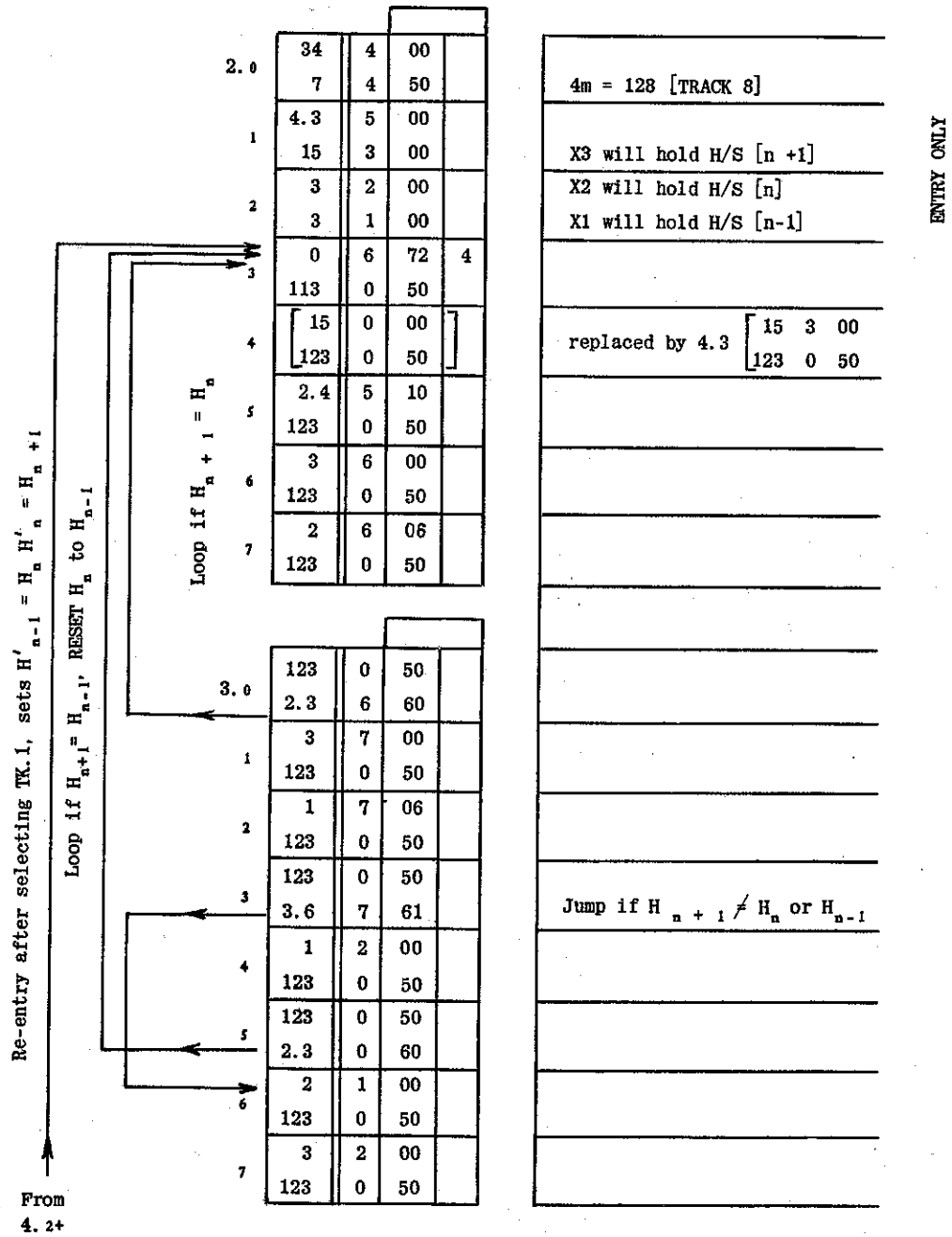
Strict records should be kept of components used so that the spares stock can be maintained at a satisfactory level. A note should be kept of components from the spares stock that are rejected for any reason.

8.5 Pegasus Log Book Analysis Programme

A description of this programme and instructions for its use are contained in the pamphlet List C.S.208 which is obtainable on request.

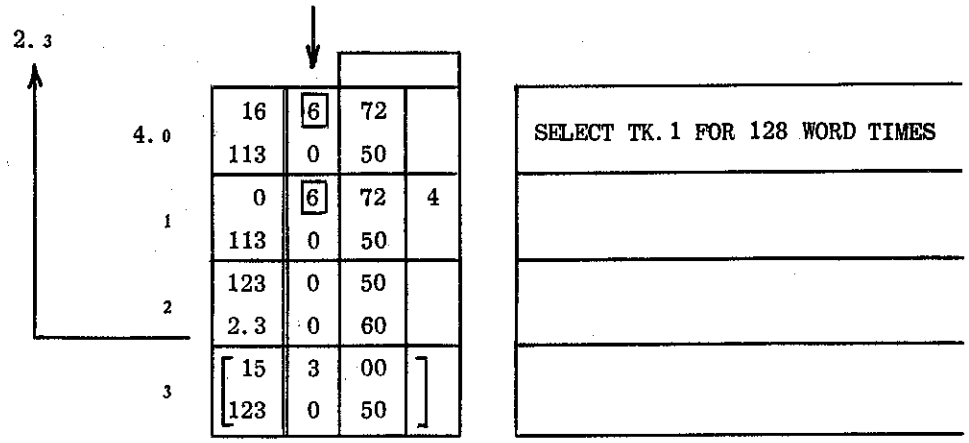
APPENDIX I

'WRITE CLOCK TRACK' PROGRAMME,
[OCTAL 'D'] [R1100]



