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ELECTRIC FIRES · CONVECTORS · FRIDGE-HEATERS · INSULATION

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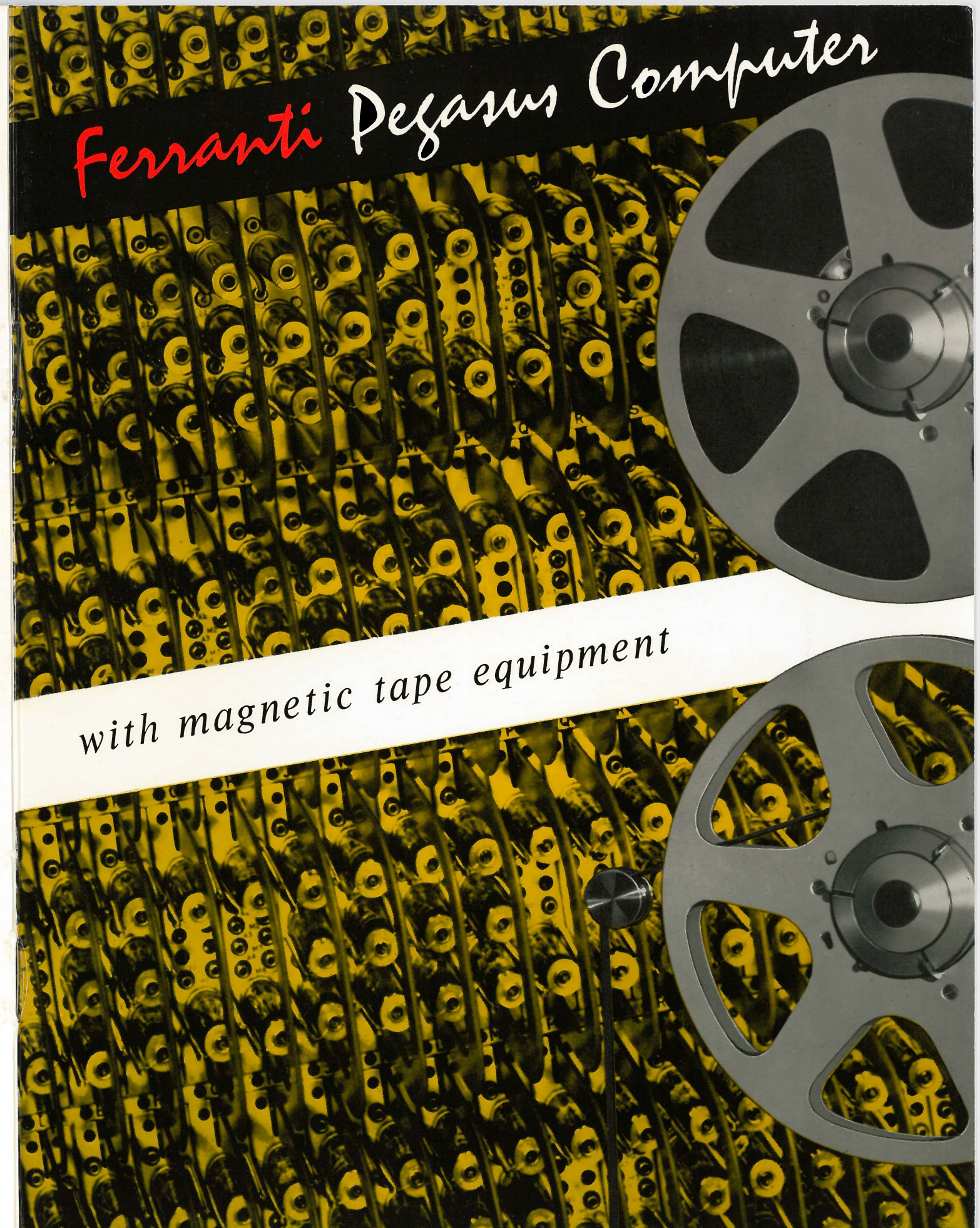