APPENDIX I

(Continued)



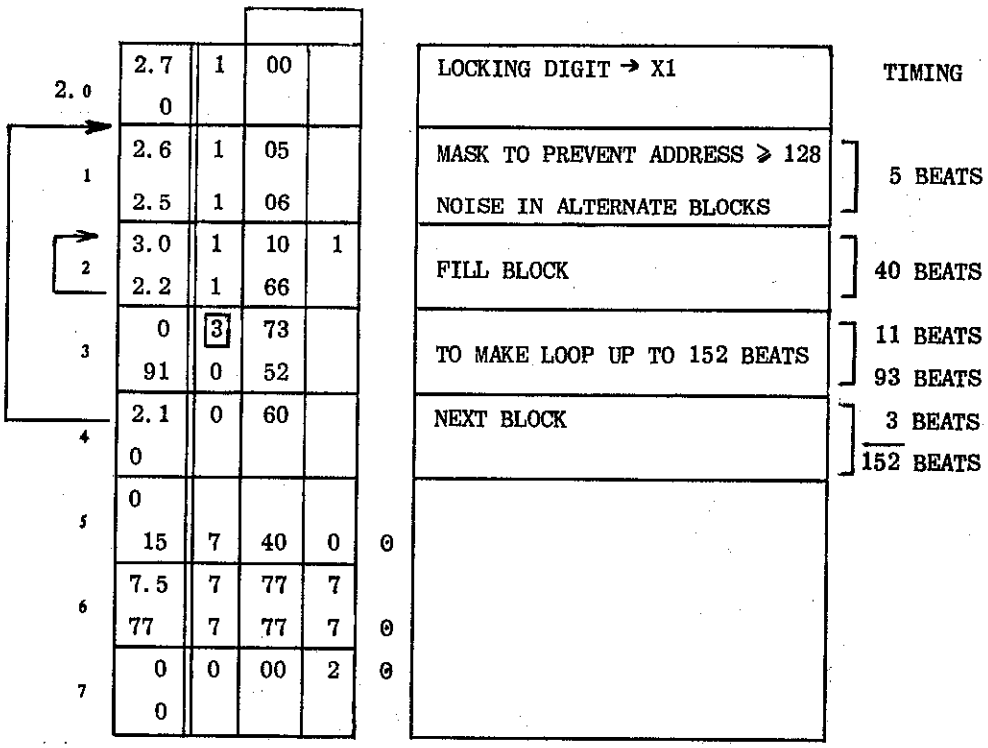
NOTES

1. Use R1120, Octal D, as the input routine. Enter by RUN. The machine will then loop 2.3.....3.0.
2. Use the C beat as a 'once per rev. trigger:' each order pair lasts 128 beats.
3. Do not forget to force permanent coincidence.
4. Any H/S key will act as a 5/5 key, bringing up the track 1 stat. for exactly 128 beats; returning the H/S will have no effect. However, any other H/S will cause the same effect whether the first H/S has been returned or not.

APPENDIX II

'WRITE ADDRESS TRACK' PROGRAMME

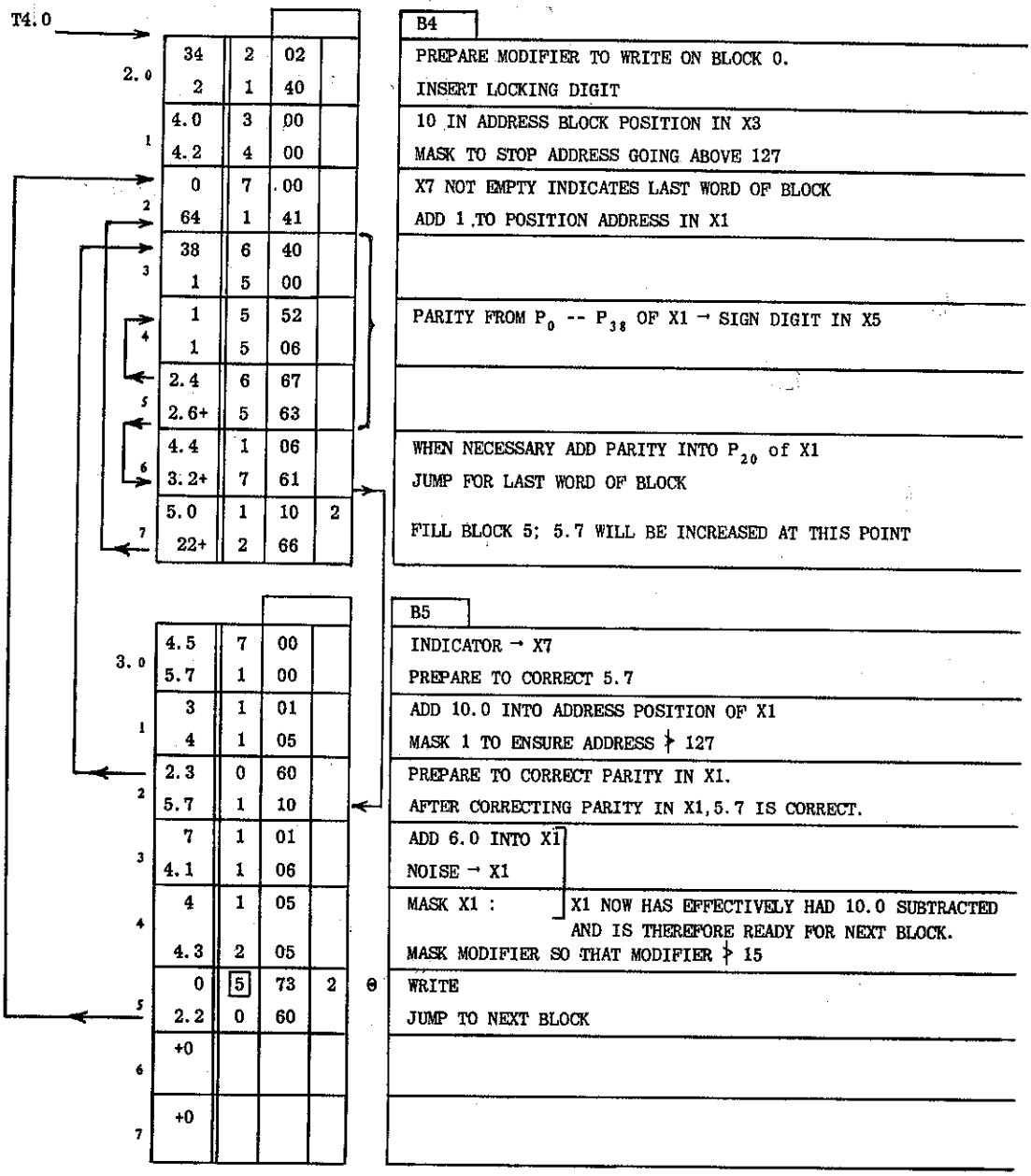
[OCTAL 'D'] [R1101]



APPENDIX III

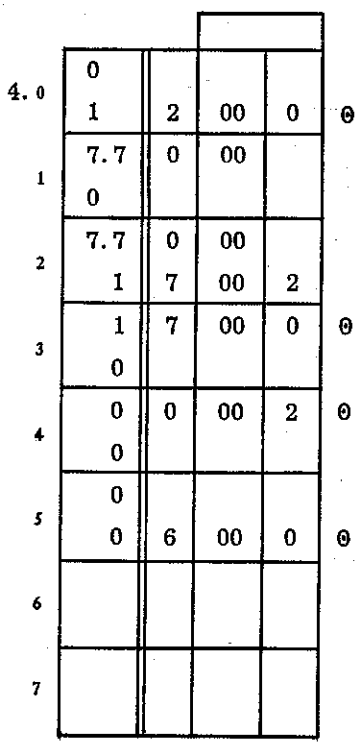
```
T2.0    4   2   72
        5   3   72
        6   4   72
       20   0   60
```

'COPY ADDRESS TRACK' PROGRAMME [R1102]
[WRITES AN ADDRESS TRACK IN
PHASE WITH AN EXISTING ONE]
AVAILABLE IN I.O OR OCTAL 'D'



APPENDIX III

(Continued)



E2.0

APPENDIX IV

DRUM TEST III [TEST NON-ISOLATED STORE] [R1103]

Programme writes a pattern eight times to all blocks and then reads back all blocks in turn. Programme then writes another pattern to alternate blocks, and reads back all blocks in turn until stopped. [Drum parity failure.]

Octal 'D' Form

2.0	34	5	02	
	32	7	00	
1	3.6	6	00	7
	5.0	6	10	5
2	2.1+	[5]	66	
	3.5	3	00	
3	0	5	73	3
	34	3	01	
4	2.5+	7	63	
	34	3	01	
5	1	3	43	
	2.3	3	67	
6	2.7	7	62	
	2.2+	7	66	
7	3.5	3	00	
	0	[5]	72	3

3.0	7	5	06		
	5.0	6	00	3	
1	3.6	6	06	5	
	3.2+	6	60		
2	0	0	77		
	3.0+	3	66		
3	2.7+	3	67		
	2.7	7	62		
4	35	7	00		
	2.1	0	60		
5	0				
	0	1	00		
6	0				
	51	1	46	3	Θ
7	7.6	3	14		
	1.4	0	00		