Ferranti Pegasus Computer

with magnetic tape auxiliary equipment

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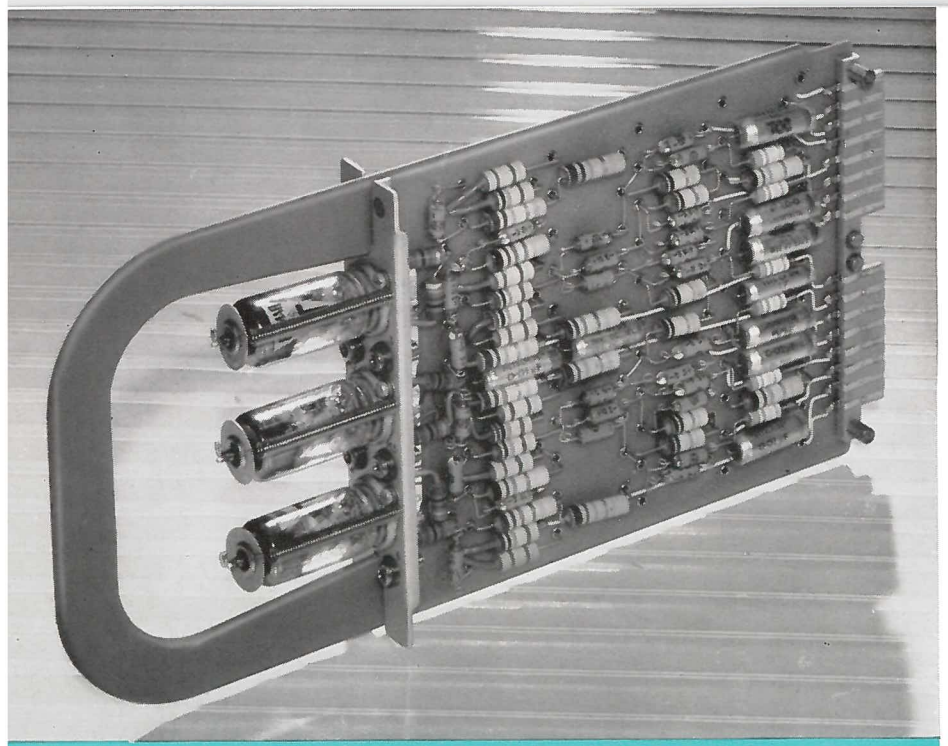
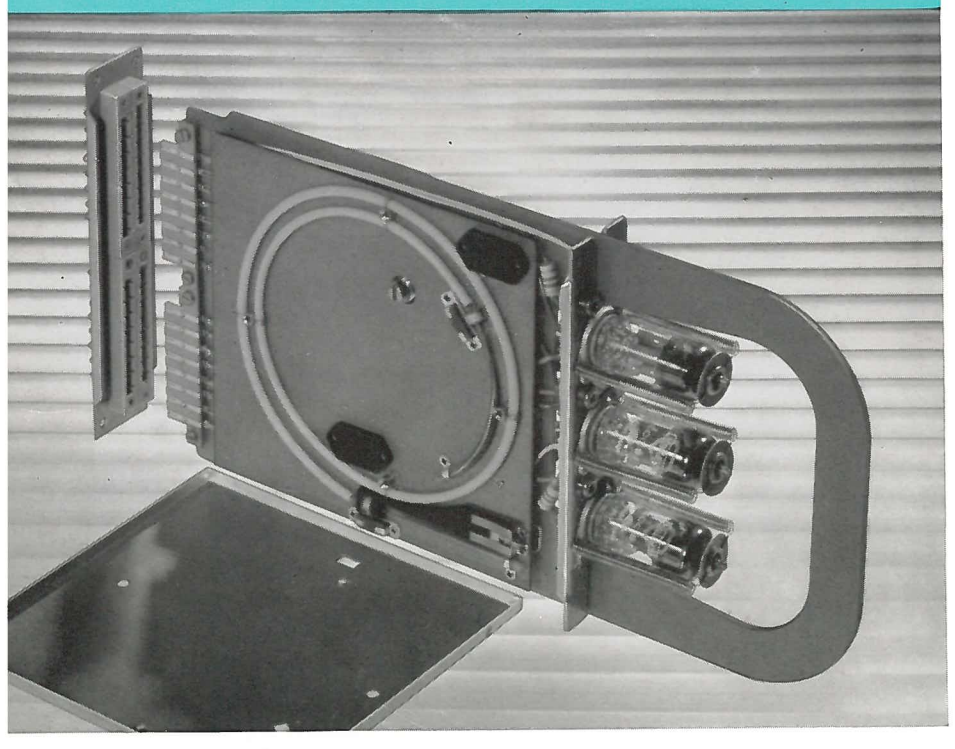
MARCH 1958





One of the main features in the construction of the FERRANTI PEGASUS COMPUTER is the plug-in unit or "package". These standardized packages make for economy of production and ease of testing and maintenance. The lower photograph shows a nickel delay-line package, a group of which form the computing store.

FRONT COVER. The background on the front cover of this brochure shows an array of packages in one of the cabinets of Pegasus.

Ferranti Pegasus Computer

with magnetic tape auxiliary equipment

The Ferranti PEGASUS computer, a medium-sized multi-purpose machine, is now in wide use. With equal ease this machine can solve scientific, industrial or commercial problems. Large enough to cope with a wide variety of calculations, it is nevertheless much smaller than some of the older "giant brains" and is therefore offered at a much lower price. A fast and powerful machine has been produced at moderate cost.

Following the introduction by Ferranti in 1951 of the first commercially available electronic digital computer – the Manchester model – the methods of applying these machines, with their new techniques, to work of industrial interest were intensively studied. It was an outcome of this experience, and the rapid technical developments of recent years, that the main features of Pegasus were determined.

The great advantage of Pegasus is that problems are much simpler and easier to prepare for it than for other computers. Ease of programming has been a foremost consideration in the design. Results are obtained in less time and with less effort.

Pegasus has an unusually comprehensive range of "orders", which define the operations that the machine is able to carry out on the numbers within it. An operation which would often need four or more orders on other computers can be performed in one order on Pegasus. All functions likely to be in frequent use are provided and the operations of the machine correspond as nearly as possible to those which seem natural or obvious to the programmer.

continued overleaf

FERRANTI PEGASUS COMPUTER

It may seem a platitude to say that the machine normally obeys the orders as they are written down. Yet some machines only attain full computing speed when their orders are written down in a sequence entirely different from that in which they are to be obeyed – a tortuous business. This technique of "optimum programming", with all its attendant difficulties, waste of programmer's time and effort is not required for Pegasus. Much work normally done by the programmer is done by the "hardware" of this machine.

Programmes can be prepared and problems solved quickly, an advantage greatest when new problems are to be solved. It is then that an answer is most urgent. But at a later stage this ease of programming has a further value – it makes it simpler to introduce minor changes in a programme to meet some change in the requirements.

Furthermore, Pegasus is now even easier to use. An Autocode has been written for the machine which greatly simplifies its use and speeds the preparation of certain types of problem. This new technique can be grasped in a day or two and problems can be prepared in hours instead of weeks. More people can get quicker solutions by themselves.

Experience has shown that Pegasus is a computer with a high performance. This performance is not due to any one property, but is derived from many aspects of the design of the machine and the technique of using it.

First, it is a fast computer. Not only are its basic operations fast, but complete calculations are carried out unusually quickly, mainly because fewer instructions are needed.

Secondly, it is capable of tackling larger calculations than at first might be expected, because the ease of programming releases the user from unnecessary complexities and enables him to exploit fully the potentialities of the computer.

Thirdly, Pegasus is found to be exceptionally reliable, with little time lost due to faults. Users are accustomed to error-free operation for weeks on end. This results from the high quality of design and manufacture, and the facility for quickly replacing a faulty package by a spare.

Users are finding that Pegasus is a computer on which a large amount of useful and reliable calculation may be done in each day.

The Pegasus computer is manufactured under patent licence from the National Research Development Corporation.

Supplementary Services

Library of Programmes and Subroutines

A comprehensive Library of standard programmes and subroutines is available with the machine to assist the user in preparing his work. Great care has been taken to make these flexible and generally useful. It is believed that this Library is superior to that for any other computer. Specifications of each are available and standard tapes are also distributed to purchasers from time to time. The subroutines, for example, are collected on a Library Tape, which is continually kept up to date. A tape reader can be made to scan the Library Tape and select the subroutines required.

Thus the purchaser saves valuable time in that he can put his computer into useful service immediately on completion of its installation and tests. He does not have to undertake a prolonged investigation to find the best way of using it.

Customer Liaison

As part of their After Sales Service, Ferranti Ltd. arrange for the interchange of information on computing techniques among the users of Ferranti machines. The opportunity exists for each user to circulate descriptions of calculations and programmes of general interest and, reciprocally, thereby benefit from the work done by other users.

Each user of Pegasus benefits by the accumulated experience of all other users; this represents a great capital asset.