Initial Order Form

B2

0.0	34	5	02	
	32	7	00	
1	1.6	6	00	7
	2.0	6	10	5
2	0.1+	5	66	
	1.5	3	00	
3	0	[2]	73	3
	34	3	01	
4	0.5+	7	63	
	34	3	01	
5	1	3	43	
	0.3	3	67	
6	0.7	7	62	
	0.2+	7	66	
7	1.5	3	00	
	0	[2]	72	3

B3

1.0	7	5	06		
	2.0	6	00	3	
1	1.6	6	06	5	
	1.2+	6	60		
2	0	0	77		
	1.0+	3	66		
3	0.7+	3	67		
	0.7	7	62		
4	35	7	00		
	0.1	0	60		
5	0				
	0	1	00		
6	0				
	51	1	46	3	Θ
7	7.6	3	14		
	1.4	0	00		

APPENDIX V

COMMISSIONING INPUT

[OCTAL 'D' AND MANUAL WRITING] [R1120]

1. THIS PROGRAMME TO BE INPUT BY "BOOTSTRAP" OPERATION
2. JUMP TO 0.7+ TO TAKE IN A PROGRAMME
3. TO ENTER SUCH A PROGRAMME AT 2.0; 'RUN'

0.0	12	2	41
	7	1	40
1	3	2	50
	0.2+	1	67
2	2	2	53
	16	2	01
3	0.1	0	64
	p.q	2	10
4	0.3	4	11
	16	2	00
5	12	2	43
	0.0	2	63
6	0.4+	2	61
	0	0	77
7	2.0	0	60
	1.2	1	00

→ ENTRY FOR OCTAL INPUT

1.0	0.3	1	10
	64	4	40
1	6	4	50
	0.4+	0	60
2	0.1	0	64
	2.0	2	10
3	15	1	00
	1	1	52
4	20	1	53
	2	1	01
5	p.q	1	10
	0		
6	15	1	00
	1.5	1	10
7	15	2	00
	1.3	0	60

SECTION FOR MANUAL WRITING

0 1. JUMP TO 1.6
SET p.q., 1 10 ON H/S
WHERE p.q is ADDRESS OF WORD
TO BE WRITTEN . . . RUN

0 2. MS HALF OF WORD ON H/S . . . RUN

0 3. LS HALF ON H/S . . . RUN

APPENDIX VI

MODIFIED VERSION OF TP10/11

NOVEMBER 1957

609

0.0	33	5	00	
	85	1	72	5
1	0	2	00	
	15	4	00	
2	15	1	00	
	28	1	53	
3	31	1	45	
	1	4	01	
4	11	1	41	
	0.7	1	63	
5	66	4	72	5
	0.5+	1	60	
6	67	0	72	5
	0.6	0	60	
7	5	1	41	
	1.5	0	60	

597

.0				
1				
2				
3				
4				
5	1.6+	1	63	
	110	5	72	5
6	5.4	0	60	
	119	2	72	5
7	2.6	0	60	
	0			

579

0.0				
1				
2				
3				
4				
5				
6	68	1	72	4
	80	2	72	4
7	90	3	72	4
	100	5	72	4

598

2.0	3.0	6	10	5	
	2.0	5	66		
1	1.0	6	00		
	0.6	6	20		
2	7	6	06		
	6	7	00		
3	3.0	7	06	5	
	2.4+	7	60		
4	0	0	77		FAULT
	2.1	5	66		
5	2.0	2	11		
	2.3	2	11		
6	1.6+	5	67		
	1.5+	1	67		END OF TP. 10
7	77	3	72	4	
	69	4	72	4	

APPENDIX VI

(Continued)

590

1.0	15	1	00	
	1.3	1	61	
1	54	0	72	4
	0.0+	0	60	
2	0.1	3	00	
	0	0	01	3
3	0.7	6	00	
	64	1	40	
4	3	1	50	
	33	2	00	
5	3	2	53	
	76	2	72	4
6	3	5	40	
	1.0	6	10	
7	0.6	6	20	
	7	6	06	

591

4.0	7	6	06	
	0.2	7	00	
1	1	6	06	7
	4.2+	6	60	
2	0	0	77	
	35	7	03	
3	3.6+	7	62	
	0.0	2	00	
4	5	6	00	
	3.1	2	67	
5	1.2	4	00	
	84	3	72	4
6	64	1	40	
	3	1	50	
7	85	4	72	4
	3.0	0	60	

FAULT

599

3.0	64	2	40	
	3	2	50	
1	0.0	2	10	
	0.1	6	10	
2	0.6	6	20	
	7	6	06	
3	34	7	00	
	1	7	53	
4	1	6	10	7
	35	7	03	
5	3.4	7	62	
	34	7	00	
6	1	7	53	
	0.2	7	10	
7	0.1	6	00	
	0.6	6	20	

APPENDIX VI

(Continued)

607

3.0	33	2	00	
	3	2	53	
1	3	5	40	
	5.0	6	10	
2	4.1	6	20	
	7	6	06	
3	0.0	6	10	5
	3.3	5	66	
4	5.0	6	00	
	4.1	6	20	
5	7	6	06	
	6	7	00	
6	0.0	7	06	5
	3.7+	7	60	
7	0	0	77	
	3.4	5	66	