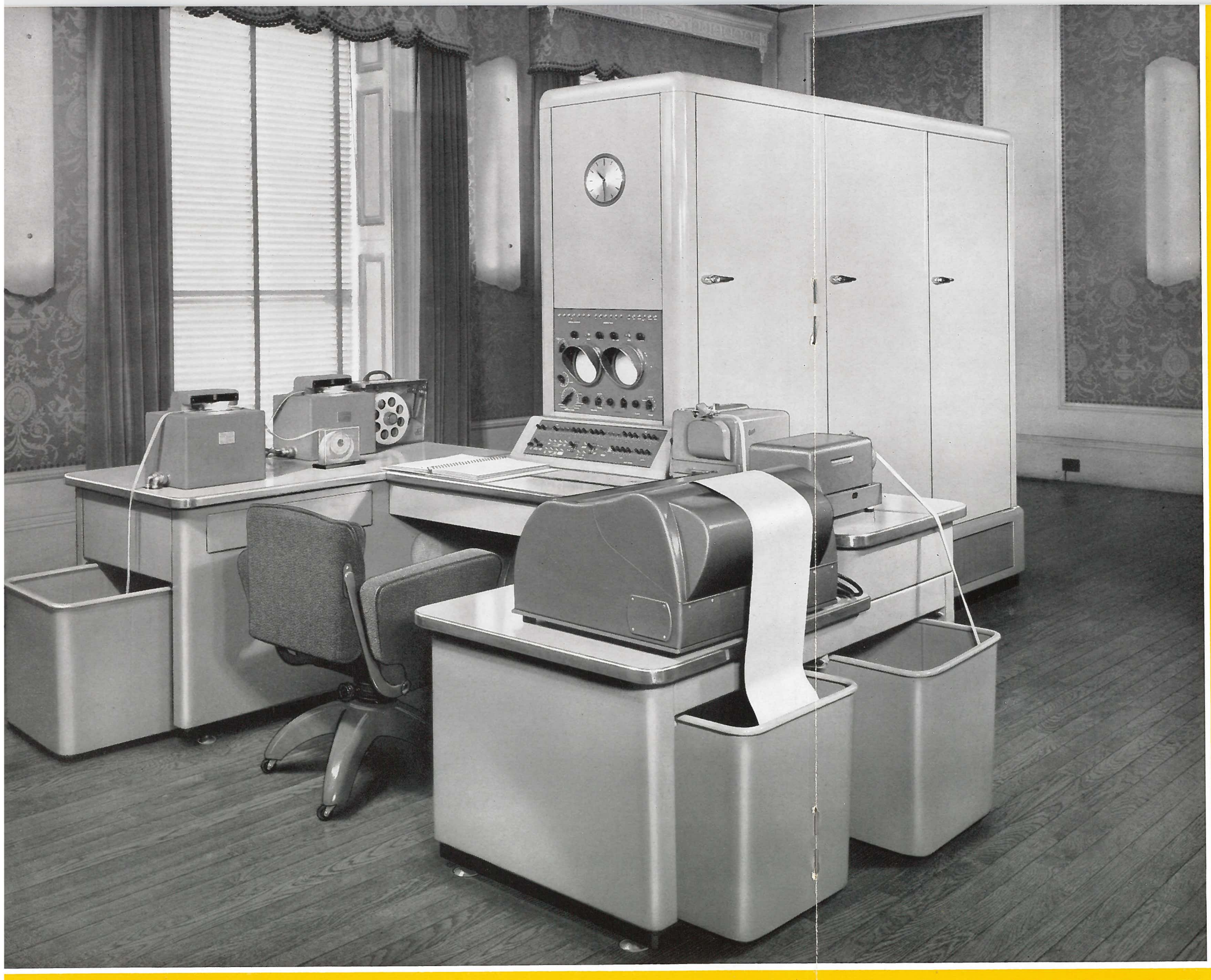
Training of Operators and Engineers

From time to time, training courses for those learning to prepare programmes are arranged by Ferranti Ltd. and the several universities which have installed Pegasus computers. These courses generally last a fortnight, assume no previous knowledge, yet at the end most students are able to write their own programmes and run them on the computer with the initial help of a trained operator.

Instruction manuals are available, covering the writing of programmes, the operation of the machine and its maintenance. Training courses are also held for maintenance engineers.

Performance Tests

It is normal practice for Ferranti Ltd. to put each computer through comprehensive performance tests, both in the factory and after installation in the customer's premises; these may be attended by representatives of the customer and also by an independent authority if required.



Pegasus installed at The London Computer Centre of Ferranti Ltd., 21 Portland Place, London, W.1.