FAULT

608

4.0	3.3	2	11	
	3.6	2	11	
1	3.1+	5	67	
	84	3	72	4
2	3.1	1	67	
	4.3	0	65	
3	15	1	00	
	4.6	1	62	
4	35	4	03	
	1	4	43	
5	68	1	72	4
	1.3+	0	60	
6	88	2	72	4
	2.4	1	61	
7	53	0	72	4
	0.0	0	60	

END OF TP 11
DUMMY

627

1.0				
1				
2				
3				
4				
5				
6	2.5	0	60	
	62	2	70	4
7				

611

2.0				
1				
2				
3	5.6	6	10	
	4.0	0	60	
4	35	1	06	
	2.6	1	61	
5	2.7	4	00	
	102	2	72	4
6	99	5	72	4
	5.3	0	60	
7	0.2	1	00	
	0	0	02	1

APPENDIX VII

PEGASUS - SUMMARISED PROGRAMMING INFORMATION

NOTATION

N	First Address in Order [Register Address]
X	Accumulator Specified in Order
x	Word in X]
n	Word in N] Before Obeying Order
p, q	Words in 6 & 7]
x', n', p', q'	Values after Obeying Order
$[pq]$	$= p + 2^{-38}q$, with $q \geqslant 0$
B	Block in Main Store
U	Block in Computing Store
P	Position-Number of Word in Block
OVR	Overflow-Indicator
x_m	Modifier in X, i.e. Integer Represented by Digits 1 to 13 of x
x_c	Counter in X, i.e. Integer Represented by Digits 14 to 38 of x
$[B.P,\ c]$	Modifier and Counter in One Word

APPENDIX VII

(Continued)

NOTES ON THE ORDER-CODE	
23	Assumes that any overflow is due to operations in 7. Clears OVR unless n' overflows. $q' \geqslant 0$.
56	Either [1] $\frac{1}{4} \leqslant [pq]' < \frac{1}{2}$ and $-1 \leqslant \mu \leqslant N-1$.
	or [2] $-\frac{1}{2} \leqslant [pq]' < \frac{1}{4}$ and $-1 \leqslant \mu \leqslant N-1$.
	or [3] $-\frac{1}{4} \leqslant [pq]' < \frac{1}{4}$ and $\mu = N-1$.
67	There is no carry from x_c to x_m.
74	If $N = 0$, main tape reader selected.
	If $N = 1$, second tape reader selected.

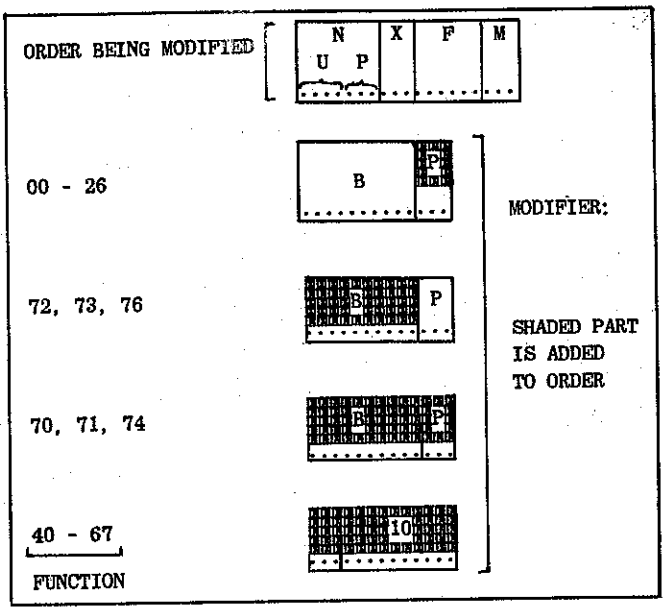
SPECIAL REGISTERS	
15	Handswitches $H0$, $H1$, ..., $H19$
16	Checked Input/Output
	Tape Reader $\rightarrow 16_c \rightarrow X_c$
	$x_c \rightarrow 16_c \rightarrow$ Output Punch
17	Direct Input/Output
	Tape Reader $\rightarrow 17_m \rightarrow X_m$
	$x_c \rightarrow 17_c \rightarrow$ Output Punch
32	-1.0
33	$\frac{1}{2}$ = [512.0, 0]
34	2^{-10} = [1.0, 0]
35	2^{-13} = [0.1, 0]

APPENDIX VII.