FERRANTI

FERRANTI

PEGASUS

COMPUTER

All operations of the machine are controlled from the desk. Punched paper-tape is the standard means for input and output of information; two high speed tape readers are on the left, and a tape punch and teleprinter for printing the results are on the right of the desk.

Special Features of Pegasus

Arrangement of Stores

Two essentials of a computer are a large information store and quick access to that store. Unfortunately quick-access stores are costly in relation to their capacity. Pegasus meets this economic difficulty by having two stores: a high-speed computing store and a slower large-capacity main store. Information can be readily transferred from one store to the other and very convenient facilities are provided for controlling these transfers.

Immediate-Access Computing Store

The actual computations are carried out in a group of registers or stores, to each of which there is immediate access. These are of the nickel delay-line type, each holding one word. In Pegasus a "word" is either a number or a pair of orders.

Seven of these registers, "accumulators", besides doing normal arithmetic, can be used to modify the addresses of orders and can count the number of times complete repetitive processes are carried out. These multiple accumulators – a single one is usual – greatly simplify and speed the writing of programmes.

The major part of the computing store is made up of 48 registers, a number which when taken in conjunction with the other features of the machine (and the technique of using it) frees the programmer from any limitations. As the programmer is working with a comprehensive range of concise orders and there is a ready exchange of information between the computing store and the main store, little benefit would result from increasing the number of registers.

Other special registers are provided for the input and output of information and for certain simple constants of value to the programmer.

Main Store

The main store is a magnetic drum containing 5120 words, *i.e.* numbers or pairs of orders. Information stored on the drum, both orders and data, is transferred automatically to or from the computing store in blocks of eight words or single words as required for the computation. The speed of revolution is 3720 r.p.m., giving an average access-time of 8 milliseconds. Since transfers are usually in blocks of eight words and there is immediate access within the computing store, the effective access-time to the main store is often only 1 millisecond per word. Particular attention has been given to simplifying the transfer of information between the computing and main stores so that to all intents and purposes for many problems – matrix work or sorting may be mentioned in particular – the programmer has in effect the use of one large fast store.

Written permanently on an isolated part of the drum are the input programme, which enables the machine to recognise and accept information from the outside world, programmes to control output, and checking and test programmes for the programmer and engineer. These storage-locations may be read from but not written into.

Checking Facilities

The self-checking facilities of Pegasus are of great importance.

Some of these are built into the machine. Each register in the computing store and every storage location in the main store has a check digit associated with it. Whenever a register or storage location is used this check will detect whether a binary digit has been erroneously lost or gained, and the computer is stopped. There are also facilities to detect whether the contents of any register have overflowed, or become too large at some intermediate stage in the calculation. The machine will always stop if asked to do something nonsensical.

Other checks are associated with the technique of using the machine, and are brought into operation as instructions or data are taken into the computer, thus picking up any faults which have slipped past the person preparing the work.

The code for the punched holes in the tapes used for both input and output is self-checking, so that errors caused while preparing tapes, or during input and output, are readily detected.

Simplified Operation

Good monitoring facilities are provided making it possible to examine any register in the computing store and to stop on any specified order. Orders can also be obeyed one by one under handswitch control. This simplified operation enables the programmer to follow his logic step by step, an advantage when he is finding his own mistakes in trial runs of his programme.

Input and Output

Orders and data are fed into the machine on punched paper tape, which is read in by Ferranti high-speed photoelectric Tape Readers at a rate of up to 200 characters per second. A character is an arrangement of as many as 5 holes in the tape which represents a number, a letter or a symbol. Two tape readers are used, switching between them being arranged by the programme.

Results are presented by a Tape Punch working at 33 characters per second. This punched paper tape is then typed out by a teleprinter.

Two systems of multi-punch output have been developed. One provides for the use of up to 6 paper tape punches operating simultaneously or independently, and the other system permits the use of 3 independent punches. Selection of punches is under programme control.

A high-speed switching system permits any one of a number of input and output devices to be automatically selected; this is of particular value for certain data-analysing or automatic control applications.

Data-Processing

Provision has been made for the extension of an installation by the addition of other input/output equipment, comprising punched cards and a high-speed line-at-a-time printer, working via magnetic tape equipment. With the computer at its centre, this constitutes the Pegasus Data-Processing System (described separately) intended for large-scale administrative and clerical applications.

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AIRCRAFT ROUTE ANALYSIS

BRISBANE - OAKEY

	MINS.	NAUT. MLS.	FUEL LB.
TAKE-OFF	1	0	60
CLIMB	14	43	738
CRUISE	2	11	115
DESCENT	6	18	66
LANDING	0	0	90
FUEL TOLERANCE	0	0	28
HEADWIND	1	6	63
TOTALS	24	72	1160

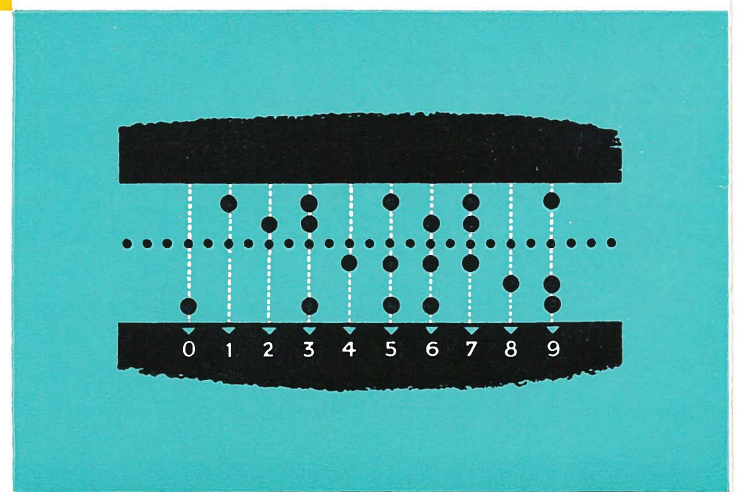
CRUISE HT. 12000 FT. T.A.S. 265 KTS.

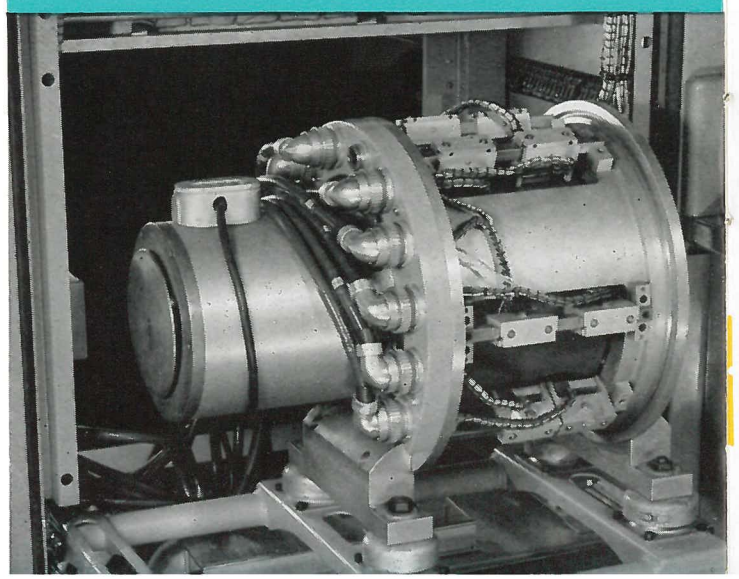
TAKE-OFF WT.	55511 LB.	MAX.	63000 LB.
LANDING WT.	54351 LB.	MAX.	56000 LB.
LESS FUEL	49000 LB.	MAX.	49000 LB.
PAYLOAD	10930 LB.		

E.A.S. 215 KTS. BLOCK SPEED 180 KTS.

A typical sheet of results as typed on the standard teleprinter. Numbers can be laid out in any way required, *e.g.* in columns with the decimal points aligned. Each sheet normally has the date, the title of the programme, column headings and notes all typed automatically.

Data are represented by holes punched in paper tape. The digits 0 to 9 are all represented by rows containing an odd number of holes. This is for checking. If an error has occurred by the omission or inclusion of a hole, the resulting character is not another number but a symbol, *e.g.* a 5 could become an arrow or an oblique stroke. On input the check is made by the computer; on output the error would be obvious.





The Main Store is a magnetic drum which rotates at 3720 r.p.m. The storage capacity is 5120 words – 4096 at the disposal of the programmer and 1024 for the permanent storage of the input/output programmes and checking programmes. Words on the drum are grouped in blocks of eight and transfers to and from the computing store may be either a word or a block at a time.

Specification of the standard Computer

Word Length

39 binary digits; a number consists of 38 digits and a sign-digit (equivalent to 11 decimal digits). Two orders are stored within one word-length.

Digit Time

3 microseconds.