(Continued)

TAPE	N		PRINTER	
	17	16	FIGS.	LETS.
.	0	16	FIG. SHIFT	
. o	1	1	1	A
.o	2	2	2	B
.oo	3	19	*	C
o.	4	4	4	D
o. o	5	21	(	E
o.o	6	22	)	F
o.oo	7	7	7	G
o .	8	8	8	H
o . o	9	25	≠	I
o .o	10	26	=	J
o .oo	11	11	-	K
oo.	12	28	ν	L
oo. o	13	13	L.F.	M
oo.o	14	14	Sp.	N
oo.oo	15	31	,	O
o .	16	0	0	P
o . o	17	17	>	Q
o .o	18	18	⩾	R
o .oo	19	3	3	S
o o.	20	20	→	T
o o. o	21	5	5	U
o o.o	22	6	6	V
o o.oo	23	23	/	W
oo .	24	24	x	X
oo . o	25	9	9	Y
oo .o	26	10	+	Z
oo .oo	27	27	LET. SHIFT	
ooo.	28	12	.	.
ooo. o	29	29	n	?
ooo.o	30	30	C.R.	£
ooo.oo	31	15	↓	↓

TELEPRINTER TAPE CODE



HOW VARIOUS ORDERS ARE MODIFIED

APPENDIX VII

(Continued)

00	$x' = n$	40	$x' = c$
01	$x' = x + n$	41	$x' = x + c$
02	$x' = -n$	42	$x' = -c$
03	$x' = x - n$	43	$x' = x - c$
04	$x' = n - x$	44	$x' = c - x$
05	$x' = x \,\&\, n$	45	$x' = x \,\&\, c$
06	$x' = x \not\equiv n$	46	$x' = x \not\equiv c$
07		47	

$c = N.2^{-38}$

10	$n' = x$	50	$x' = 2^N x$	SINGLE-LENGTH ARITHMETICAL SHIFTS
11	$n' = n + x$	51	$x' = 2^{-N} x$ [ROUNDED]	
12	$n' = -x$	52	SHIFT x UP N PLACES	SINGLE-LENGTH LOGICAL SHIFTS
13	$n' = n - x$	53	SHIFT x DOWN N PLACES	
14	$n' = x - n$	54	$[pq]' = 2^N [pq]$	DOUBLE-LENGTH ARITHMETICAL SHIFTS
15	$n' = n \,\&\, x$	55	$[pq]' = 2^{-N}[pq]$ [UNROUNDED]	
16	$n' = n \not\equiv x$	56	$[pq]' = 2^{\mu}[pq]$: $x' = x - 2^{-38}\mu$ [NORMALISE]*	
17		57		

$x' = x$ if $N = 0$

$p' = p$, $q' = q$ if $N = 0$

20	$[pq]' = n.x$	60	JUMP TO N IF $x = 0$
21	$[pq]' = n.x + 2^{-39}$	61	JUMP TO N IF $x \neq 0$
22	$[pq]' = p + 2^{-38}q + n.x$	62	JUMP TO N IF $x \geqslant 0$
23	$[nq]' = n + 2^{-38}q$ [Justify]*	63	JUMP TO N IF $x < 0$
24	$q' + 2^{-38}\, p'/n = \frac{x+2^{-38}q}{n}$ $0 \leqslant p'/n < 1$	64	JUMP TO N IF OVR CLEAR AND CLEAR OVR
25	$-\frac{1}{2} \leqslant p'/n < \frac{1}{2}$	65	JUMP TO N IF OVR SET AND CLEAR OVR
26	$q' + 2^{-38}\, p'/n = x/n$ $-\frac{1}{2} \leqslant p'/n < \frac{1}{2}$	66	$x'_m = x_m + 1$. JUMP TO N IF $x'_m \neq 0$ [mod 8]. [UNIT MODIFY]
27		67	$x'_c = x_c - 1$. JUMP TO N IF $x'_c \neq 0$. [UNIT COUNT]*

30		70	SINGLE-WORD READ TO ACCUMULATOR 1. $x'_1 = s$
31		71	SINGLE-WORD WRITE FROM ACCUMULATOR 1. $s' = x_1$
32		72	BLOCK READ FROM MAIN STORE $u' = b$
33		73	BLOCK WRITE TO MAIN STORE $b' = u$
34		74	EXTERNAL CONDITIONING*
35		75	
36		76	
37		77	STOP [WAIT]

* See previous page, "Notes on the ORDER-CODE"

PROGRAMME FOR PUNCH TEST [TAPE READER AND PUNCH TEST Mk. II].

T2.0

2.0	127	1	40		← ENTER
	17	1	10		
1	2.0+	1	67		
	63	1	40		
2	17	0	10		
	2.2	1	67		
3	0	0	70		
	3.6	5	00		
4	1	5	70		
	5.0	3	00		
5	7	1	40		
	4.7	7	00		
6	15	6	00		
	2.7+	6	63		
7	4.7	7	20		
	6	4	00		

T3.0

3.0	19	4	53		
	15	4	45		
1	2.3	6	06		
	1	4	43		
2	4.3+	4	62		
	4.3	6	66		
3	15	6	00		
	3.5+	6	60		
4	33	6	05		
	3.6	6	61		
5	2.6	0	60		
	2.7	5	67		
6	2.4	5	00	0	0
	0	1	00		
7	5.0	3	00		
	7	1	40		

T4.0

4.0	16	4	00		
	3	4	06		
1	31	4	45		
	4.4	4	60		
2	15	6	00	0	0
	0.0	6	60		→ EXIT
3	0	0	50	6	
	16	3	10		
4	5	3	53		
	6.1	1	67	5	
5	35	1	01		
	5.0	3	00	1	
6	7	1	41		
	6.1	0	60	5	
7	98	6	42	3	0
	4.1	1	11	7	

T5.0

5.0	10	0	35	3	0 BLOCK
	4.6+	6	67	6	OF
1	7	2	05	5	0 PATTERN
	126	6	72		
2	6	1	04	6	0
	6.1	2	03	3	
3	2	4	31	0	0
	16	3	01	7	
4	1	0	40	6	0
	41	6	30	7	
5	1	1	13	0	0
	2	4	70	1	
6	5	4	11	4	0
	58	0	14	5	
7	8	0	31	0	0
	117	3	56	3	

T6.0

0.0	8	2	72
	9	3	72
1	10	4	72
	11	5	72
2	12	0	72
	2.0	0	60

CONTROL TO ENTER T. R. TEST

APPENDIX VIII

(Continued)

PROGRAMME FOR TAPE READER TEST [TAPE READER AND PUNCH TEST Mk. II]

T8.0

2.0	5.3	7	00		← ENTER
	0	0	74		
1	4.7	5	00		
	16	4	00		
2	15	6	00		
	2.3+	6	63		
3	5.3	7	20		
	6	1	00		
4	19	1	53		
	63	1	45		
5	5.7	6	06		
	1	1	43		
6	5.4+	1	62		
	5.4	6	66		
7	15	6	00		
	3.5	6	60		

T9.0

3.0	1	6	52		
	3.6	6	63		
1	1	6	52		
	3.3	6	63		
2	2.2	5	63		
	2.0+	0	65		
3	2.2	5	62		
	1	0	74		
4	4.7	5	01		
	2.1+	0	60		
5	2.3	5	67		
	3.3+	0	64		
6	5.2	1	00		
	15	7	00		
7	0	4	00		
	0	5	00		

T10.0

4.0	1	0	74		
	17	5	01		
1	0	0	74		
	4.3	7	62		
2	17	4	00		
	4.4+	0	60		
3	16	4	01		
	4.0	1	67		
4	25	5	53		
	5	3	00		
5	4	3	06		
	4.7	3	60		
6	4.2	1	61		
	0	0	77		
7	15	6	00		
	0	1	00		

T11.0

5.0	0.0	6	60			→ EXIT
	2.0	6	62			
1	7	6	06			
	3.7	6	60			
2	2.0	0	60			
	0	0	20			
3	98	6	42	3	0	
	4.1	1	11	7		
4	0	0	50	6		
	1	4	41			
5	16	3	00			
	31	4	45			
6	4	3	06			
	2.5+	3	60			
7	0	0	77			
	2.1+	0	60			

T12.0

0.0	2	2	72		CONTROL TO ENTER PUNCH TEST
	3	3	72		
1	4	4	72		
	5	5	72		
2	6	0	72		
	2.0	0	60		

APPENDIX IX

SUGGESTED PROGRAMME OF PACKAGE SPECIFICATION CHECKING
(BASIC AND TAPE - MODIFIED PEGASUS)
RATE - 4 PACKAGES/DAY

Day	1		2		3		4	
	Position	Type	Position	Type	Position	Type	Position	Type
1	10Y	1	11U	2	11X	6	11H	8
2	11E	1	11P	3	11C	4	11W	2
3	11F	1	12E	2	21L	6	12F	8
4	11G	1	11T	3	11D	4	25P	6
5	11J	1	12U	2	25Q	6	12K	8
6	11Q	1	12C	3	11R	4	10C	12
7	11S	1	12V	2	30D	6	13Q	8
8	11Y	1	12L	3	12G	4	10D	13
9	12D	1	12W	2	30T	6	13U	8
10	12H	1	12T	3	13G	4	10E	13
11	12J	1	13C	2	31Y	6	13V	8
12	12M	1	12Y	3	13H	4	10J	13
13	12P	1	20H	2	32X	6	20D	8
14	12Q	1	13E	3	13J	4	10K	13
15	12R	1	20L	2	33E	6	20Q	8
16	12S	1	13L	3	13W	4	20M	2
17	12X	1	20R	2	33K	6	20U	8
18	13D	1	20C	3	20P	4	10L	12
19	13F	1	20S	2	33L	6	21K	8
20	13K	1	20G	3	21G	4	10M	13
21	13M	1	20T	2	33S	6	22P	8
22	13P	1	20V	3	21R	4	10P	13
23	20E	1	20Y	2	33U	6	22Q	8
24	20F	1	21F	3	22J	4	10Q	13
25	20J	1	21C	2	36L	6	22U	8
26	20K	1	21J	3	22Y	4	10S	12
27	20W	1	21M	2	36M	6	23J	8
28	20X	1	21Q	3	24S	4	10T	13
29	21D	1	21P	2	36R	6	23P	8

APPENDIX IX

(Continued)