Computing Store

7 accumulators with all the usual arithmetical and logical facilities; each accumulator can be used for modifying the addresses of orders (B-registers) and for counting. 48 immediate-access single-word registers, also capable of addition and subtraction.

7 special-purpose registers.

Main Store

A magnetic drum with a capacity of 4096 words which may be transferred to and from the computing store in blocks of 8 words or a single word at a time. A further 1024 words for the permanent storage of the input routine and checking programmes. The average access-time is 8 milliseconds.

Input

Two tape readers for punched paper tape with a maximum speed of 200 characters per second. Facilities for switching from a number of input devices.

Output

By punched paper tape with a speed of 33 characters per second or typed out at a speed of 7 characters per second. Facility for switching to a number of output devices.

Speed of Operation

Most orders take 0·3 milliseconds to be carried out. Multiplication takes 2 milliseconds, division 5·5 milliseconds.

Checking Facilities

Parity check on every accumulator and register of computing store, and every location of main store. Sensing of overflow in any operation in computing store. Self-checking input and output tape code. Comprehensive checks in input programme.

Testing Facilities

As a marginal testing facility the high-tension voltages may be varied while the machine is running. In this way a faulty component is detected before it fails in normal use. Its position is located with the help of test programmes. A separate package testing unit is available.

Power Requirements

17·5 kVA supplied through a motor-alternator set. The standard supply is 240/415 volts, 3-phase, 50 c/s, but the equipment can be adapted to accept alternating-current supply at any voltage or frequency.

Dimensions

Computer $96\frac{1}{2} \times 25\frac{1}{4} \times 83$ inches ($245 \times 64 \times 211$ cm.) Control Desk $54 \times 99\frac{1}{2}$ inches (137×252 cm.) Power Supply Cubicle $65 \times 25\frac{1}{4} \times 83$ inches ($165 \times 64 \times 211$ cm.)

Transport

The computer may be split up into the desk and 3 cabinets, and the power supply cubicle into 2 cabinets. Most connections between units are by plugs and sockets.

Magnetic Tape Equipment

Introduction

Magnetic tape equipment is available as an optional extra for the Pegasus computer. It may be added to the standard machine at any time.

Magnetic tape gives the user a computer with virtually unlimited storage capacity; it makes it possible to do exceptionally large technical calculations as well as a full range of data-processing operations.

Pegasus with magnetic tape comprises a system with very high performance, and it is ideal for those organizations with both technical and data-processing work to be done.

All programmes written for the standard Pegasus can be run without alteration on a machine fitted with magnetic tape. Many standard programmes exploiting the magnetic tape are available in the Library.

Magnetic Tape

The magnetic tape used with Pegasus is half an inch wide and is supplied in multiple lengths of 600 ft., with a maximum of 3000 ft. in one reel.

Information is stored on the tape in either 16- or 32-word sections. A 3000 foot reel can, for example, hold about 8500 32-word sections (272,000 words) or 10,000 16-word sections (176,000 words); this corresponds to nearly two million alpha-numeric characters on each reel.

Each section is individually addressed, from 0 through to the maximum, so that it can be readily located. These addresses are so placed that any faulty regions of the tape are never used for recording information.

The tape mechanisms have a high performance. Searching (forwards or backwards) for a required address takes place at the rate of 24 16-word sections or 19 32-word sections per second. It takes 5 minutes to rewind a full-sized reel, and any number of mechanisms rewinding simultaneously.

Tape Control Unit

Up to four magnetic tape mechanisms can be linked to Pegasus via a tape control unit (or, if required, 8 tape mechanisms with 2 tape control units). Information is transferred to and from the computing store by means of this unit which contains a buffer store of 32-words.