Day	1		2		3		4	
	Position	Type	Position	Type	Position	Type	Position	Type
30	21E	1	21V	3	24Y	4	22R	2
31	21H	1	22S	2	36S	6	23T	8
32	21S	1	21X	3	25H	4	36T	6
33	21T	1	22T	2	36U	6	24L	8
34	21U	1	22D	3	26T	4	10U	13
35	21W	1	23C	2	36X	6	24Q	8
36	21Y	1	22W	3	30C	4	11K	10
37	22C	1	23E	2	36Y	6	24U	8
38	22E	1	22X	3	30W	4	11L	10
39	22F	1	23F	2	37C	6	25R	8
40	22G	1	23K	3	31F	4	11M	10
41	22H	1	23H	2	37D	6	25S	8
42	22K	1	23L	3	31M	4	11V	7
43	22L	1	23M	2	37E	6	26U	8
44	22M	1	23U	3	31U	4	23Q	2
45	22V	1	23R	2	37F	6	27L	8
46	23V	1	23W	3	32M	4	13R	7
47	23X	1	23S	2	37J	6	[T] 27M	8
48	24M	1	24K	3	33D	4	13S	7
49	24S	1	23Y	2	37K	6	30G	8
50	24V	1	24P	3	33F	4	13T	7
51	24X	1	24C	2	37L	6	30R	8
52	25C	1	24R	3	33J	4	13X	9
53	25D	1	24E	2	37M	6	31G	8
54	25E	1	24W	3	33M	4	13Y	9
55	25H	1	24F	2	37R	6	31R	8
56	25J	1	25F	3	33T	4	23D	7
57	25T	1	24H	2	37S	6	32C	8
58	25V	1	25L	3	33W	4	24J	2
59	25X	1	25G	2	37T	6	32D	8
60	25Y	1	25U	3	33Y	4	37U	6
61	26E	1	25M	2	37X	6	[T] 32E	8
62	26F	1	26D	3	34G	4	23G	7

APPENDIX IX

(Continued)

Day	1		2		3		4	
	Position	Type	Position	Type	Position	Type	Position	Type
63	26L	1	25W	2	37Y	6	[T] 32G	8
64	26M	1	26G	3	35E	4	24D	7
65	26Y	1	26C	2	38E	6	[T] 32H	8
66	30E	1	26H	3	35U	4	24G	7
67	30H	1	26Q	2	38F	6	[T] 32J	8
68	30K	1	26K	3	36Q	4	27C	20
69	30L	1	26R	2	38J	6	33Q	8
70	30P	1	26P	3	36W	4	27D	18
71	30Q	1	26S	2	38K	6	34E	8
72	30S	1	26W	3	37H	4	26U	2
73	30X	1	26X	2	38L	6	34M	8
74	31D	1	30F	3	37Q	4	27E	18
75	31H	1	27K	2	38M	6	34P	8
76	31K	1	30J	3	37W	4	27F	15
77	31L	1	30M	2	38R	6	34X	8
78	31P	1	30U	3	38D	4	27G	15
79	31S	1	30V	2	38S	6	35D	8
80	31T	1	30Y	3	38H	4	27H	21
81	31W	1	31E	2	38T	6	35L	8
82	32K	1	31C	3	38Q	4	27J	11
83	32R	1	31Q	2	38U	6	35Y	8
84	32T	1	31J	3	38W	4	27R	14
85	32U	1	31V	2	38X	6	27S	14
86	32V	1	31X	3	39H	4	32P	2
87	32W	1	32S	2	38Y	6	28C	16
88	33P	1	[T] 32F	3	39Q	4	39C	6
89	33W	1	[T] 33G	2	39D	6	28D	17
90	34C	1	32L	3	39W	4	28E	16
91	34F	1	34D	2	39E	6	28F	17
92	34K	1	32Q	3	28G	18	28H	16
93	34L	1	34H	2	39F	6	28J	17
94	34Q	1	33C	3	28K	16	28L	17
95	34S	1	34R	2	39J	6	28M	16

APPENDIX IX

(Continued)

Day	1		2		3		4	
	Position	Type	Position	Type	Position	Type	Position	Type
96	34U	1	33H	3	28Q	19	28R	14
97	34V	1	34T	2	39K	6	28S	14
98	34Y	1	33R	3	29C	16	28T	14
99	35C	1	35F	2	39L	6	28U	14
100	35S	1	33X	3	29D	17	35P	2
101	36E	1	35Q	2	39M	6	28V	14
102	36P	1	34J	3	29E	16	28W	14
103	36V	1	35R	2	39R	6	28X	14
104	37G	1	34W	3	29F	17	28Y	14
105	37P	1	35V	2	39S	6	29G	18
106	37V	1	35M	3	29H	16	29J	17
107	38C	1	35W	2	39T	6	29K	16
108	38G	1	35T	3	29L	17	29M	16
109	38P	1	35X	2	39U	6	29Q	19
110	38V	1	36F	3	35G	9	-	-
111	39G	1	36G	2	39X	6	35H	9
112	39P	1	-	-	35J	9	-	-
113	39V	1	36H	2	39Y	6	35K	9