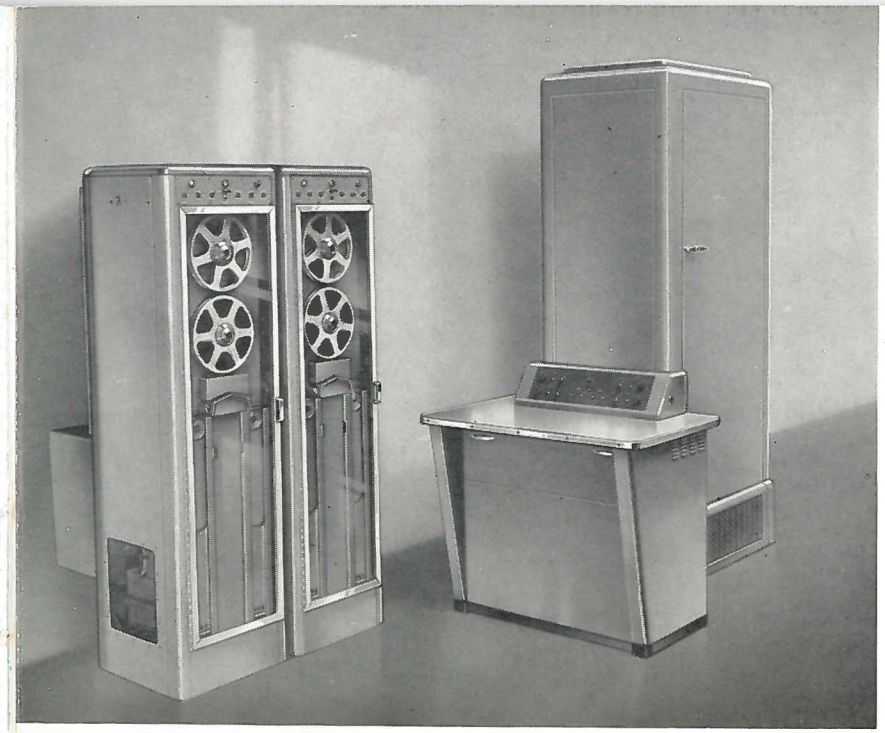
All magnetic tape operations are autonomous:

information can be read from magnetic tape into the buffer store,
or written from the buffer store on to magnetic tape,
or an address on the magnetic tape can be searched for,

while the computer is obeying a programme. In this way there is a great saving of time.

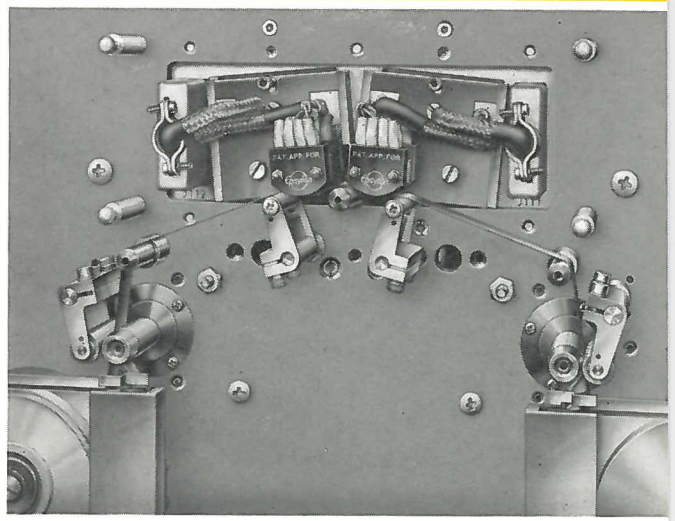
To transfer a 16-word section from the magnetic tape to the buffer store takes 41 milliseconds, a 32-word section 53 milliseconds. But to transfer information between the buffer store and the computing store of Pegasus takes only $1\frac{1}{4}$ milliseconds for each 8-word block – 5 milliseconds for the total contents of the buffer store.

Moreover, the buffer store consists of two independent halves, so it is possible for a 16-word section to be transferred to or from magnetic tape with one half, while in the other a 16-word section is being transferred to or from the computer.



▲ The magnetic tape control unit and two magnetic tape mechanisms. Up to four mechanisms may be connected *via* the control unit to the computer.

A close-up of a magnetic tape mechanism. Information is recorded on the tape with the left-hand group of heads, and immediately checked by the reading heads, the right-hand block. Tape is driven by the lowest rollers shown, which rotate continuously in opposite directions; the tape is pressed against one or other drive roller by a clamping roller mounted on a cranked arm, to give motion in either direction. ▼



Checking

Magnetic tape operations on Pegasus are very comprehensively checked. The aim is to prevent any error from passing undetected, and to stop the equipment immediately there is any fault.

The checks are carried out automatically, in the following ways:

1. The parity check on every word (as used in the computing and main stores) is carried through the buffer store and magnetic tapes. This checks against the loss or gain of any one binary digit.
2. As each section is recorded on the magnetic tape, a check sum is formed by the electronic circuits and automatically recorded at the end of the section.
3. Immediately after recording on magnetic tape, the information is read back again and the check sum automatically verified. This ensures that all information is put on the tapes correctly.
4. On reading from magnetic tapes a check sum is again formed automatically and compared with that previously recorded. This ensures that there are no reading errors.